

UNIVERSITY OF OXFORD

TURKISH CONSUMPTION AND SAVING

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ABSTRACT

The principle aim of this thesis is to construct a consumption function for Turkey for policy analysis using the annual State Planning Organisation (SPO) time-series data. This study commences from 1962 and extends until the end of 1994, when a financial crisis occurred in Turkey. It attempts to analyse not only the decline in the private savings rate during the first half of the 1980s, but also the significant rise from 1986 onwards.

The thesis starts with an introduction which explodes the main research objectives, considers the existing consumption theories and extensions, records the main data features to be explained, briefly overviews the modelling strategy and discusses the basic considerations of the research and gives the structure of thesis.

A literature survey on the theory of consumption is given in Chapter 2. The Life-Cycle/Permanent-Income hypothesis is considered as central to the two mainstream approaches: the Euler approach and the solved-out approach. These approaches are further extended by considering uncertainty and precautionary saving, credit restrictions, saving and leisure, habit or costs of adjustments and the durability of goods, the role of assets and asset prices, financial liberalisation and demographic factors. Finally, comparisons between the two approaches are made in the conclusion of that chapter.

Theory can deliver concepts with permanent relationships in economics, but it should be supported by empirical findings, since theory alone is insufficient to determine the actual economic relationship. Hence, Chapter 3 focuses on theoretical and applied modelling issues to construct a theory-consistent, congruent and encompassing consumption function. Congruency implies that the empirical model matches the available evidence in all measured attributes (i.e., it is consistent with the theory from which it was derived, has unexplained components that are innovations against available information, has basic parameters that are constant, is data admissible, and where any conditioning variables are weakly exogenous for the parameters of interest). Encompassing denotes that the model of interest can account for the result of rival models of the same phenomena. I also define structure as the set of invariant features of the economic mechanism. A parameter can be structural only if it is invariant for an extension of the sample period (constant), is invariant with respect to changes elsewhere in the economy (regime shifts), and is invariant over extensions of the information set (adding more variables).

Chapter 4 examines the small-sample properties of the statistical methods used by means of Monte Carlo simulations. The informativeness of the data is investigated in an unrestricted Vector Auto-regression (VAR) with small-samples of noisy data combined with a high real growth rate and nominal inflation. This is to see how the relative drift dominates in explaining the informativeness of the data. The Monte results are summarised by using response surfaces to relate the biases to sample size. The ratio of standard deviations to standard errors in each equation is also analysed. The strong

impacts of the system error variances in these response surfaces indicate the importance of high variances in VARs. Furthermore, I found noise, and a function of the signal to noise ratio, and cross-equation correlation had a large impact, but less effect from the relative drift.

Chapter 5 presents an overview of the Turkish Economy, particularly during the sample period, by pointing out the lessons to be drawn from the stabilisation experiments and their effect on the private sector saving decision in Turkey.

The aim of Chapter 6 is to get nominal housing wealth and housing price data from the available data, such as the nominal private disposable income, nominal private investment in the housing sector and the consumer price index, since housing wealth is claimed to be a major determinant of private savings in Turkey.

Chapter 7 aims to reveal the problems of Turkish data by analysing the history of the Turkish National Accounts to construct a data-base for estimating a consumption function for Turkey. GDP by expenditure is constructed from five different sources. Turkish accounting residuals are allocated by applying the linear regression approach. The results show that GDP-by-output is more reliable than the GDP-by-expenditure measure for Turkey.

Chapter 8 is devoted to the time series modelling and evidence. Previous findings on consumption for Turkey have been formulated using conventional econometric techniques with a static estimation methodology within the Permanent Income Hypothesis (PIH). I adopted the equilibrium correction model (ECM) solved-out consumption function approach and tried to incorporate the effects of age, precautionary behaviour in the case of uncertainty, credit constraints, habits or costs of adjustments, and the durability of goods for developing better understanding of private sector savings behaviour in Turkey.

The modelling is based on the dynamic econometric methodology that involves the estimation of a general unrestricted model (GUM), a co-integration and long-run analysis, and the simplification of the GUM to a parsimonious dynamic model that is deduced by applying a sequential testing procedure. The final model is congruent: It matches the available evidence in all measured attributes and forecasts well, has white noise errors and constant parameters, and encompasses the VAR model equation as well as other specifications in previous models. Moreover, the model has a structural interpretation.

The results of the final model reveal strong positive effects of the real interest rate, inflation and inflation uncertainty, a strong negative effect of population aged 15-44, a positive effect after one lag period of the change in the average propensity to consume, which represents the effects of expectations, habits or adjustment costs, in addition to the significant effects of the inverse of *per capita* Private Disposable Income and the change in housing wealth to income ratio on the private average propensity to consume in Turkey. These findings offer an explanation for the salient features of the Turkish consumption pattern observed from the time series data.

These results also provide some policy implications such that inflation control should be strengthened and improved for consumption stabilisation. Furthermore, interest rate policy also has an important role to play in the savings process in Turkey.

The research on small-sample properties of the statistical methods by means of Monte Carlo Simulations strengthens the results of the empirical model. These, confirm

the poor determination of intercepts in I(1) VARs, and the corresponding advantages of an equilibrium correction model formulation. Furthermore, the insignificance the of irrelevant dynamics should encourage model builders to use a dynamic econometric methodology to develop parsimonious models, such as used for building a consumption model for Turkey in this thesis.

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Chapter 1:

INTRODUCTION

1. RESEARCH OBJECTIVES

The principal aim of this thesis is to conduct an econometric analysis of aggregate private consumption for Turkey for the period 1962-1994. The modelling not only aims to explain the large drop in the average propensity to consume in the late 1980s, but also to develop and estimate a congruent and encompassing econometric model which will be constant as well as having reasonable forecast performance and innovation errors. Previous studies of Turkish Consumption have been formulated using conventional econometric techniques within the theory of the permanent income hypothesis. The main contribution of the thesis is that the econometric model of the Turkish Consumption in this thesis is based on an extension of existing consumption theories, modelled using a dynamic econometric approach. These are the basic considerations and constitute the basic strategies for the research in this thesis.

Due to data availability, total private consumption - which involves durable as well as non-durable expenditure - is the subject of the study. This delivers different results as compared to the analysis of non-durable expenditure, especially in terms of responses to interest rates and inflation. Income data is also total private disposable income which involves firms as well as households.

Although we have thirty-two years of annual data for the econometric model, the sample size is only one of several factors which determine how much information in the sample, as shown in Chapter 4. This is another important contribution of the thesis.

2. EXISTING CONSUMPTION THEORIES AND EXTENSIONS

Aggregate private consumption accounts for a large share of GDP, and thus the fluctuations in consumption behaviour have crucial consequences for output, employment and the business cycle. Furthermore, it is impossible to understand the transmission of economic fluctuations, or the way in which fluctuations can be moderated, without an understanding of the determinants of aggregate consumption. Therefore, a study of a consumption function, especially for a developing country, can have important implications for policy analysis.

Consumption functions are empirical models which explain the behaviour of consumption with relationships between consumer spending, income, wealth, assets, interest rates, *etc.* Pioneering work on consumption functions was initially done by Friedman (1957), Ando and Modigliani (1963), Ball and Drake (1964), Spiro (1962), and Stone (1964). At the micro level, these relationships are a solution to an optimisation problem over an individual's life cycle (LC), resulting in some version of the LC (Modigliani and Brumberg, 1954, 1979) or permanent-income hypothesis (PIH) (Friedman, 1957). These are sometimes called 'solved-out' or 'structural' consumption function. Since 1978, another way of modelling consumption has been the 'Euler equation' form (see, Hall 1978).

Under the usual assumptions of life-cycle theory, the target level of real consumption C^* is proportional to real life-cycle wealth W :

$$C^* = A(r)W \quad (1.1)$$

where the factor of proportionality $A(\cdot) > 0$ depends on the long-run real rate of return, r . W consists of financial and physical wealth H , and human capital defined as the discounted present value of current and expected future real non-property income Y_n . If Y_n were a random walk with constant drift, then for an infinitely lived consumer, when $r > g$, $W = H + Y_n / (r - g)$ where g is the long-run growth rate of Y_n . To obtain a log-linear functional form for consumption, we use the approximation

$$\ln W \approx y_n - \ln(r - g) + (r - g) \frac{H}{Y_n} \quad (1.2)$$

where lower-case letters denote logs, so that the linear combination of y_n and H/Y_n proxies $w = \ln W$. From (1.1) and (1.2)

$$c^* = \beta_0 - \beta_1 r + \beta_2 y_n + \beta_3 \frac{H}{Y_n} \quad (1.3)$$

where β_0 depends on g .

Equation (1.3) omits five potentially important influences on consumers' behaviour: (a) income uncertainty; (b) credit constraints; (c) demographic changes; (d) liquidity; and (e) dynamics.

The thesis discusses the roles of these in the context of the Turkish economy. We first record some of the main data features to be explained.

Although, the consumption-to-income ratio had been relatively stable in Turkey until 1985, the late 1980s saw a huge drop in this ratio, which stabilised in the 1990s.¹ Developing an understanding of the drop that occurred in the late 1980s is an important purpose of this thesis. One factor behind this development is attributed to the housing boom that started after 1985 with the help of subsidised credits, particularly to housing co-operatives. The availability of low-cost housing credits stimulated housing starts, and this process in turn encouraged savings. Wealth effects, especially those from housing wealth which have arisen since 1987, are significant in the consumption function for Turkey; these have been left out in much of the literature on the Turkish consumption function. Apart from wealth effects, the decline in consumer expenditure in Turkey can be explained by demography, changes in uncertainty, precautionary reasons and the direct effects of financial liberalisation. Financial liberalisation in 1980 raised both credit demand and interest rates, as credit rationing was used less to curtail demand. Empirical studies find small negative effects of interest rates on consumption as opposed to the textbook idea that higher interest rates raise the saving rate, but these negative effects are generally not very stable when re-estimated over different samples. This study empirically investigates the effect of interest rates on Turkish consumption, especially for the period after 1980 when financial liberalisation took part. The Turkish economy entered a process, starting in the early 1980s, in which inflation became a chronic problem. The average annual inflation rate was 80%, and was very volatile, and the trend was upward. Although inflation is not an argument of the theoretical consumption function, it is significant when added to the empirical function, so is incorporated into the

¹ While C/Y has remained within the range 0.73-0.92, and hence C is highly correlated with Y , the ratio C/Y in Turkey has dropped substantially over the last thirty years.

consumption function, with the coefficient determined by the data. It sometimes makes sense to postpone decisions as long as possible so as to take advantage of new information as it evolves. Since Keynes (1936) and Friedman (1957), the propensity to spend out of permanent income is assumed to be a decreasing function of income uncertainty so richer and more realistic models should be able to deal with the way in which expectations of the future are affected by current events. A 3-year moving standard deviation of inflation and income growth are used to take into account inflation and income uncertainty. Demographic effects are also potentially of great importance, in particular the increase in the population of the young (aged 15-44), and the decrease in the relative number of children may have depressed consumption in Turkey. Finally, habits or adjustment costs can cause lags in behaviour.

3. MODELLING STRATEGY

The explicit model design begins from a statistical model corresponding to the Haavelmo distribution, also called the general unrestricted model (GUM). Hence, we started by formulating a GUM that would contain a parsimonious, interpretable and invariant econometric model. In analysing private consumers' expenditure in Turkey, the GUM comprised the current values, and two lags of each of logs of consumption; income; past wealth, involving the decomposition of wealth into housing and financial wealth; interest rates; measures of demographic structure; and inflation. We allowed for everything at the outset that might be significant and then investigated whether and how this initial general model can be reduced without significant loss of information about the parameters of interest. In this process, rigorous testing and evaluation, and some restrictions on the

model are important to ensure valid statistical inference, as described in the dynamic econometric methodology (see, Hendry 1995). The primary role of the GUM is to define the innovation process in the statistical analysis, and to determine the variance of that innovation process such that no other model on the same data dominates. The residuals should therefore be innovations against available information. While the GUM is itself a reduction, it ought to be able to account for all previous results produced when analysing the same data-set, as reviewed in Chapter 3. Economic theory information helps specify the vector of parameters of interest; however, the parameters of interest might come from a data-instigated model. Moreover, theory consistency is essential, so that there is no evaluation conflict between the model and the theory interpretation. Thus a congruent model is the aim of this thesis, which will not only characterise the main features of the consumption-determination mechanism in Turkey, but also will have reasonable performance on goodness of fit and forecasting. The residuals should also be innovations against available information.

4. BASIC CONSIDERATIONS OF THE RESEARCH

A serious concern of this study is the quality of Turkish data. Measurement errors should not be ignored in the econometric analysis of the Turkish economy, even though they are awkward to handle. Chapter 7 is devoted to the analysis of the Turkish National Accounts and the main problems and solutions. The investigation shows that despite the severity of the problem, solutions to the problem exist and this should not prevent us from building econometric models for countries like Turkey, although measurement errors will be larger than in the data for developed countries.

As discussed in Chapter 5, Turkey has been undergoing immense changes over the past few decades. This is a further reason for concern about the lack of invariance of any model to structural, as well as induced, changes in private agents expectations, perhaps making the model vulnerable to the Lucas critique (Lucas, 1976). However, as shown in Chapter 3, the Lucas critique is both confirmable and refutable, by taking account of the joint implications of super-exogeneity tests and encompassing tests. Furthermore, the constancy of the conditional model in Chapter 8 in the face of a changing marginal process entails that agents do not use expectations models to predict future values of the relevant decision variables, because in practice contingent planning dominates forward-looking behaviour.

Although the sample with 32 observations is small given the structure of the system to be analysed, Chapter 4 shows that in terms of the informativeness of the data the sample size alone does not dominate, but the noise, the signal to noise ratio, and cross-equation correlations also matter greatly.

5. STRUCTURE OF THE THESIS

The thesis is divided into nine chapters. Chapter 1 serves as an Introduction, and Chapter 2 provides the theoretical and methodological bases for constructing a consumption function. The underlying theory - the Life-Cycle/Permanent-Income hypothesis - is considered as central to the two mainstream approaches: the Euler approach and the solved-out approach. Various extensions to these approaches are reviewed. Finally, comparisons between the two approaches are made in the conclusion of that chapter.

Chapter 3 summarises the econometric methodology which has been widely used throughout this thesis. The dynamic econometric methodology is adopted for modelling, and the main features of this methodology are explained in that chapter.

Chapter 4 examines the small-sample properties of the statistical methods used by means of Monte Carlo simulations. The informativeness of the data is investigated in an unrestricted Vector Auto-regression (VAR) with small-samples of noisy data combined with a high real growth rate and nominal inflation. This is to see how the relative drift dominates in explaining the informativeness of the data. The Monte Carlo simulations are performed by using a pre-released version of PcNaive. The results are summarised by using response surfaces to relate the biases to sample size. The ratio of standard deviations to standard errors in each equation is also analysed. The strong impacts of the system error variances in these response surfaces indicate the importance of high variances in VARs.

Chapter 5 presents an overview of the Turkish Economy, especially during the sample period, by pointing out the lessons to be drawn from the stabilisation experiments and their effect on the private sector saving decision in Turkey.

Housing wealth is claimed to be a major determinant of private savings in Turkey. However, lack of proper data on this variable makes analysis quite difficult. I used the private housing investment to private disposable income ratio, and the private housing investment to total private investment ratio as approximations and found that neither of them was significant. This forced us to construct housing wealth for Turkey. Hence, the aim of Chapter 6 is to get nominal housing wealth and housing price data from the

available data, such as the nominal private disposable income, nominal private investment in the housing sector and the consumer price index.

Chapter 7 aims to reveal the problems of Turkish data by analysing the history of the Turkish National Accounts to construct a data-base for estimating a consumption function for Turkey. GDP by expenditure is constructed from five different sources. Turkish accounting residuals are allocated by applying the linear regression approach. The results show that GDP-by-output is more reliable than the GDP-by-expenditure measure for Turkey. The experiments and estimations are carried by using Object Oriented Matrix Programming (OX) language and PcGive version 9.0.

Time series modelling and evidence are discussed and in Chapter 8. First, the results of earlier research on the Turkish consumption function are summarised. Then the explanatory variables in the model are described. The general-to-specific approach is adopted in time-series modelling which involves the estimation of the general unrestricted model, the long-run solution or the cointegration analysis, the simplifications of the GUM to a parsimonious dynamic model, and evaluation of the resulting model with various tests. The results of the model with its economic implications, particularly for policy analysis, are discussed and the forecast performance of the model is evaluated. PcGive 9.0 and PcFiml 9.0 software packages are used in this chapter. Comments, discussion and future research are also suggested in this chapter.

The overall results of the thesis are summarised in Chapter 9.

Chapter 2:

THE THEORY OF CONSUMPTION

1. INTRODUCTION

The relationship between aggregate consumption or aggregate savings and aggregate income (generally termed the consumption function) has been investigated since Keynes' General Theory (1936).¹ The study of consumption or savings not only brings an analysis of income but also labour supply, demographics, economic growth and government policy.²

The Keynesian Consumption function³ given by the following equation dominated the early empirical literature of the late 1930s and 1940s.

$$C = \alpha + \beta Y \quad \alpha > 0 \quad \text{and} \quad 0 < \beta < 1 \quad (2.1)$$

¹ For surveys of early empirical studies of consumption function, see Orcutt and Rroy (1949), Ferber (1953) and Suits (1963). For the stylised history of the early econometrics of the consumption function, see Kuznets (1942), Smithies (1945), Haavelmo (1947), Brady and Friedman (1947), Dusenberry (1948), Reid (1952), Friedman (1957), Ackley (1961), Evans (1969, 1984), Timbrell (1976), Sargent (1979), Parkin and Bade (1982), Leighton (1984), Dornbusch and Fischer (1987), Thomas (1989) and Spanos (1989).

² Inaccuracy of the equations can cause huge errors in the predictive power of models. E.g., in the early 1970s equations relating consumption solely to income failed to predict the increase in the saving ratio that occurred with the rise in inflation. Thus, the success of a policy of stimulating the economy by reducing inflation depends crucially on the likely response of consumers' expenditure. Also, the choice between alternative demand injections will be influenced by the properties of consumption functions. The assumed consumption reaction of the economy is also important in the routine assessment of fiscal policy.

³ A simplified version of Keynes' theory of the consumption function known as the Absolute Income Hypothesis (AIH) could be summarised by the following four propositions:

- i) Real consumption is a "stable" function of real income, i.e. $C=f(Y)$.
- ii) $0 < MPC < 1$, where $MPC = \left(\frac{\partial C}{\partial Y}\right)$ - The Marginal Propensity to Consume.
- iii) $APC > MPC$, where $APC = \left(\frac{Y}{C}\right)$ - The Average Propensity to Consume.
- iv) The proportion of income consumed decreases as income rises, i.e. $\frac{\partial[(C/Y) / \partial Y] < 0$.

Until the late 1940s, equation (2.1) was a reasonable characterisation of the observed data. Despite the theoretical and statistical confirmation of the Absolute Income Hypothesis (AIH), the empirical consumption function ran into various difficulties in the late 1940s. The first problem was that it consistently under-predicted the post war period (1946-1950). The second problem was brought by Kuznets (1942): the average propensity to consume (APC) for the period 1869-1938 was constant, varying between 0.84 and 0.89 in contrast to the implication from (2.1) that it is a decreasing function of Y . The third problem was that the estimates of the marginal propensity to consume (MPC) based on cross section data appeared to be invariably lower than the time-series estimates. Moreover, there appeared to be an upward shift of the estimated consumption functions over time. In view of Kuznets' findings the cross-section evidence was taken to imply an apparent contradiction between the long run (time series over long time) and short run (cross-section and short-time series) empirical results. Kuznet suggests that although there was a proportionate relationship between consumption and income in the long run, in short sub-periods the intercept moved up over time, the so-called 'ratchet' effect.⁴

The subsequent literature of the 1950s and 1960s is commonly interpreted as extensions of the AIH which account for the 'stylised facts'. Therefore, specification of the consumption function was modified in a number ways; to capture the 'ratchet' effect, Smithies (1945) introduced a trend term into the consumption function and Brown (1952) introduced lagged consumption. Duesenberry (1949) analysed the

⁴ By the late 1940s and early 1950s the following problems were considered to be 'stylised facts':

- i) AIH empirical consumption functions were unstable.
- ii) The APC was constant over long periods.
- iii) Short run consumption functions tended to confirm the AIH, but long run estimates seemed to reject it, and
- iv) Cross-section estimates of the MPC were systematically lower than time-series estimates and appeared to shift upwards over-time.

cyclical variations with the Relative Income Hypothesis, in which the ratio of current saving to current income depends on the ratio of current income to past peak income. A theoretical breakthrough came with Friedman's work (1957) Permanent Income Hypothesis-PIH and Modigliani and Brumberg's (1954) Life Cycle Hypothesis-LCH. Thus, the LCH and PIH could be viewed as theoretical specifications which are acceptable reparameterizations/restrictions of a statistically adequate specification. The major difference between the LC and PIH is that the LCH does not require rational expectations which is important later on the thesis. Empirical models based on (2.1) are statistically seriously misleading and so any conclusions based on such models are erroneous. Thus, the apparent paradoxes of the 'stylised history' turn out to be either erroneous interpretations of the evidence or they are easily explainable on statistical grounds.⁵ The under-prediction for the post-war period can be easily explained as symptomatic of the serious dynamic misspecification or the failure of the temporal interdependence assumption. A re-appraisal of Kuznet's findings using the original data reveals that the APC is not constant but growing steadily over the period in question, where the ten year averaging did not 'iron out' the short-run dynamics. However, it is well-known that short-run dynamics and long-run effects are closely interrelated and cannot be separated by transformation of data. Apart from the theoretical advancement over the Absolute Income Hypothesis (AIH) (because of their explicit modelling of the dynamics), the initial success of the empirical models based on the LC and PIH can be explained on statistical grounds as being based on more adequate statistical models.

However, evidence against the equation (2.1) occurred much earlier. Much of the early work was conducted by economists who had experience working with cross-

⁵ Spanos (1989) argues that the inadequate attention paid to the question of statistical adequacy which is largely responsible for the proliferation of misspecified empirical models that are used to draw misleading conclusions.

sectional data on family expenditure studies. Their awareness of the complexities of family expenditure meant that equation (2.1) never dominated these studies and many of the puzzles that were to be answered by theoretical developments in the mid-1950s were well known in the 1930s. Staehle (1937) included a variable to measure the effects of changing income distribution. The earliest studies of the consumption function in the 1930s and 1940s had a continuity with a tradition of cross-sectional studies of family expenditure, which disappeared with the concentration on aggregate time series data in later years.

Consumption functions are empirical models which explain the behaviour of consumption with relationships between consumer spending, income, wealth, assets, interest rates, *etc.* Pioneering work on consumption functions was initially done by Ando and Modigliani (1963), Ball and Drake (1964), Spiro (1962), and Stone (1964). At the micro level, these relationships are a solution to an optimisation over an individual's life cycle, resulting in some version of the LC (Modigliani and Brumberg, 1954, 1979) or PIH (Friedman, 1957)- 'solved-out' or 'structural' consumption function. Since 1978, another way of modelling consumption has been the 'Euler Equation' form.

The life-cycle model of Modigliani and Brumberg is a corner-stone of post-war economics. The basic idea is that households try to smooth consumption so that workers save in order to spend in retirement. The appropriate basis for a theory of consumption is the theory of intertemporal choice which formalises the trade-off between present and future consumption. One macro prediction from the theory which appears satisfied is the role of wealth effects on consumption. However, cross-section evidence suggests that consumption tends to follow the hump shape of income of the life-cycle more closely than theory implies and that the old do not dissave quite on the scale one might have expected. Also, consumption profiles for economies growing at

different rates are not consistent with the basic hypothesis that consumption at all ages is determined by lifetime resources.

Thus, standard life-cycle permanent income theory seems to be contradicted by empirical evidence: the old save too much, in cross-sections consumption follows income too closely and consumption growth, in theory unpredictable, responds significantly to predictable income growth.

Two benchmark papers on aggregate consumption function were published in 1978; one was Davidson, Hendry, Srba, and Yeo (1978) DHSY, which introduced the notion of 'Equilibrium Correction Model', setting the scene for subsequent work on cointegration of non-stationary time series; and the other paper of that year was Hall (1978). In this paper Hall effectively analysed changes in consumption without asset data; estimated directly from aggregate data, the first-order condition or 'Euler Equation', for an optimal inter-temporal consumption decision by a 'representative consumer'⁶; and adopted the rational expectations approach. Hall showed that, under certain assumptions, the best forecast of next period's consumption was this period consumption - in other words, it had no forecasting value for consumption changes.

Two macro consumption puzzles which have pre-occupied economists in recent years have arisen in the Euler equation form of the life-cycle/permanent income theory. The first is 'excess sensitivity': the fact that the change in consumption which, according to theory, should be unpredictable, in fact responds to predictable income and other predictable variables. Much of consumption research has been concerned with relaxing one or more of the key assumptions that underlie Hall's result to explain why

⁶ Representative agents have two great failings: they know too much and they live too long. However, an aggregate of individuals with finite lives and with limited and heterogeneous information is not likely to behave like the single individual.

consumption growth is forecastable. The second is 'excess smoothness': if aggregate real income follows a random walk or similar stochastic process, then income innovations are permanent and consumption should vary as much as income. In fact, consumption is much smoother: this is the 'Deaton' paradox.

In this chapter, I will analyse the theory of consumption. Section 2 deals with life-cycle hypothesis and a need for modification. Section 3 analyses the consumption function under point expectations and section 4 analyses the consumption function under stochastic income expectations where we obtain Hall's stochastic Euler equation. Section 5 focuses on augmented structural consumption function. Section 6 concludes.

2. LIFE-CYCLE HYPOTHESIS AND A NEED FOR MODIFICATION

The basic idea of the life-cycle model of Modigliani and Brumberg (1954, 1979)⁷, based on inter-temporal utility maximisation, is that households try to smooth consumption over time so that workers save in order to spend in retirement. The theory especially emphasises the role of asset or wealth effects on consumption; and the association of high aggregate saving rates with population and income growth. However, higher expected real *per capita* income growth for given individuals will, if borrowing is

⁷ The life-cycle hypothesis assumes that consumption is determined by the value of lifetime resources, whereas the permanent income theory of Friedman (1957) assumes that consumption is determined by permanent income (average or expected income). If permanent income is taken to be annuity value of life time resources, the two theories are very close. The permanent income theory is concerned with the dynamic behaviour of consumption particularly over the short-run and in relation to income and concerns itself little with the relationship between age, saving and the creation of wealth. Permanent income depends not just on income in one year, but on income over a number of years, therefore it is unlikely to fluctuate much in response to short-term fluctuations in income. Over spans of many years permanent income will look like measured income so that in the long run, consumption will be proportional to income. The permanent income theory also predicts that tax-induced changes in household incomes will only change consumption to the extent that they change permanent incomes so that some types of fiscal policy are likely to be much less effective than would be supposed from their effects on measured income. The permanent income theory assumes that consumption is the annuity value of current financial and human wealth which is consistent with the theory of inter-temporal choice.

possible for the young, result in higher consumption for them, which could partially offset, or even more than offset (for very high growth rates), the higher saving rate which comes from the bigger earning power of the working population. By contrast, the traditional Solow (1956) growth model predicts that exogenous increases in growth make subsequent saving fall, while exogenous increases in saving make subsequent growth rise. They argue that in the steady state, the growth rate of income is determined by the technological growth parameter and it does not depend on the saving rate. In the short- and medium-run, however, there are several different channels through which saving and growth are related, and the sign and magnitude of the correlation between the two is theoretically ambiguous.

Carroll and Weil (1994) try to explain these results by a shock to the discount rate and with a change in the exogenous rate of technological progress. If there are shocks to the discount rate we would expect saving to Granger cause growth, with a positive sign. If there are shocks to the growth rate of technology, then at least in the medium run we would expect growth to Granger cause savings, with a negative sign.⁸

Carroll and Weil (1994) apply the Granger causality test to 22 OECD countries and to a broad sample of 64 countries. At the aggregate level, they show that the periods of high income growth are followed by periods of high savings - growth Granger causes savings but saving does not Granger cause growth. They also show that in high-saving high-growth East Asian countries such as Japan, South Korea, Singapore and Hong Kong, high growth is followed, rather than preceded, by high saving. On the other hand, household data suggests that households with predictably higher income

⁸ However, Kremer (1994) argues that plausible shocks to exogenous variables can cause increases in growth to precede increase in savings. He suggests that shocks to taxes, regulation, the terms of trade or the level of technology can cause growth to Granger-cause savings within the neo-classical growth model. Furthermore, in theory, one way to decide whether increased savings are due to growth under habit formation or to improved investment opportunities would be to look at foreign investment.

growth save more than households with predictably low growth. They suggest that a model which combines liquidity constraints, precautionary saving, habit formation and income uncertainty may provide an explanation for their empirical results. As in the usual life-cycle permanent income hypothesis (LCPIH) framework, uncertainty about future income should significantly reduce the willingness of households to base current spending on expected future income.

The stripped-down life cycle model [see Deaton (1992a) pp.17] predicts that both demographic and productivity growth will generate saving, and that without either there will be no net saving in the economy as a whole. Saving is zero if growth is zero and that saving is a concave increasing function of the growth rate of aggregate income. Saving is done by young people, and dis-saving by the old. If the population is stationary and if the incomes of the young are the same as the incomes of the old were, then saving and dis-saving are equal and opposite. With productivity growth, the young are richer than their parents at that age, their saving is on a larger scale than that of their parents was, and net saving is positive. The faster the growth, the higher the saving rates. Population growth works exactly the same way; if there are more young people than old people, their total saving outweighs the total dis-saving by members of their parents' generation, so that once again there is positive saving in society as a whole. However, if consumption is constant over life, it is possible that young consumers may want to *borrow*, not save, in the early years of their careers. If so, then at rapid enough growth rates, additional growth will *decrease* saving, as higher growth rates magnify early borrowing relative to later payment. If consumers anticipate real growth, then there is again an incentive to borrow against that growth and the borrowing will rise with the growth rate. The general point is that growth will increase aggregate saving if life-cycle saving occurs at earlier ages than life-cycle dissaving. Deaton (1992a)

suggests that inter-country taste variation can explain the correlation between saving and income. Rebelo (1991) finds a positive relationship between the investment share and growth in the long run. Romer (1990) posits that countries with low rates of time-preferences will have high saving and high growth. Deaton and Paxson (1992) find little evidence that household saving can be described as hump-saving. Households save at all ages, the saving rate tends to increase with age. Ando and Kennickell (1987) show that most families save a relatively small portion of their income throughout the period of their active participation in the labour force and after they retire, they dissave very little; keeping their assets more or less at the same level.

Moreover, the stripped-down model recognises old age, but not childhood. The presence of children, by placing an additional burden on young workers, may precipitate borrowing in the early years of the life cycle, and again reduce the postulated effect of productivity growth on saving. Empirically, consumption follows income rather more closely over the life cycle than predicted by the simplest life-cycle models where consumers try to keep planned consumption constant [Carroll and Summers (1991) and Deaton (1992a)]. The variation of needs over the life cycle, especially related to child bearing, is considered to be an important reason for this empirical result. The reason why many young couples, who expect higher earning opportunities later, may not want to borrow, is that they also expect higher expenses, particularly if one of them stops or reduces work for several years to bring up children. We can conclude that if life-cycle saving means saving in late middle age followed by limited dissaving in retirement, then increased growth can be expected to generate increased saving. But the evidence for dissaving in retirement is at best mixed, and if there is borrowing by young consumers, the life cycle effects of growth may be to magnify borrowing, not saving.

Carroll and Summers (1991) consider two otherwise identical economies, one of which has had no income growth for a very long time, namely, the Ivory Coast, while the other has been growing steadily for an equally long time, Thailand. It is found that the Thai consumption age-profile peaks much later in the life cycle than it does for the Ivory Coast. This raises the issue of inter-temporal tastes; without the assumption that the structure of inter-temporal tastes is the same in different countries, the life cycle story delivers no predictions about the effects of saving on growth in an international cross-section.

Clearly, a simple relationship between consumption and income is not a good alternative, if only because annual consumption is smoother than annual income⁹, then it is worth considering hypotheses that link consumption and income over shorter periods rather than complete life cycles. This suggests that simple life-cycle theory is in considerable need of modification. However, the precautionary and habit formation models can reconcile the theory with the evidence, since both tend to depress consumption early in life when income is low.

3. THE CONSUMPTION FUNCTION UNDER POINT EXPECTATIONS

Under point expectations, the individual believes that next period's income will take a particular value rather than a range of values, each with associated probability.

A) The Two-Period Case

In nominal, i.e. current price, terms the period to period budget constraints are

⁹ More volatile quarterly or monthly in agricultural countries; the opposite where agriculture is minor.

$$p_1 c_1 + p_1 A_1 = p_1 y_1 + p_0 A_0 (1 + r_0^*) \quad \text{and}$$

$$p_2^e c_2 + p_2^e A_2 = p_2^e y_2^e + p_1 A_1 (1 + r_1^*) \quad (2.2)$$

where the 'e' superscript indicates expectations, c is consumption, y is non-property income and A is assets, all measured in constant prices, i.e. in real terms.

The pair of nominal, period-to-period budget constraints is converted to real, i.e. constant price, terms by dividing throughout by p_1 and p_2^e respectively. Then, we have

$$c_1 + A_1 = y_1 + A_0 (1 + r_0) \quad \text{and} \quad c_2 + A_2 = y_2^e + A_1 (1 + r_1) \quad (2.3)$$

where r is the 'real' interest rate. The period 1 real interest rate is defined by

$$1 + r_1 = p_1 (1 + r_1^*) / p_2^e \quad (2.4)$$

We find that the real interest rate is approximately equal to the nominal rate minus expected inflation. This says that (assuming no bequests) the discounted present value of consumption equals the discounted present value of income plus the initial asset endowment from last period, augmented by the asset return.¹⁰

When end of period 2 assets, A_2 , are zero because life is not expected to extend beyond 2 period, the full discounted present value form of the life-cycle budget constraint is derived from (2.3) by eliminating A_1 :

$$c_1 + c_2 / (1 + r_1) = A_0 (1 + r_0) + y_1 + y_2^e / (1 + r_1) \equiv W_1 \quad (2.5)$$

which defines life-cycle wealth. Increases in labour income, now or in the future act so as to increase consumption. The size of the effect of changes in current income on current consumption depends on how future income is linked to current income. An increase in interest rate (r_1):

¹⁰ If interest rates have an effect on saving, then there is a direct link between policy, particularly monetary and fiscal policy and economic performance.

- a) Makes future consumption cheaper relative to current consumption, 'The substitution effect'.
- b) Permits more second-period consumption with the same total resources and without cutting first period consumption, 'The income effect'.
- c) If y_2 is positive, reduces the present discount value of total life-time resources, 'The human wealth effect'.

If we assume inter-temporally additive preferences, life-time utility, U , is the sum of the sub-utilities of consumption in each period, discounted using the subjective discount rate, δ . Additivity means that the marginal rate of transformation between two periods is independent of the level of consumption in any other period. Additivity rules out habit formation or the existence of goods such as treats or holidays.

Inter-temporal Optimisation and Consumption Decisions:

$$U = u(c_1) + \{1/(1+\delta)\}u(c_2) \text{ where } u' > 0, u'' < 0 \text{ and } \delta \geq 0. \quad (2.6)$$

This could be optimised by substituting the period-to-period budget constraints (2.3) into the utility function (2.6), optimising with respect to A_1 . At the optimum we find that

$$\partial U / \partial A_1 = (\hat{a}u / \hat{a}c_1)(\hat{a}c_1 / \partial A_1) + (1/(1+\delta))(\hat{a}u / \hat{a}c_2)(\hat{a}c_2 / \partial A_1) = 0 \quad (2.7)$$

Alternatively, if we maximise (2.6) subject to (2.5), using the Lagrangian technique to obtain the same relationship between current marginal utility and next period's planned marginal utility as implied by (2.7):

$$\hat{a}u / \hat{a}c_1 = \{(1+r_1)/(1+\delta)\}\hat{a}u / \hat{a}c_2 \quad (2.8)$$

which is a monotone decreasing function.

The inter-temporal optimisation conditions together with the budget constraint tell us how the consumption levels of an optimising household will evolve over the life cycle. Equation (2.8) links consumption in period (2.2) and (2.3) and so defines a stochastic difference equation that governs the behaviour of consumption over time.

This is the Euler equation, i.e., the first-order condition which says that marginal utility now equals next period's marginal utility, weighted by the ratio of market and subjective discount terms. The simplest and most drastic case of (2.8) comes from assuming that the felicity functions are independent of age. If $r = \delta$ (2.8) becomes:

$$\hat{a}u / \hat{\alpha}_1 = E_t \hat{a}u / \hat{\alpha}_2 \quad (2.8a)$$

The stochastic process governing marginal utility is a martingale; this period's expectation of next period's marginal utility is equal to the current value of marginal utility as indeed are the current expectations of all future values of marginal utility.

When preferences are quadratic:

$$U = -[(1/2)(\beta - c_1)^2 + \{1/(1 + \delta)\}(\beta - c_2)^2] \quad (2.9)$$

where β is the bliss point: $c < \beta$ for non-satiation.

In this case, the Euler equation (2.8) takes the form:

$$\beta - c_1 = \{(1 + r_1)/(1 + \delta)\}(\beta - c_2) \quad (2.10)$$

$$\text{If } r_1 = \delta \text{ then } c_1 = c_2 \quad (2.11)$$

When we substitute (2.11) into the life-cycle budget constraint (2.5) we find **the solved-out or the structural consumption function:**

$$c_1 = W_1 / \kappa_1 \quad (2.12)$$

where the inverse MPC out of assets, $\kappa_1 = 1 + 1/(1 + r_1)$.

When preferences have the Constant Elasticity of Substitution (CES) form:

$$U^{-\rho} = c_1^{-\rho} + \{1/(1+\delta)\}c_2^{-\rho} \quad (2.13)$$

where the elasticity of substitution, $\sigma = 1/(1+\rho)$, $\rho > -1$.

The simultaneous additivity induced by inter-temporal additivity and expected utility implies that the degree of inter-temporal substitutability is inversely related to the degree of risk aversion. In an uncertain world, the substitutability of future consumption for current consumption inevitably increases exposure to risk, and those who are willing to contemplate the former must be willing to face the latter.

The elasticity of substitution, σ , measures how responsive is the ratio of consumption in the two periods to relative prices i.e. to $1/(1+r_1)$.

In this case, the Euler equation (2.8) takes the form

$$c_1^{-1/\sigma} = \{(1+r_1)/(1+\delta)\}c_2^{-1/\sigma} \quad (2.14)$$

Taking logs of the Euler equation (2.14) in this case shows that the planned log-change in consumption is approximately equal to $\sigma(r_1 + \delta)$. Thus, the greater the elasticity of substitution, the greater the reduction in current consumption in order to substitute into higher future consumption when real interest rate rises. Since consumers prefer consumption to be steady over time, an elasticity of substitution certainly below unity, and probably under one-half is likely.

To derive the solved-out or the structural consumption function, take the $-\sigma$ power of (2.14) and combine with the life-cycle budget constraint (2.5) to find that (2.12) holds again, but where

$$\kappa_1 = 1 + \{1/(1+\delta)\}^\sigma \{1/(1+r_1)\}^{1-\sigma} \quad (2.15)$$

For small values of δ and r_1 ,

$$\kappa_1 \approx 1 + [1/\{1+\sigma\delta + (1-\sigma)r_1\}] \quad (2.16)$$

Here, the inverse MPC out of assets, κ_1 , depends on the weighted average of the subjective discount rate, δ , and the market rate, r_1 .

When $\sigma = 0$ and $y_2^e = y_1$, the solved-out or the structural consumption function is:

$$c_1 = \left[\frac{A_0(1+r_0)}{1 + \frac{1}{1+r_1}} \right] + y_1 \quad (2.17)$$

The special case where the elasticity of substitution is zero yields important insights into the effects one might expect the real interest rate to have in a solved-out consumption function. If, in addition, future non-property income is expected to be the same as the present, this results in the solved-out consumption function (2.17). An increase in the real interest rate, r_1 , increases current consumption: effectively, initial assets yield higher returns and consumption rises with the real rate of return. The bigger the initial assets are, the stronger the positive effect of interest-rates on consumption will be. However, this will depend on the growth of income, when growth is low or negative, consumers will start by saving so that higher interest rates will make them better off and increase consumption. With positive growth consumers start off as borrowers and higher interest rates will decrease consumption. If the elasticity of substitution is positive and assets zero, then the interest-rate increase has an unambiguously negative effect on consumption. If preferences are Cobb-Douglas, the elasticity of substitution is unity and initial assets are positive, then consumption will fall and saving will rise in response to an increase in interest rates - the substitution effect outweighs the income effect. With positive assets the overall effect is ambiguous if the elasticity of substitution is below unity, but more likely to be negative with higher elasticity. It is less likely to be positive with a low ratio of assets to income. Since, the ratio of assets to income varies over the business cycle, one should not expect a stable

aggregate real interest-rate effect. An elasticity of 0.5 or less would be consistent with a relatively small and unstable real interest-rate effect in aggregate consumption functions [Deaton 1992a].

Deaton (1992a) argues that except under patently false assumptions, infinitely lived or dynastic households that plan ahead for an infinite future, economic theory does not predict any simple relationship between consumption growth and the real interest rates.

B) The Multi-period Case

Maintaining the assumption of point (i.e. not probability) expectations, the multi-period extension of (2.5) simply extends the utility function (2.6) and the discounted present value of non-property income, often termed 'human capital', to the horizon, T , instead of just to the next period. The Euler equations are the same as in the two-period case, while the solved-out or the structural form of the consumption function maintains the generic form (2.12). It is often assumed that the same real interest rate will persist across periods.

The effects of age on the marginal propensity to consume out of assets:

If the subjective and the market discount rate coincide, and if we have static real income expectations (i.e. $y_2^e = y_1$).

$$c_1 = A_0(1+r_0)/\kappa_1 + y_1 \quad (2.18)$$

The inverse MPC out of assets, for the CES case is the straightforward generalisation of (2.16):

$$k_1 = 1 + a + a^2 + \dots + a^{T-1} \quad \text{or} \quad (2.18a)$$

$$k_1 = (1 - a^T) / (1 - a)$$

where $a = \frac{1}{(1 + \sigma\delta + (1 - \sigma)r)}$.

If $\delta = 0.05$ and $a = 1/1.05$, then

$k(10) = 8.1$

$k(20) = 13.1$

$k(30) = 16.1$

$k(40) = 18$

$k(\infty) = 21$

The effect of age on consumption will operate entirely through κ_1 , the inverse MPC out of assets. This suggests that older people with their shorter time horizons, have a larger MPC out of assets than younger people. Note that the difference between the old and young MPCs rises as the average discount rate falls. For the aggregate consumption function the old/young difference is important because the age distribution of assets will then affect consumption. This issue is central to the question of the effects of *per capita* real income growth on aggregate savings behaviour. An economy with a higher growth rate will generally have a bigger share of wealth held by the young, if the young were free of credit constraints, then with optimistic expectations regarding their future income they would borrow to smooth life-cycle consumption. On the other hand, if the old are heavily invested in illiquid assets, such as equities and land, that may appreciate with economic growth, especially if this growth is partly unexpected.

If we replace the assumption of static real income expectations by the hump profile of earnings, then the smooth nature of the aggregate profile reflects variations over individuals in the age of retirement. Someone at the earnings peak in middle age can only expect lower incomes ahead and will have the lowest MPC out of current earnings. Deaton (1992a) shows that the age profile of saving varies a good deal across

countries. Especially raised saving rates in the years just before retirement indicates that the expected drop in income at retirement clearly has an important influence on saving in the years immediately preceding.

4. THE CONSUMPTION FUNCTION UNDER STOCHASTIC INCOME EXPECTATIONS

More plausible than point expectations about future income is the association of different probabilities with different income level.

i) The Hall Euler Equation Model

If we make expectations explicit in the Euler condition which holds in the multi-period as well as the two period case, gives the result, from (2.8), that marginal utility in period 1 equals the mathematical expectations of the product of the ratio of discount factors $(1+r_1)/(1+\delta)$ and of the marginal utility in period 2.

However, in general, the real interest rate is stochastic and the expectation of the product of two stochastic variables is not the product of the expectations; and, the marginal utility is non-linear in consumption and then the expectation of next period's marginal utility of consumption is different from the marginal utility of expected consumption. Hence, the derivation of an exact analytical solution for consumption, c_1 will be problematic. If, however, we use quadratic preferences in (2.9), this implies that marginal utility is linear in c . Then, the Euler equation is the expectation of the linear equation (2.10), as if expected consumption were known with certainty which implies 'certainty equivalence'. If the market interest rate and the subjective discount rate coincide, current consumption equals the expectation of next period's consumption:

$$c_t = E_t(c_{t+1}) \quad (2.19)$$

where E_t denotes expectations given the information set at t .

$c_{t+1} = E_t(c_{t+1}) + \varepsilon_{t+1}$ where ε_{t+1} is a surprise or innovation error, i.e. is non-forecastable, and shifting time back one period, we obtain:

$$c_t = c_{t-1} + \varepsilon_t \quad (2.20)$$

This is Hall's (1978) stochastic Euler equation which implies that under certain assumptions, the best forecast of next period's consumption is this period's. The change in consumption from t to $t-1$, which is unpredictable at time $t-1$, is straightforwardly related to 'news' about income. New information at t will generally cause the consumer to revise previously held expectations about current and future labour income, so that discounted present value of these expectations will itself change. This is the change in permanent income that is warranted by the news, and it is this that sets the change in consumption. Hence, the disturbance, ε_t summarises the impact of all new information that becomes available in period t about the consumer's lifetime well-being. However, these results say nothing about the variance of ε_t and in particular there is no presumption that it will be constant. Equation (2.20) is not strictly a random walk but a martingale, although the term is often used to describe it.

The assumptions for Hall's hypothesis are:

- i) no credit restrictions or other non-linearities in the budget constraint;
- ii) a quadratic utility function additive over time;
- iii) no habits or adjustment costs;
- iv) non-durable goods;

- v) the subjective discount rate, δ , the same across consumers and, for (2.19), equal to the market interest rate, r ;
- vi) no measurement errors or transitory shocks to consumption;
- vii) the coincidence of the frequency of consumers' decision making with the frequency of the data;
- viii) a constant interest rate; and
- ix) rational expectations.

The consumption innovation is equal to the news about permanent non-property income, defined as that income level which sustained over the life-cycle has the same present value as the actually expected income stream. The restriction imposed on (2.20) by rational expectations is the orthogonality condition on the disturbance term. Income revisions must be orthogonal to (independent of) lagged available information with the implication that consumption growth should not respond to variables anticipated last period.

The Solved-Out or Structural Consumption Function under Rational Expectation Permanent Income Hypothesis (REPIH):

With quadratic preferences and constant interest rate r , stochastic income expectations simply puts the expectations operator, E , in front of the right-hand part of each of the expressions (2.10)-(2.13). Thus (2.13) implies,

$$c_1 = E_1 W_1 / \kappa_1 = [A_0(1+r) + y_1 + E_1\{y_2 / (1+r)\}] / [1 + \{1 / (1+r)\}] \quad (2.21)$$

Permanent non-property income, y^p , for the two-period case:

$$y_1^p [1 + \{1 / (1+r)\}] = y_1 + E_1\{y_2 / (1+r)\} \quad (2.22)$$

Then we have

$$c_1 = E_1 W_1 / \kappa_1 = A_0(1+r) / \kappa_1 + E_1 y_1^p \quad (2.23)$$

Thus, under the REPIH, consumption equals permanent non-property income, y^p , plus a component proportional to assets, A_0 .

ii) Testing the Hall Model and the Excess Sensitivity of Consumption

The orthogonality assumption can be tested by adding variables (dated $t-1$ and earlier) to equation (2.20) and testing for their significance. Hall (1978) found that the change in consumption was independent of lagged income using standard significant levels, but not of lagged stock prices. However, Hall tested these variables one at a time. We could find these variables jointly significant but not individually. Despite his formal rejection of the model, he noted that the additional information contained in stock prices contributed little to consumption growth, therefore the REPIH was a reasonable approximation.

However, so much evidence shows the violation of the orthogonality condition of the REPIH model.¹¹ Davidson and Hendry (1981) find that lagged income, consumption and liquidity measures have significant explanatory power. Consumption responds to predictable changes in income.¹²

¹¹ See also Mankiw (1981, 1982), Glyfason (1981), Blinder and Deaton (1985), Campbell and Mankiw (1991), Molana (1991), Wirjanto (1991), Daly and Hadjimatheou (1981), Bilson (1980), Flavin (1981), Rossi and Schiontarelli (1982), Hansen and Singleton (1982), Johnson (1983), Peck (1983), Muellbauer (1983), Bean (1986), Deaton (1987), Campbell (1987), Quralis (1990), and Attfield, Demery and Duck (1990).

¹² The main reasons for excess sensitivity of consumption are:

- 1) At least some consumers are unable borrow as much as they would like.
- 2) The vitiating influence of transitory consumption and/or mis-measurement of consumption.
- 3) Differences between the planning periods of agents and the frequencies of data available for model testing. If, for instance, data is collected annually but agents make their decisions every six months then there will be a positive correlation between the annual change in consumption and the previous year's change in income.
- 4) Aggregation in the presence of data-processing lags.
- 5) Aggregation over consumers at different points in their life.

Overall, researchers claim to find that changes in consumption exhibit excess sensitivity to anticipated income. However, excess sensitivity is not to the innovation in income, but to the *anticipated* component of income, which, under rational expectations, is already incorporated into lagged consumption.

A correlation between changes in consumption and lagged changes in income can be explained once preferences are modified so as to permit durability or habits.¹³

iii) The Solved-out or Structural Consumption Function and the Persistence of Income

Deaton (1992a) suggests a direct link between excess sensitivity and excess smoothness, the latter being a result of the fact that changes in consumption are not unpredictable.

¹³ If we make each period's utility a function of stocks of durable goods; but maintaining assumptions of quadratic utility and $r = \delta$ then consumption follows a martingale.

If the utility function is $v(\alpha c_t + \beta S_t)$ and

$$S_t = (1 - \theta)S_{t-1} + c_t \quad (1)$$

We have:

$$\alpha c_t + \beta S_t = \alpha c_t + \beta S_t + u_{t+1} \quad (2)$$

$$(\alpha + \beta)\Delta c_{t+1} = \alpha(1 - \theta)\Delta c_t + u_{t+1} - (1 - \theta)u_t \quad (3)$$

$\alpha c_t + \beta S_t$ is a martingale, then we obtain:

$$\alpha c_{t+1} + \beta(1 - \theta)S_t + \beta c_{t+1} = \alpha c_t + \beta(1 - \theta)S_{t-1} + \beta c_t + u_{t+1} \quad (4)$$

$$(\alpha + \beta)\Delta c_{t+1} = \alpha(1 - \theta)\Delta c_t + u_{t+1} - (1 - \theta)u_t$$

Therefore, consumption changes will no longer be serially uncorrelated nor will the change in consumption be uncorrelated with the lagged changes in income, since u_t will be determined by the income innovations. The positive correlation between the change in consumption and the lagged changes in income in the data can be interpreted in terms of habit formation. According to (4), the change in consumption (durable goods and services) displays negative first order auto-correlation. Mankiw (1982) finds that purchases of durable goods and services like non-durables are a martingale. Bertalo and Caballero (1990) has shown how non-convex and asymmetric adjustment costs at the individual level will result in a slow and prolonged adjustment in the aggregate. Caballero (1990) finds that time series of changes in durable purchases show negative auto-correlation over substantially longer periods than a single quarter, a finding that is consistent with the predictions of the adjustment cost models. The data on non-durables and services can be explained with habit formation easier than durability. Blinder and Deaton (1985) show that consumption series has a positive first order autocorrelation which is consistent with habits, with time aggregation or with some combination of the two. If consumers make decisions more frequently than monthly, then time aggregation will induce a positive auto-correlation in consumption changes measured at both monthly and quarterly frequencies.

To find out the size of the response of consumption to current income, the MPC out of current income, under the permanent-income hypothesis, we look at how responsive expected permanent (non-property) income is to current (non-property) income. Under the further hypothesis of rational expectations, this responsiveness depends on the degree of *persistence* in the income process. For instance, if income follows this following process:

$$y_t = \lambda_0 + \phi t + \lambda y_{t-1} + \varepsilon_t \quad (2.24)$$

where ε_t is a random income shock with mean zero and ϕt represents a deterministic trend effect.

When $\lambda = 1$, then is complete persistence: all income shocks, ε_t , translate one-for-one into changes in permanent income. The best estimate of permanent income, y_t^p , is then current income, y_t , plus the discounted present value of any drift term, λ_0 , which then reflects trend-like growth in income. Here, we assume an infinite horizon, if we have shorter horizons then there is greater responsiveness of y_t^p with respect to y_t when λ is less than one. If $\lambda = 1$, ϕ would have to be zero to prevent income from accelerating permanently ($\phi > 0$) or decelerating permanently ($\phi < 0$). When $\lambda = 0$, persistence is zero. The best estimate of permanent income only gives any weight to current income to the extent that, in a finite sample, the current observation is included to derive estimates of λ_0 and the trend coefficient, ϕ . The response of permanent income to current income depends on λ , the interest rate, r , and the length of the horizon.

In practice, it is difficult to distinguish empirically the hypothesis $\lambda = 1$ from $\lambda = 0.95$ and hence to establish the degree of responsiveness, under rational expectations, of permanent to current income.

iv) The Excess Smoothness Debate

If income has a persistent unit root process, then permanent income responds strongly to shocks in current income. Under the Euler equation (2.20), in the absence of transitory consumption shocks or measurement errors, the consumption surprise equals the surprise in permanent income. Thus, the variance of the consumption innovation should be at least as great as that of the current income innovation, if income has a persistent unit root process. However, empirical evidence shows that consumption appears to be excessively smooth, (i.e. insufficiently volatile), for the assumption that income is generated by a difference stationary (DS) process.¹⁴ This is known as 'Deaton's Paradox' [Deaton (1987, 1992a) and Campbell and Deaton (1989)]. Deaton (1987) emphasises the interaction between the time series representation of income and the life-cycle model. If real disposable income can be adequately represented as a first-order auto-regressive process in first differences, then consumption is not sensitive enough to innovations in current income. Thus, the representative agent version of the PIH can be rejected because it fails to predict the fact that consumption is smooth. Deaton also argues that permanent income is noisier than current income so that permanent income theory fails to offer any straightforward and well-supported account of why

¹⁴ Deaton (1992a) shows that if labour income is trend-stationary and de-trended income follows the stationary second order auto-regression, he obtains that:

$$\alpha(L) = 1 - 1.42L + 0.45L^2$$

Changes in permanent income are smaller than innovations in income so that consumption itself does not respond to news about income ($\Delta c_t = \Delta y_t^p = 0.28\varepsilon_t$).

If labour income is difference stationary and its first difference follows:

$$\alpha(L) = (1-L)(1-0.44L) = 1 - 1.44L + 0.44L^2, \text{ then } \Delta c_t = \Delta y_t^p = 1.77\varepsilon_t.$$

Permanent income responds more than one for one with innovations in income which offers a great difficulty in using permanent income theory to explain why consumption is smoother than income. Therefore, he concludes that the length and structure of that data on income are such that it is essentially impossible to infer whether the permanent income theory does or does not offer an explanation for the smoothness of consumption.

consumption is smoother than income. The correlation between the 'excess sensitivity' of changes in consumption to anticipated changes in income accounts for the fact that consumption is excessively insensitive to unanticipated changes in income. If consumption is slow to adjust to innovations in income, changes in consumption are related to averages of previous innovations, thus explaining both the smoothness and the correlation.

The issue of excess smoothness can be resolved by precautionary behaviour, liquidity constraints, habit of consumers and varying interest rates. Aggregation can also explain both excess sensitivity of consumption growth to anticipated income and the excess-smoothness phenomenon.

5. AUGMENTED STRUCTURAL CONSUMPTION FUNCTIONS

5.1. UNCERTAINTY AND PRECAUTIONARY SAVING

Consumption under uncertainty depends on the same variables as consumption under certainty: current and anticipated rates of return and labour income, and wealth. But uncertainty about labour income generally creates an additional precautionary motive for saving. The precautionary motive for saving is consistent with the basic theory of intertemporal allocation, but is ruled out by the certainty equivalence assumption that generates the permanent income model. Liquidity constraints, by contrast, are ruled out by the assumptions in the life-cycle model; they have often been seen as likely culprits for the empirical failures of the model.

Blanchard and Fischer (1989) emphasise the difficulty of solving for optimal consumption analytically in the presence of prudent behaviour. However, Blanchard and

Fischer (1989) and Caballera (1990) derive the effect of income uncertainty on saving analytically under constant absolute risk-aversion and normally distributed income. Thus, approximate analytical results for the traditional consumption function can be obtained by the exponential utility function and its implied constant relative risk-aversion.¹⁵ Higher income uncertainty and higher risk aversion will lead to more prudent behaviour and will prompt a reduction in current consumption, and increase in saving, given income and wealth. However, under constant absolute risk aversion, the marginal utility of consumption is finite at zero consumption, which means that consumption could be negative along the optimal path. Constant relative risk aversion, on the other hand, would rule out negative consumption. Consumers who want to avoid zero consumption when labour income is non-diversifiable will want to exercise extreme prudence and build wealth as a precaution. Then, the dichotomy between the effects of expected income and the effects of uncertainty disappears. On the one hand, the impact of uncertainty depends on the level of wealth, and thus it becomes less important as wealth increases. But, because uncertainty affects the marginal propensity to consume, a large increase in expected income may decrease the need for precautionary saving and lead to a large increase in consumption. Precautionary behaviour in the traditional consumption function implies that income uncertainty is

¹⁵ The utility function is: $U = \frac{1}{\alpha} \exp(-\alpha c_t)$. If the real interest rates are zero, then for a consumer with a finite life ending at calendar date T , and whose labour income follows a random walk with normally distributed innovations with variance σ^2 , the consumption follows a random walk with a drift $(\alpha\sigma^2/2)$.

$$c_t = \frac{A_t}{T+1-t} + y_t - \frac{\alpha(T-1)\sigma^2}{4}$$

Variance in income process tilts the consumption trajectory downward early in life, so that uncertainty generates additional consumption growth, because it induces consumers to postpone their consumption.

approximately equivalent to a certainty-equivalent problem, in which expected income is reduced by a discount factor reflecting uncertainty.

Caballero (1990) shows that once higher moments are stochastic and possibly correlated with income innovations, it is no longer the case that marginal propensity to consume out of current income obtained under a constant absolute risk aversion (CARA) utility function equals that of a certainty-equivalent model. In particular, if labour income and its variance innovations are positively correlated, the marginal propensity to consume implied by a CARA is lower than that of the certainty-equivalent model. Thus, the link between precautionary savings and conditional heteroscedasticity of labour income is potentially able to provide simultaneous explanations for the *excess smoothness* and the *excess sensitivity* of consumption to unanticipated and anticipated labour-income changes, respectively.

Skinner (1988) develops a closed-form multi-period life cycle model of consumption with uncertain interest rates and earnings. The true optimal consumption path is approximated by solving for the second-order Taylor-series expansion of the Euler conditions. Precautionary savings are calculated to be 56% of aggregate savings. The importance of precautionary savings depends crucially on the structure of earnings uncertainty. The closer the earnings process is to a random walk, the greater will be the precautionary savings. Moreover, increasing the measure of risk-aversion in the model to 6.0 increases precautionary savings to 76% of aggregate savings, while reducing to 1.0 leads to only 18% precautionary savings.

Kimball (1990) deals with this in a two-period context, where certainty-equivalent income, y_2^* , is defined as that certain income level which makes second-period marginal utility equal to expected marginal utility, given the probability

distribution of y_2 . Then Kimball shows that $y_2^* < Ey_2$. It can be shown that with the CES utility function and with $A_1 = 0$, $y_2^* \approx Ey_2 / (1 + \sigma \cdot z)$ where z depends on σ (the degree of risk aversion) and on the coefficient of variation of income in period two. For example, with a 10% coefficient of variation and $\sigma = 1/3$, the discount on expected income is 2%. With a 20% coefficient of variation, the discount rises to 8%. For a consumer with debts, i.e. $A_1 < 0$, the discount is bigger, while for a consumer with an initial asset, the discount is smaller. This is called a 'buffer-stock theory of saving', in that a major motive for holding assets is to shield consumption against unpredictable fluctuations in income (Carroll 1992). The unemployment expectations are important because typically the most drastic fluctuations in a household's income are those associated with unemployment. 'Buffer-stock' saving behaviour can emerge from the standard dynamic optimisation framework when consumers facing important income uncertainty are both *impatient* and *prudent*. When consumers become more pessimistic about unemployment, their uncertainty about future income increases, so their target buffer-stock increases, and they increase their saving to build up wealth toward the new target. If future income is more heavily discounted because of uncertainty, then current income must necessarily play a bigger role in determining current consumption. This helps to explain why consumption follows income more closely over the life cycle than simple life cycle theory would suggest. The result is that consumption tracks income. The key is the combination of uncertainty and convex marginal utility. Consumers who have low incomes and low assets early in the life cycle face greater consumption uncertainty in the future than do those with high incomes or high assets and plan to postpone consumption. Such a result in principle accounts for *excess sensitivity*.

It should be noted that the degree of precaution and risk aversion are not the same thing. Risk aversion is controlled by the degree of concavity of the utility function, but the degree of precaution is the degree of convexity of the marginal utility function. Risk-aversion depends on the second derivative of the utility function, and precaution on the third derivative, and it is only for very special functions that one can be inferred from the other.

Zeldes (1994), in his example assumes that individuals have constant relative risk utility functions, face uncertain labour income streams and a riskless technology for borrowing and lending, and are fully optimising. Then he derives the optimal consumption function with a numerical technique. However, the resulting consumption function differs from the common certainty equivalence, especially when the 'certain' component of lifetime resources are small relative to the risky components of lifetime resources; i.e., when financial assets are small to human capital. This implies that the level of precautionary saving calculated for individuals is large, suggesting that precautionary saving may represent a significant fraction of the total saving of US households. Thus, the growth of unemployment and the other forms of insurance may help to explain the secular decline in the US saving rate. The results indicate that rational individuals with constant relative risk aversion utility will optimally exhibit 'excess' sensitivity to transitory income, save 'too' much and have expected growths of consumption that are 'too' high, relative to a simple PIH benchmark, even in the absence of borrowing constraints.

Hayashi (1982) used the assumption of a constant discount factor and geometrically decaying weights to suggest a method for estimating solved-out consumption functions, which avoids having to generate explicit income forecasts. This method uses quasi-difference transformation, exploiting the geometrically declining

weights associated with future incomes. However, because the discount factor including the risk premium is different from the real interest rate due to high income uncertainty, the resulting equation relates c_{t+1} to c_t, A_t, A_{t-1} and y_t , instead of just to c_t , so that lagged information other than consumption matters. Hayashi, using annual US data, finds the real interest rate to be around 3.4% and discount rate for income to be 13.2%. The data suggest that US households discount future income at a much higher rate than would be implied by the real interest rate and the majority of households in the population are forward-looking consumers as envisioned by the PIH, trying to shield the flow of consumption from short-run fluctuations in their disposable income. As it was raised by Friedman (1957, 1963), the income discount rate might be as high as 33%.

The effects of uncertainty in the Euler equation when consumers are risk averse can also be examined directly. Higher uncertainty operates like a higher real interest rate here too; it depresses consumption in the first period, raising the planned growth rate, other things being equal.

Hubbard *et al.* (1994) suggest that features of the US income-support system additionally discourage saving and may help to account for the decline in the saving rate in the 1970s and 1980s. The US system makes payment of most welfare benefits conditional on the household owning very little in the way of assets. For households with some probability of income falling below the support level, this strongly discourages the accumulation of assets.

Another kind of uncertainty concerns the date of death. Uncertainty about date of death, as with the bequest motive, modifies the conclusion that the MPC out of assets for the retired will be rather smaller than the theory predicts when there is no uncertainty. Both considerations help to explain why the retired do not dissave on anything like the scale predicted by simple life-cycle theory.

The uncertainty also effects the rate of return on savings. The consumption capital asset pricing model is based on the existence of a safe asset (Lucas, 1978; Breeden, 1979; Grossman and Shiller, 1981; Hansen and Singleton, 1983 and Singleton, 1990). If the rate of return on saving is uncertain, the above analysis of certainty equivalence applied to income can be used to analyse the implications of an increase in the rate-of-return uncertainty. Rate-of-return uncertainty and income uncertainty have often risen together with inflation and inflation uncertainty. However, empirically, the two effects may be hard to distinguish.

The major effects of the precautionary motive are as follows:

First, precautionary behaviour may enhance the stability of consumption and hence help to explain the excess-smoothness and the response of consumption to income innovations. A large positive income shock is likely to be taken as an indicator that there is more uncertainty about the new higher level of income and so lead to a smaller rise in consumption than there would be in the absence of the precautionary motive. **Second**, as far as testing the Hall model and 'excess sensitivity' is concerned, precautionary behaviour, as modelled by Hayashi (1982) implies that lagged income and other information matters. The same implication follows from the approximate Euler equation which incorporates uncertainty. Under a precautionary savings motive, household will tend to save more earlier in life than would be the case under the Permanent Income Theory. This helps explain why consumption and income often rise together in the early part of the life cycle. **Third**, precautionary motives can also help to explain why older households dissave less than would be explained by permanent income versions of life cycle hypothesis. Uncertainty about the life-span, about health and health costs, and the extreme unpleasantness of poverty in old age, combine to make

older people very cautious about running down their assets. Such behaviour also explains partially the important role of accidental bequests in the transmission of wealth. Engen and Gale (1991) show that a model of precautionary savings can explain why households hold Individual Retirement Accounts (IRAs) as well as other forms of saving given that the former have both lower yields and penalties for early withdrawal.

Fourth, the proliferation of government programmes such as unemployment insurance and welfare, by reducing income risk, could lower precautionary savings and hence contribute to a decline in the savings rates. Thus, a higher level of pension provision lowers saving out of after-tax income. Feldstein (1977, 1980), finds that increases in the extent of social security coverage and the relative level of benefits substantially depress the rate of private savings. Feldstein (1977) examines the model of household saving and retirement in an economy with social security benefits. The model reveals that there are two important ways in which a social security programme influences individual saving: *a wealth replacement effect* and *an induced retirement effect*. These programmes affect the distribution of income, both directly and indirectly, through changes in the supplies of capital and labour. Risk-averse behaviour under uncertainty suggests additional reasons for such a relationship. Unemployment benefits insure against income shortfalls, as does an income support floor present in the welfare states of advanced industrial countries. By making income less risky, these institutions reduce precautionary saving. **Fifth**, progressive taxation reduces the upper tails of the distribution of agents' uncertain future incomes. If consumers have a precautionary savings motive and if taxes are an increasing function of incomes, then a substitution of lower current taxes for higher income taxes later will reduce the uncertainty of future income and will reduce the need for current precautionary saving. Even if the tax cuts

have to be repaid in their lifetimes, current consumption will increase and the Ricardian Equivalence Proposition will fail.

5.2. CREDIT RESTRICTIONS

People have preferences that may make them unwilling to borrow in any circumstances, and there will be many others who, like the standard life-cycle consumers, want to accumulate first and run down assets later, so that the question of borrowing never arises. Borrowing is most desired when initial income and assets are low relative to expected income and when real interest rates and uncertainty are low. For those who want to borrow, limited credit is likely to be available. It is those who are impatient, whose preferences make them want to consume more heavily early in life, and whose incomes are rising over time, who are most likely to be unable to find the unsecured loans that would enable them to carry out the consumption plans that they would like. The presence of borrowing constraints fundamentally alters the way in which consumers behave, even though there will often be few periods in which the constraint is binding.

The precautionary motive for saving is also strengthened by the existence of liquidity constraints. If the ability to borrow is closed off, consumers will have to accumulate additional assets as a buffer against fluctuations of income and the inability to borrow. The precautionary motive operates through increases in *consumption uncertainty* increasing expected marginal utility through a convex marginal utility function. If there are borrowing restrictions, high consumption levels are more likely to be disallowed than low consumption levels, so that the expected marginal utility is further increased. Even if preferences are quadratic and $r = \delta$, there will be a precautionary saving motive if borrowing is not allowed. Increase in future uncertainty will reduce the expected future consumption. In these circumstances, we need to make

assumptions about the preferences and the behaviour of incomes in order to characterise the behaviour of consumption [Deaton (1991)]. Preferences are such that consumers typically would like to borrow. The only assumption is the *income process*¹⁶: when incomes are stationary, and independently and identically distributed (iid) over time, assets play the role of a buffer stock, and the consumer saves or dissaves in order to smooth consumption in the face of income uncertainty. It is possible to make consumption much smoother than income without borrowing and without accumulating different types of assets. The more prudent are consumers, and the more uncertain is income, the greater is the demand for these precautionary balances. Deaton (1991) suggests that for an impatient household with serially correlated but stationary income, buffering behaviour will be easier or harder depending on the nature of the auto-correlation. Positive serial correlation in the income process diminishes both the desirability and the feasibility of using assets in this way. When income is a random-walk, there will be no consumption smoothing and consumption will equal income; the liquidity constraints generate the same solution as the permanent income hypothesis. When income is a random walk, all shocks are permanent, therefore consumers will adjust consumption immediately to the new permanent situation. However, if income is the sum of a random-walk and white-noise; and the growth rates mimic aggregate data which are positively serially correlated, then when consumers follow the optimal consumption policy, saving is *contra-cyclical*, rising at the onset of the slump, when incomes are falling, and falling at the onset of the boom, when incomes are rising. The amplitude of income cycles is exaggerated by the auto-correlation so that the consumer needs more assets and has to hold them longer than is the case when incomes are independent. However, the presence of substantial transitory income at the individual

¹⁶ If income is known to be growing, consumers are more likely to borrow than if it is falling.

level is quite likely to generate *negative* serial correlation in individual income *growth rates*, and this can generate buffering behaviour as in the simple models with no growth. If an agent's income process is independent of all others, such behaviour will not generate savings in the aggregate, because buffering will be both cheaper and more effective than when incomes are (*iid*). However, Deaton (1991) constructs a simple model in which individual income growth is negatively auto-correlated, aggregate income growth is positively correlated, and aggregate saving is *pro-cyclical*, because some component of aggregate fluctuations in income growth is common to all consumers, and even though it accounts for only a very small fraction of individual income changes, its existence can generate savings in aggregate.

Credit restrictions are an obvious reason for the tendency for consumption to follow the hump-shaped profile of life-cycle income more closely than is predicted by the life-cycle model. Thus, credit restrictions explain the 'excess sensitivity' of consumption changes to predictable income changes and the effectiveness of public financial policies and transitory taxes. Assets are only used as a buffer and because even a few assets can be effective in smoothing consumption; consumption and income are tied together over periods longer than a few years. In the short run; high frequencies weeks or months; consumption and income are largely independent and shocks to income have only a modest effect on consumption. Over longer periods, at low frequencies, consumption and income move together. The effective planning horizon in the buffer-stock model is the period until assets run-out, a period that the simulations suggest is a few years, not a lifetime. Income is smoothed over this much shorter time-frame, not over the lifetimes that are predicted by the life cycle theory. The presence of liquidity constraints also explains why predictable increases in income are associated

with predictable increases in consumption, both on a short-term year to year basis as well as over the decades during which life cycle income patterns unfold.

Liquidity constraints should be expected to affect more people in countries with poorly developed consumer credit markets. Haque and Montriol (1989) find that of the 16 developing countries, the fraction of liquidity constrained households in the total exceed 30% in 10 cases with Thailand 71%, and Turkey 47%.

Credit constraints also help explain the smoothness of changes in consumption and offer a potential explanation of an 'equilibrium correction' form of the consumption function.

Generally speaking, for the majority of credit-constrained households, consumption equals income, though some of such households will have a small level of initial assets and some may have debts. Hall and Mishkin (1982), and Campbell and Mankiw (1989, 1991) assumed that consumption is just equal to income for the credit-constrained households in the Euler equation context.

If the fraction of credit-constrained households is π , aggregate consumption is given by :

$$c = (1 - \pi)c^u + \pi.c^c \quad (2.25)$$

The most popular failure of the Hall's Euler equation has been proved by Hall in Hall and Mishkin (1982) by violating the no-credit restriction assumption. The martingale condition (2.20) holds for the non-credit-constrained: $c_t^u = c_{t-1}^u + \varepsilon_t$, while it is assumed that the credit constrained just consume income: $c_t^c = y_t^c$. If the latter holds without error, first differencing of (2.25) gives

$$\Delta c_t = (1 - \pi)\Delta c_t^u + \pi\Delta c_t^c = (1 - \pi)\varepsilon_t + \pi\Delta y_t^c \quad (2.26)$$

The change in income for the credit constrained is proxied by the change in average non-property income, which is partly predictable and gives an explanation of the excess sensitivity of consumption changes to anticipated income changes. Also, if current income plays a central role in consumption, then the failure of the permanent income hypothesis casts doubt on the Ricardian Equivalence proposition's empirical validity; rule-of-thumb consumers are unlikely to increase private saving and bequests in response to government deficits.

Equation (2.26) implies that the consumption innovation is the weighted average of ε_t , the innovation in permanent income for those whose consumption follows permanent income, and of the current income innovation for the credit-constrained.

The presence of transitory consumption implies that the change in transitory consumption is added to equation (2.26). But at time t , last period's transitory consumption should be known and can be estimated from observed c_{t-1} and y_{t-1} .

Campbell and Mankiw (1989, 1991) take expectations at $t-2$ of the relationship between consumption growth and income growth to explain transitory errors. If transitory errors are serially uncorrelated, taking the expectations at $t-2$ eliminates transitory errors at $t-1$ as well as at t . They assume that observable *per capita* real disposable income growth is proxy for the income growth of households who are credit constrained, or who simply spend current income because of myopia. Estimates of the consumption share of such households for six countries lie in a 0.2-0.6 range. They suggest that the cross-country differences may be related to how developed the credit markets are: France has a relatively high value of the share of income-constrained households, while Sweden, Canada and the US have lower values.

The buffering models are where precautionary saving and liquidity constraints look most alike. In general, they are capable of producing very different behaviour.

Borrowing is entirely consistent with the precautionary motive, although prudent consumers will generally borrow less than those who exhibit certainty equivalence. Liquidity constraints also interact with prudence, since the inability to borrow in a tight spot is an additional reason to accumulate precautionary balances. Both models differ from the traditional life-cycle models; in liquidity constrained models, consumption responds very directly to income with little attention to the future; whilst, in precautionary models the future is to some extent discounted. Both models differ very sharply from traditional life cycle and permanent income models, although perhaps less from the original permanent income model of Friedman where the future is heavily discounted and the horizon is short.

In the context of an overlapping-generations model, Jappelli and Pagano (1994) empirically show that liquidity constraints on households (rather than on firms) raise the saving rate, strengthen the effect of growth on saving, and foster productivity growth in models in which growth is exogenous. Countries with lower than average loan-to-value ratios exhibit higher than average saving, other things being equal. The contribution of loan-to-values ratio to growth in countries where credit is more easily available, as in the United States, the United Kingdom and Scandinavian countries, is negative. Where credit is more tightly rationed, as in Japan, Greece, Italy and Turkey, the contribution is positive. Outside the OECD, liquidity constraints have a remarkable effect on the growth performance of Taiwan and Korea. The decline in the national average saving rate by 5.1 percentage points, from 15.1% in the 1970s to 10% in 1980s in OECD countries can be explained by financial deregulation. In the UK, deregulation explains 60% of the two points reduction in the national saving rate.

5.3. SAVING AND LEISURE

The dependence of consumption decisions on leisure and leisure expectations rather than only on non-property income is another reason for the failure of the random-walk consumption model.

For some households at least, income is a choice variable to the extent that decisions on hours, labour participation and human capital accumulation are made by individuals in households. If inter-temporal consumption decisions are separable from leisure decisions, conditioning consumption on labour income incurs only a potential endogeneity bias. If separability does not hold, and consumption and leisure were a specific substitute, then high earnings parts of the life cycle are expected to exhibit high levels of hours at work and high consumption to compensate. ($E_{t-1}\Delta c_t$ depends on $E_{t-1}\Delta leisure$, which depends on $E_{t-1}\Delta unemployment$). In the structural consumption model, consumption rises as unemployment rises, given real wages. Changes in unemployment are a good proxy for income uncertainty and should have a negative coefficient in the structural consumption function. Hours worked tend to follow labour income over the life-cycle, if consumption is a substitute for leisure, it would make sense to use consumption of middle age. However, hours worked and wage rates also have their own life-cycle and business cycle pattern, and it turns out that neither substitutability nor complementarity of leisure for goods can account for the co-movements of hours, wages and consumption.

However, if they were complements, consumption would tend to be lower in high earnings phases of the life cycle (Deaton and Muellbauer, 1980). Blundell (1988) and Blundell *et al.* (1994) show some evidence on separability between consumption and leisure. Browning *et al.* (1985) for the UK and Ando and Kennickell (1987) for the

US argue that neither assumption can explain the way hours, wages, and consumption move together in terms of voluntary choice by households.

5. 4. THE ROLE OF LAGGED CONSUMPTION AND DURABILITY

In applied econometrics, lagged dependent variables represent agents' expectations or adjustment costs, habits, or the durability of goods.

Muellbauer (1988) considers two versions of habit formation, rational and myopic. When habits are rational, consumers are aware that their current and future behaviour may have direct implications for future marginal rates of substitution. If habits are myopic, past consumption influences current rates of substitution, consumers are unaware that current consumption may do likewise in the future. Muellbauer (1988), supports habit effects, but ones which could be rational or myopic. Habits, like convex adjustment costs, imply partial adjustment of consumption to life-cycle wealth, defined by,

$$c_t = \beta(W_t / \kappa_t) + (1 - \beta)c_{t-1} \quad (2.27)$$

where β is a parameter reflecting the size of adjustment costs. This has a partial explanation for 'excess smoothness', because only part of any period's shock is adjusted to within the period. It also gives an alternative link between the aggregate saving rate and aggregate growth rates, as consumption lags behind an increase in the growth rate of income. Muellbauer (1988), in the Euler equation context, explains why changes in consumption are not innovations via habits,

$$\Delta c_t = a\Delta c_{t-1} + \varepsilon_t \quad (2.28)$$

where a is the habits parameter. However, empirical evidence does not support (2.28) as a complete explanation of the failure of the Hall model (2.20), due to measurement errors in high-frequency data and time-aggregation problems in high-frequency data.

Habits or convex costs of adjustment also imply partial adjustment in stocks of durables. The stock-flow relationship is as follows

$$S_t = (1-d)S_{t-1} + cd_t \quad (2.29)$$

where S is the stock, d is the rate at which the stock wears out and cd is the flow of purchases. Hall's Euler equation (2.20) applies to only stocks without habits or adjustment costs, but (2.29) implies negative first order serial correlation of residuals in the equation for the change in purchases.¹⁷

¹⁷ Hayashi (1985) and Muellbauer (1988) consider the following auto-regressive models:

$$U = \sum_{t=1}^T v_t(c_t, S_t) \quad (1)$$

$$S_{t+1} = (1-\theta)S_t + c_{t+1}$$

$$U = E_t \sum_t v_t(\alpha c_t + \beta S_t) \quad (2)$$

$$S_{t+1} = (1-\theta)S_t + c_{t+1}$$

where $\alpha \geq 0$ and $0 \leq \theta \leq 1$. To have positive marginal utility of consumption, we need $\alpha + \beta > 0$. In the steady state consumption is constant; $S = c/\theta$, and the utility function is $[(\alpha + \beta)/\theta]c$. Since this must be increasing in c ; we need $\alpha\theta + \beta > 0$.

If $\alpha = 0$ and $\beta > 0$, the state variable is stock of durable goods which generates utility through a proportional service-flow. The stock depreciation at rate θ ; and is augmented by purchases c_t . If $\alpha > 0$ and $\beta < 0$, the model is habit formation; in which the stock of habits S_t is increased by consumption. The larger the habit, the less the pleasure from a given amount of consumption; and the larger must be purchases to generate the same benefit. In all of these models; it is assumed that the consumer is entirely aware of the effects of current consumption on future utility.

Now, instead of (2.19) we have:

$$\alpha c_t + \beta S_t = \alpha c_{t-1} + \beta S_{t-1} + \varepsilon_t \quad (3)$$

$$(\alpha + \beta)\Delta c_t = \alpha(1-\theta)\Delta c_{t-1} + \varepsilon_t - (1-\theta)\varepsilon_{t-1}$$

If $\alpha = 0$, the lagged first difference of consumption plays no part so that the durability modifies the original martingale result by replacing the innovation by a moving average of current and first-lagged innovations. If $\beta < 0$, habits are important. With the parameterization of the habit model $\beta = -\gamma/(1-\theta)$, $\alpha = 1-\beta$ and $\theta = 0$; with utility depending on consumption and lagged

consumption $U = E_t \sum_t v_t(c_t - \gamma c_{t-1})$, (3) becomes:

5.5. ALTERNATIVES TO RATIONAL EXPECTATIONS

There are two main types of alternatives to rational expectations. First, alternative rules of thumb for forecasting can be asserted without providing any well-defined theoretical basis. Second, different micro theories about consumer behaviour can be used to infer expectations processes. For example, the optimising problem for consumers can be reformulated to take into account the costs of information acquisition relative to the benefits of forecasting accuracy. In Pischke's (1991) model consumers do not have the expensive macro information to distinguish micro and macro elements in the shocks they observe. Deaton (1992a) shows that this has predictable consequences for aggregate behaviour quite similar to those of habits. Cochrane (1989) found very small wealth costs (only trivial utility losses) from near-rational alternatives to full-information inter-temporal maximisation. He argues that the utility costs of deviations from an optimal path depend on the absolute deviation of the alternate path from the optimal path. Hence, high frequency deviations like lagged responses, or failure to adjust consumption immediately in response to information announcements, have low

$$\Delta c_t = \gamma \Delta c_{t-1} + \varepsilon_t \quad (4)$$

so that the first difference of consumption is autoregressive. Consumption is no longer expected to be constant, instead the consumer plans for $(\alpha c_t + \beta S_t)$ to be constant at k so that, eliminating the state variable using (1) then the planned consumption will satisfy the difference equation:

$$c_t = \frac{\alpha(1-\theta)}{\alpha+\beta} c_{t-1} + \frac{\theta k}{\alpha+\beta} \quad (5)$$

Since $\beta + \alpha\theta > 0$, the coefficient on lagged consumption is less than unity, and the difference equation is stable. Consumption eventually asymptotes to the constant value $\frac{\theta k}{\beta + \alpha\theta}$.

Consumption will increase or decrease depending on the initial endowment of the state variable S_t and on the sign of β .

If $S_t = 0$ and $\beta > 0$ (the durable-goods case) consumption will decrease.

$\beta < 0$ (the habit case) consumption will increase.

Hence, if $\beta > 0$ consumption must decrease as the stock accumulates, while if $\beta < 0$ consumption continually increase so as to offset the negative effects of the ever increasing stock of habits.

utility costs.¹⁸ He argues that the failures of the PIH are timing failures, with consumption changes coming too early or too late, but not being lost altogether. We know that fluctuations in consumption do not reduce welfare very much, since the utility depends on second-order effects.

However, Deaton (1992a) argues that Cochrane's low cost estimates carry over to the level of individual households. Furthermore, Campbell and Mankiw (1991) show that utility costs are quite small if all agents share equally in aggregate consumption, but they are much larger if some agents are consuming current aggregate income.

Simon (1978) argues that once information acquisition and processing costs are introduced, the benefits of full information inter-temporal optimisation may be too small to warrant the costs, simple rules of thumb are likely to be optimal.

Batchelor and Dua (1992) use survey-based measures of expectations and uncertainties about income and real interest rates into conventional consumption functions. They find that survey expectations provide significant information pertinent to the explanation of changes in consumption, additional to that contained in wealth, income and price movements.

The assumption of rational expectations is intrinsically linked to Lucas' (1976) critique where if there is a change in the underlying process generating income, then the model of consumption conditional on income (and indirectly on expected income) should also change. Hendry (1988a) tests whether expectations are primarily backward- or forward-looking and finds that for sufficient change in the marginal processes, it is feasible to tell the model types apart despite their similarities, see Chapter 3.

¹⁸ He calculates that for reasonable measure of risk aversion, the utility loss to setting consumption equal to income is only between 0.10\$ and 1.00\$ *per quarter*. The other major problem with the cost estimates is that they are based on the experience of representative agent, and it is difficult to know what the estimates mean for the individuals whose behaviour is being averaged. While it is clear that variability of individual consumption is larger than the variability of the average.

5. 6. THE ROLE OF ASSETS AND ASSET PRICES

Illiquidity has the following dimensions:

- a) Capital uncertainty;
- b) Transactions costs;
- c) Transactions restrictions; and
- d) Indivisibilities.

Differences in liquidity suggest, as far as spending decisions are concerned, associating different spendability weights with different types of assets and debt. Barnett (1981) suggests that we should measure monetary aggregates with the index-number approach in which the budget constraint is formulated to reflect the points (a)-(d). Thus, we associate shadow prices or Lagrange multipliers with each of the constraints. One could then measure the marginal utility of increasing each asset by £1 relative to marginal utility of increasing current income by £1. Cash then has a relative shadow price or spendability weight of 1, and less liquid assets would have lower spendability weights. One would expect the assets with the highest long-term after-tax returns to have the lowest spendability weights. However, spendability weights on illiquid asset would be expected to increase with financial deregulation, even though in the short term returns on such assets increased after deregulation.

Breeden (1979) and Singleton (1990) develop the consumption capital asset pricing model (CAPM) which examines the set of inter-temporal efficiency conditions holding for each of a vector of assets. However, realistic specifications of the budget constraints entail non-convex transactions costs and other trading restrictions on illiquid assets. These destroy the simple structure of the consumption CAPM, and make it

difficult to articulate, particularly for aggregate data, and also alter as credit conditions alter.

It is important to note that owner-occupied housing wealth has spending consequences which differ from those of illiquid financial assets in one significant respect, because housing services also appear in the utility function. Housing is the consumer durable *per excellence* and is distinguished by the low rate of wearing out and also by its different treatment in national accounts statistics compared with other durables. The imputed value of owner-occupied housing services is included both in consumption and in income in the national accounts. The relative price of durables enters the consumption function for non-durables as well as its own expenditure equation. Similarly, the demand for non-housing consumption will be effected by the price of housing. If we consider a permanent change in the price of housing after which the relative prices of non-housing consumption and housing is expected to remain fixed, it can be shown that there are two effects: one is a positive wealth effect for those with housing wealth; the other is a negative combined income and substitution effect from facing a higher house price. For those without housing wealth, there is no wealth effect so that the negative effect remains.

Increases in real house prices tend to redistribute wealth between young households, since the young have typically accumulated less housing wealth. To the extent that older households may have higher MPCs to spend out of housing wealth, this distribution adds to the aggregate spending effect.

Evidence is accumulating that house prices have these dual effects: a positive wealth effect, which depends on the degree of liquidity of houses and a negative relative price effect. Bosworth, Burtles and Sebelhaus (1991) and Skinner (1993) find a significant positive relation between consumption and housing wealth for the US at

times when house values rise. They show that the average saving rate of home owners fell by around 6% over the period from the mid-1960s to the early 1980s – a period when real house prices rose substantially – while the average saving rate of non-home owners was little changed. Murata (1994) finds sensible wealth effect for the aggregate Japanese consumption function without a negative price of land effect. Lattimore (1994) finds a similar effect for Australia. Muellbauer and Murphy (1994) find a negative relative price effect alongside a positive wealth effects on regional UK consumption data. Barot (1995) finds a strong positive wealth effect for aggregate Swedish consumption function. Kennedy and Andersen (1994) do a survey on the consumption effects of house price increases in a range of OECD countries and find mixed effects; but these results are not based on formal econometric work or a comprehensive model of consumption.

5. 7. FINANCIAL LIBERALISATION

Financial reform measures are introduced in a number of different dimensions: interest rates, credit allocation, bank ownership, prudential regulation, security markets and openness of the capital accounts. Thus a competitive liberalised financial system will typically be characterised by improved savings opportunities, including higher deposit interest rates, a wider range of savings media with improved risk-return characteristics and in many cases more banks and bank branches, as well as other financial intermediaries. These long-term effects of liberalisation on aggregate private saving will be felt through changes in rates of return and in the degree of credit restrictions. Moreover, if financial liberalisation also has a favourable effect on the allocation of resources this will generate increases in income that will, in turn, increase savings. However, financial liberalisation is a multi-dimensional and phased process, so the

long-term effect of liberalisation on savings may differ substantially from the impact effect. When the process of domestic portfolio adjustment is combined with liberalisation of the foreign exchange market, then large capital inflows may be induced. If not sterilised, such inflows can result in a credit boom leading to real income surges, which in turn have a direct effect on the volume of saving. Therefore, some of the overall effects can come through the effect of income on saving. The impact effect of financial liberalisation on saving could be larger than the sustained long-term effect. This is because households will be able to revise target precautionary balances, allowing for example some middle-aged households that had been constrained from life-cycle borrowing to consume at a higher rate than they would have over a full-lifetime of unconstrained access to borrowing. These transitional effects suggest that aggregate household saving could dip below its steady state level, and that a surge in consumption may be observed (Muellbauer, 1994). Hence, the impact on saving comes through the associated changes in availability and cost of credit, revised expectations of income growth, and increases in financial wealth, especially due to upward movements in property prices. All this may lead to consumption booms and a fall in the saving rate. Miles (1994) argues that an important constraint on home buyers in the 1960s and 1970s was the need to save a deposit to finance house purchase, whilst existing home-owners could not easily borrow against accumulated housing wealth, therefore price rises reduced spending. However, in the mid- and late 1980s when borrowing against housing collateral became easier, changes in house values boosted the spending power of credit-constrained home owners.

The UK and Scandinavian countries in the 1970s had very progressive income-tax systems and tax deductibility of interest payments on debt, though in some cases, as in the UK, it was restricted to mortgage debt. After the first oil shock of 1973-4,

inflation rose sharply in these countries while nominal interest rates rose only moderately. These negative real interest rates created strong incentives to borrow and a demand for credit which was held in check by rationing. From 1979, in the UK, the first steps were taken for financial de-regulations by rising nominal interest rates.¹⁹ From 1980 to 1989 household debt-to-income ratios in the UK more than doubled, becoming one of the highest ratios in the world. This resulted in a boom in house prices in which real prices in the UK doubled over the same period.

Financial liberalisation can have several effects on the parameters of a consumption function:

* It could reduce the share of the credit-constrained, but the Euler equation evidence for the UK suggests that the proportion of credit-constrained households *rose* in the UK during the 1980s. This could be explained by a shift in the spendability coefficients associated with illiquid assets and debt. Financial liberalisation, by making asset-backed credit more easily available, made illiquid assets more spendable. It is also plausible that it would have increased the spendability weight on debt, bringing it close to that on liquid assets, but with the sign reversed.

* During credit rationing, inter-temporal substitution (which is partly represented by the real interest effect), is less likely to be operative. However, if inflation and interest rates both rise and credit is rationed, a 'front-end loading problem' arises for borrowers whose cash debt-service payment rises as a bigger fraction of the long-term burden of interest charges and repayment is loaded on to the current period. This causes a

¹⁹ For financial deregulation in the industrial countries, see OECD (1987), Muellbauer and Murphy (1989), Bayoumi (1990, 1992), Bayoumi and Koujianou (1990), Mathieson and Rojas-Suarez (1990), Llewellyn (1991) and Blundell *et al.* (1994). Bayoumi (1992) uses pooled data comprising of regional data on household saving rates with an over-lapping generation model to look at the effect of deregulation. He finds that deregulation lowered the equilibrium level of saving over the 1980s, probably by $2\frac{1}{4}$ % per annum, as well as making saving significantly more dependent on changes in wealth, income and real interest rates.

negative nominal interest rate effect on aggregate spending. We would expect more powerful real interest effects after financial liberalisation. In addition, one must recognise that financial liberalisation involves more than just a change in interest rates.

* Other dimensions of financial liberalisation, such as increased household access to consumer credit or housing finance, might also work to reduce private savings rather increasing them (Muellbauer and Murphy, 1990 and Jappelli and Pagano, 1994). It should be noted that increased household borrowing may not all go to consumption or housing. A relaxation of borrowing constraints could promote human capital formation, though this will normally be measured as consumption in the National Accounts.

* The availability of a variety of alternative non-financial assets will also have a great importance for aggregate saving, however, the return on which may not be captured by deposit interest rates. Therefore, it would be very useful to take explicit account of alternative investment opportunities, notably the rate of return on owner-occupied housing and other real estate investment. Many developing countries have experienced property booms, and household saving may have been sensitive to the after-tax rate of return on investment in real estate (Koskela and Viren, 1994). However, in most cases data on such rates of return are not available for developing countries.

* To the extent that financial liberalisation reduces borrowing constraints, saving ratios could be lowered (Jappelli and Pagano, 1989; 1994): First, when the borrowing constraint binds, it induces the individual to consume less. Second, even when the constraints are not binding in the current period, the expectation that they may bind in the future reduces today's consumption. Therefore, any dependence of the change in consumption on income might reflect the inability of households to smooth the intertemporal pattern of their consumption through borrowing (see, Cambell and Mankiw, 1989; 1991 and Zeldes, 1989). Furthermore, such dependence has been higher

for developing countries than the developed countries (see, Rossi, 1988, Haque and Montiel, 1989 and Corbo and Schmidt-Hebbel, 1991). Sarno and Taylor (1998) estimate a non-linear model for consumption which allows for liquidity constraints through a time-varying parameter dependent on a proxy for financial deregulation using non-linear instrumental variables. They find that UK financial deregulation has significantly reduced liquidity constraints faced by consumers, allowing a higher percentage of the population to smooth consumption.

* More subtly, as part of the uncertainty discount factor applied to future expected income growth rests on the possibility of future credit rationing, it is possible that the coefficients on expected income growth would increase with financial liberalisation.

Bandiera, Caprio, Honohan and Schiantarelli (1999) review the studies that take into account the effects of financial liberalisation on saving. The main variables that are added to the econometric specifications in order to explain the effects of financial liberalisation on saving are a dummy variable for pre- and post-liberalisation periods (de Melo and Tybout, 1986); a linear trend reflecting gradual liberalisation (Muellbauer and Murphy, 1993a and 1993b); the volume of consumer credit (Jappelli and Pagano, 1989; 1994 and Ostry and Levy, 1995); the percentage of home-owners in certain age-groups, the interest rate wedge on consumer and mortgage loans (Jappelli and Pagano, 1989); the rate of consumer credit delinquencies (Carroll, 1992); and financial depth variable measured by the ratio of M2 to GDP in order to take into account liquidity constraints.

Bandiera, Caprio, Honohan and Schiantarelli (1999) summarise exogenous changes in interest rate regulation, reserve requirements, directed credit, bank ownership (moves toward privatisation), liberalisation of securities markets, prudential regulation, and international financial liberalisation by constructing a financial liberalisation index for each of eight developing countries: Chile, Ghana, Indonesia, Korea, Malaysia,

Mexico, Turkey and Zimbabwe. Based on an analysis of the historical evaluation in each cases they have identified the timing of major moves on eight different dimensions towards a more liberalised system. Using the principal components of the resulting matrices of zero-one variables (ones correspond to the years after a particular reform is introduced) they obtain a continuous financial liberalisation index for each of eight countries. They estimated the long run and short run relationship between savings and its determinants separately for each country over the period 1970-1994. The private saving rate is modelled as a function the natural log of real *per capita* Gross National Disposable Income, the real interest rate, the financial liberalisation index, the inflation rate and the government saving rate. They find no evidence from the country-by-country estimates of a significant distinct positive effect of the real interest rate on savings as well as the effect of financial liberalisation. When the long run responses are constrained to be equal, the effect of the financial liberalisation index is significantly negative and large enough to offset the positive effect of the interest rate increases that accompanied the reforms. A negative average value for the effect of liberalisation on saving suggests that the negative impact of relaxation of borrowing constraints is the dominant factor. The fact that the estimated effect varies from country to country suggests that the process of financial liberalisation may have increased consumers' access to credit in differing degrees from country to country to an extent not fully captured by the index.

5. 8. DEMOGRAPHIC FACTORS

Brenner *et al.* (1992) find evidence for the effect of the presence of young children on labour-force participation and hours of work by mothers. Lower income is typically associated with the higher needs following the arrival of young children. Brenner *et al.*

(1992) also suggest that part of the reason for the fall in the US personal sector savings rate from the mid 1970s to the mid 1980s is connected with the changing circumstances of women. They argue that liberalisation of divorce laws in the 1960s and 1970s was followed by a great rise in divorce rates. This created incentives for women to accumulate personal human capital rather than financial capital and led to a fall in the savings rate. Muellbauer and Murphy (1993a) find that the US women's labour force participation, offset by the proportion of young children in the population, appears to explain much of the decline in the savings rate in the US.

Depending upon the system of finance for higher education, saving for college education becomes more important as children enter the teenage years, followed by a certain amount of running down of assets when the children reach college age. Over the individual life-cycle, this suggests quite sharp fluctuations in the saving rate. Although these effects in cross-section data could be picked up by conditioning on the age and number of children as well as on the age and expected income profiles of the adults: on aggregate time-series data alone the effects of such demographic variations are very difficult to estimate robustly.

When the utility of the children's consumption enters the parents' utility function, then bequests are made. The marginal utility to the parents of the assets bequested can be low for two reasons: one is that the parents apply a bigger subjective discount factor to the utility from consumption of the children and the other is that the receiving household may have its own assets and income prospects. This gives us a reason for a failure of the Barro (1974) Ricardian equivalence, under which households do not respond to tax cuts now on the grounds that they or their descendants will have to pay higher taxes in the future.

6. CONCLUSIONS:

As we have seen, the Euler approach assumes rational expectations and focuses on the inter-temporal efficiency condition linking consumption in adjacent periods, whereas, the solved-out consumption function solves the full set of these efficiency conditions stretching to horizon to derive a solution for consumption in terms of initial assets and human capital. The main reasons a researcher might prefer modelling Euler equations to modelling solved-out consumption functions are that for individual households under rational expectations, taking expectations of the inter-temporal efficiency condition eliminates the need to model expectations explicitly and introduce asset data, which may not always be accurate or easily available. Secondly, under uncertainty, with risk averse behaviour, the individual household Euler equation can be directly estimated using the generalised method-of-moments estimator.

However, if a particular Euler equation held at micro level, it would not hold in aggregate data except under incredible assumptions about behaving as if life were infinite. Second, when some households are credit constrained, simplifying approximations for modelling aggregate behaviour are needed in both the Euler and solved-out approaches. Third, knowledge of the parameters of an Euler Equations consistent with risk averse behaviour would be of limited usefulness for forecasting or policy analysis. Fourth, when a significant fraction of households do not have rational expectations, the martingale or surprise formulation of the Euler equation breaks down. Finally, because the Euler approaches involved something close to the first-differencing of the data, it throws away long-run information on the levels of consumption, income, assets and demography.

As we have seen, both Euler equations and solved-out consumption functions need to incorporate the effects of age, and a reasonable treatment of aggregate over

households, precautionary behaviour in the face of uncertainty, credit constraints, habits or costs of adjustments and the durability of goods.

2. INTRODUCTION

In this paper I discuss the role of the household in the economy and the implications for policy. The household is the basic unit of production and consumption in the economy and its behaviour is crucial to the determination of aggregate supply and demand.

Any household in equilibrium must satisfy the budget constraint, the utility maximization problem, and the market clearing conditions. The household's utility maximization problem is to choose consumption and leisure to maximize utility subject to the budget constraint. The budget constraint is determined by the household's income, which is the sum of wages and profits. The market clearing conditions require that the household's demand for goods and services equals the supply of goods and services. The household's utility maximization problem can be written as a constrained optimization problem. The first-order conditions for this problem are the Euler equation, the budget constraint, and the market clearing conditions. The Euler equation is a necessary condition for utility maximization and it states that the marginal utility of consumption must be equal to the marginal utility of leisure. The budget constraint states that the household's expenditure must equal its income. The market clearing conditions require that the household's demand for goods and services equals the supply of goods and services.

Barro and Sala-i-Martin (1995) argue that the household's utility maximization problem can be written as a constrained optimization problem. The first-order conditions for this problem are the Euler equation, the budget constraint, and the market clearing conditions. The Euler equation is a necessary condition for utility maximization and it states that the marginal utility of consumption must be equal to the marginal utility of leisure. The budget constraint states that the household's expenditure must equal its income. The market clearing conditions require that the household's demand for goods and services equals the supply of goods and services.

Chapter 3:

ECONOMETRIC ISSUES

1. INTRODUCTION

In this chapter I discuss theoretical and applied econometric modelling issues which are necessary for constructing a theory-consistent, congruent and encompassing consumption function.

Any theoretical or empirical model should be useful for at least one of understanding economic behaviour, for testing economic theories, for forecasting and for analysing economic policy. Sustainable empirical relationships between observed economic magnitudes involve these four objectives. However, since empirical models are inevitable simplifications of a large economy, they must be false. Hendry (1995) proposes two main concepts to judge empirical models; congruence and encompassing. The former denotes that the empirical model matches the available evidence in all measured attributes (i.e., it is consistent with the theory from which it was derived, has unexplained components that are innovations against available information, basic parameters that are constant, data admissible, and any conditioning variables are weakly exogenous for the parameters of interest). The latter denotes that the model of interest can account for the result of rival models of the same phenomena.

Hendry and Mizon (1990) argue for seeking models that are congruent with the available information, and in addition any model claiming to be '*structural*' must have invariant parameters and be able to parsimoniously encompass the associated

unrestricted system. Hendry (1995a) defines structure as the set of invariant features of the economic mechanism. A parameter can be structural only if it is invariant for an extension of the sample period (constant), invariant with respect to changes elsewhere in the economy (regime shifts), and invariant over extensions of the information set (adding more variables).

However, empirical models are implicitly derived from the data generation process by reduction operations that entail transformations of the original parameters of the Data Generating Process (DGP) where empirical models involve observable outcomes. Invalid restrictions or inappropriate reductions could lose constancy or invariance, even when both are present in relationships defined at the level of DGP; or induce residual auto-correlation (non-congruence); or generate non-encompassing models. To characterise data parsimoniously in a general economic framework, the statistical analysis should commence from the joint distribution of the observable variables, often called Haavelmo distribution, after Haavelmo (1944) and test all reductions.

The simplification¹ procedures used in data modelling may induce sample dependence (i.e., results that vary as the sample is changed although rigorous testing seeks to offset that). Such an approach then relies on multiple tests, which raises difficulties about the overall sizes of tests. However, a misplaced objection to statistical testing is that 'test statistics' can be made insignificant by construction: this entails that they have become design criteria in modelling, so 'testing' requires 'outside' information. The recent developments proposed by Hoover and Perez (1999)

¹ We do not know in advance whether the simplifications we have made are valid. Despite the complexity of economies, limited observation sets typically force us to consider relatively simple models.

suggest that the simplification mediated by encompassing does not induce major test-size distortions. Further, since rejecting a null hypothesis against a specific alternative hypothesis provides no information about an appropriate alternative model, it cannot guide model revision. Mizon (1993) argues that rejecting an empirical model does not entail rejecting the theory from which it was derived, nor does accepting the model entail the validity of the theory: mutually incompatible congruent empirical models can be designed to match inconsistent theories. Of course, encompassing tests will generally reveal both models to be invalid. Thus, we will develop our empirical models by simplification after testing that the general model does describe the evidence.

Hendry (1995) discusses five cases in which investigators may seek to determine *structure: identified cointegrating vectors; orthogonal parameters; inappropriate estimation; residual analysis and expectations*. In the following sections, I will try to analyse these conditions as well as the other concepts necessary to develop a congruent model.

2. UNIT ROOTS, INTEGRATION AND COINTEGRATION

Nelson and Plosser (1982) find that all but one of the series they tested have a unit root (the exception being unemployment) and conclude that the non-stationarity of macro time series is in general stochastic.² The hypothesis of a unit root has

² A variable is integrated if it requires differencing to make it stationary. If a variable x_t follows a first-order autoregression,

$$x_t = \pi_1 x_{t-1} + \varepsilon_t \quad (\text{a})$$

it can be rewritten as:

$$\Delta x_t = \pi x_{t-1} + \varepsilon_t \quad (\text{b})$$

where $\pi = \pi_1 - 1$ by subtracting x_{t-1} from both sides of (a). If $\pi_1 = 1$ or $\pi = 0$, then x_t has a unit root and is said to be integrated of order one [denoted I(1)], meaning that x_t must be differenced

important implications in economics, because a unit root is often a theoretical implication of models which postulate the rational use of information that is available to economic agents. The limiting distribution theory that is usually applied in econometrics for stationary time series is no longer valid for non-stationary cases. The distribution theory for the latter belongs to the general class of functional limit theory on metric spaces rather than the central limit theorems in Euclidean spaces conventionally used in econometrics. Dickey and Fuller (1979) and Dickey and Said (1984) propose well-known unit root tests. Alternative procedures for testing the presence of a unit root are proposed by Phillips (1985, 1986, 1987a, 1987b, 1988), Phillips and Perron (1986, 1988), and Perron (1986, 1988, 1990). Phillips (1985) develops an alternative testing procedure which does not rely on an auto-regressive correction to account for short-run dynamics. Phillips and Perron (1986) and Perron (1986) extend Phillips (1985) to accommodate a fitted time trend and a non-zero drift. Phillips (1986) develops an asymptotic theory of regression which is applicable when the variables are quite general integrated processes. This includes spurious regressions. This asymptotic theory of regression also applies to cointegrating regressions. Phillips (1987a) proposes an approach based on non-parametric correction with respect to nuisance parameters and thereby allows for a wide class of time series models in which there is a unit root. This includes ARIMA models with heterogeneously, as well as identically, distributed innovations. Phillips (1987b) shows that simple least squares regression consistently estimates a unit root under very general conditions, in spite of the presence of weakly dependent and

once to achieve stationarity. In (a), x_t is a random walk if it has a unit root. If $|\pi_1| < 1$, then x_t is stationary for an appropriate distribution of x_0 and $\{\varepsilon_t\}$. For general autoregressive processes, (a) includes additional lags of x_t ; thus (b) includes lags of Δx_t .

heterogeneously distributed innovations. Phillips (1988) includes a drift and a drift and a linear trend in the specification and finds the asymptotic distribution theory underlying this procedure, so critical values already provided by Fuller (1976) may be used. Perron (1990) considers a hypothesis that a time series has a unit root³ with possibly non-zero drift against the alternative that the process is trend stationary and allows for the presence of a one-time change in the level or in the slope of the trend function. He shows that most macroeconomic variables are 'trend stationary' if one allows a single change in the intercept of the trend function after 1929 and a single change in the slope of the trend function after 1973 and concludes that trend stationary processes with a break are nearly observationally equivalent to unit root processes with strong mean-reversion and a fat-tailed distribution for the error sequence.

The main difficulties that arise in modelling *non-stationary* variables are as follows: *First*, the presence of unit root induces non-standard distributions of the coefficient estimates. Moreover, these distributions change with the presence of deterministic terms. *Second*, the error process may not be a martingale difference sequence, if other non-stationarities are present. *Third*, the explanatory variables may each be generated by processes that display auto-correlation. Taken in conjunction with the second effect, this gives rise to 'second-order' biases. *Fourth*, combinations of variables may be stationary, so there may be more than one cointegrating vector. *Finally*, the explanatory variables in the single equation will not be weakly exogenous

³ The most important implication of the unit root revolution is that under this hypothesis random shocks have a permanent effect on the system. Fluctuations are not transitory. Perron shows that most macroeconomic time series are not characterised by the presence of a unit root and that fluctuations are indeed transitory. Only two events (shocks) have had a permanent effect on the various macroeconomic variables: the Great Crash of 1929 and the oil price shock of 1973. This evidence conflicts strongly with Nelson and Plosser (1982).

for the parameters being estimated, if a cointegrating vector enters more than one equation in the system generating the variables.

Static regressions can be affected by all five of the problems listed above while appropriately specified dynamic models may be able to accommodate the first three effects. However, estimates derived from single-equation dynamic models are not optimal if weak exogeneity fails to hold.

An important problem arises especially when we apply standard distributions to inference where there are non-stationary series present. Mankiw and Shapiro (1985, 1986) discuss this issue in the context of consumption economics as well as the problem of inference concerning orthogonality between series. The regressions under this specification are called *unbalanced regressions* or *inconsistent regressions*: that is, regressions in which the regressand is not of the same order of integration as the regressors, or any linear combination of the regressors.

Mankiw and Shapiro test the life-cycle/permanent-income model which, given a stringent set of assumptions discussed in Chapter 2, implies that consumption should follow a random walk.

$$E_{t-1}(y_t) = y_{t-1} \text{ implying } y_t = y_{t-1} + v_t, \quad E_{t-1}(v_t) = 0 \quad (3.1)$$

where E_{t-1} is interpreted as the expectation, conditional on information realised at time $t-1$, of the value of some variables which may be dated in the future. That such a condition holds is often tested with a regression such as

$$\Delta y_t = c_1 + c_2 x_{t-1} + v_t \quad (3.2)$$

where $c_2 = 0$ under the null hypothesis that (3.1) holds.

Mankiw and Shapiro examine the case in which the regressor x_t follows the AR(1) process:

$$x_t = \theta x_{t-1} + \varepsilon_t \quad (3.3)$$

with

$$\text{corr}(\varepsilon_t, v_t) = \rho \quad \text{and} \quad \text{corr}(\varepsilon_{t+j}, v_t) = 0 \quad \forall j \neq 0.$$

Mankiw and Shapiro use Monte Carlo simulations to tabulate estimates of the actual rejection frequencies and critical values in t -type tests of $H_0: c_2 = 0$, when standard t -values are used. For $\theta = 1$, test size distortions persist as $T \rightarrow \infty$, and the standard testing procedure is greatly biased toward finding 'excess sensitivity' of consumption to current income.

Galbraith, Dalodo and Banerjee (1987) show that the critical values are sensitive to nuisance parameters of the underlying DGP, and, in considering a more general DGP, it is possible to relate the problem of size distortions to cointegration among regressors and so to the *balance* or *imbalance of the regression model*.

In the consumption example, both consumption and income are integrated of order one. Thus, the regression (3.2) has an I(0) variable (differenced consumption) regressand on an I(1) variable (lagged income in level) and the regression is unbalanced. An attempt to explain an I(0) variable by a variable integrated of higher order will fail, as the two variables must diverge by ever-larger amounts. Test statistics designed to test regressand and regressors having different orders will have non-standard distributions. Even when the regressand (e.g., y_t) and the regressor (x_t) are both integrated of order 1 and are co-integrated, the t -statistic on the coefficient of x_t still has a non-standard distribution which makes ordinary t and normal tables unusable for purposes of inference. Only, if the order of integration is zero, the t -statistics can be shown to have asymptotically normal distributions. This implies some advantage to the use of dynamic rather than static regressions. The possibility

of transforming in such a way that the regressors are integrated of the same order as the regressand, so the probability of a co-integrated set being present is increased in a dynamic model, is important in this perspective.

A dynamic specification that is as general as the constraints of data and sample allow increases the chances of obtaining a co-integrated set of regressors. A dependent variable made stationary by differencing can be regressed on this co-integrated set, and standard *t*-tables can be used for inference. The regression would take the form of a differenced variable as the regressand, and differences and levels of variables as regressors. Sims *et al.* (1990)⁴ have variables with drifts and allow them to integrate and co-integrate in arbitrary order. They show that estimators of those parameters which can be rewritten as coefficients on mean-zero, non-integrated regressors that will have asymptotically normal joint distributions, converging at a rate $T^{1/2}$ to their probability limits. Non-integratedness is achieved if and only if subsets of the regressors are co-integrated. There are three important properties of these transformations. *First*, the original parameters of interest can be identified from the parameters of the transformed regression. *Second*, because the transformed parameter estimates are asymptotically normally distributed, so are the untransformed estimates, because linear transformations do not alter any of the statistical properties of the estimators of the regression coefficients. *Finally*, because any information obtained from a transformed regression can be obtained from an untransformed regression as well, the essential point is not that the transformations actually be undertaken, but rather that the scope exists for the appropriate transformations to be made, because appropriate regressors are present.

⁴ See also Sims *et al.* (1986) and West (1986).

A dynamic regression equation can be transformed to validate the use of asymptotic normal distribution theory. Stock and West (1988) test the Hall (1978) permanent income hypothesis. Hall's regression takes the following form:

$$c_t = \mu + \beta c_{t-1} + \pi_1 y_{t-1}^d + \dots + \pi_p y_{t-p}^d + \varepsilon_t \quad (3.4)$$

where c_t is consumption in period t and y_t^d is disposable income. The processes generating c_t and y_t^d are assumed to have two properties. First, c_t and y_t^d have unit roots. Second, given that the permanent income hypothesis is correct y_t^d may be shown to be co-integrated with c_t . The permanent income hypothesis has two implications: first, $\beta = 1$; and second, $\pi_1 = \pi_2 = \dots = \pi_p = 0$. Stock and Watson (1988) restrict β to its hypothesised value of one. Thus, the joint test of the permanent income hypothesis takes the form of testing the joint exclusion restrictions on the π_i . Although, the joint test of the restrictions does not have the usual F -distribution, the F -test on the π_i does.

In the equation above all the coefficients of income can be written as coefficients of mean-zero stationary variables.

$$c_t = (\mu + \pi_1 k + \dots + \pi_p k) + (\beta + \pi_1 + \dots + \pi_p) c_{t-1} + \pi_1 (y_{t-1}^d - c_{t-1} - k) + \dots + \pi_p (y_{t-p}^d - c_{t-1} - k) + \varepsilon_t \quad (3.5)$$

or

$$c_t = m + \phi c_{t-1} + \pi_1 (y_{t-1}^d - c_{t-1} - k) + \dots + \pi_p (y_{t-p}^d - c_{t-1} - k) + \varepsilon_t \quad (3.6)$$

where k is the intercept of the long run consumption function, $m = \mu + k \sum_{i=1}^p \pi_i$, and

$$\phi = (\beta + \sum_{i=1}^p \pi_i).$$

Theorem 1 in Sims *et al.* (1990) implies that the OLS estimators of $\{\pi_i\}$ are jointly asymptotically normally distributed, converging to the true values at the rate $T^{1/2}$. Furthermore, theorem 2 of Sims *et al.* implies that the t or F -tests on any or all subsets of these estimated π_i coefficients have the usual asymptotic distributions.

Banerjee and Dolado (1988)⁵ consider the following regression

$$\Delta c_t = \sum_{j=1}^{n-1} \alpha_j \Delta y_{t-j}^d + \sum_{j=1}^{m-1} \gamma_j \Delta c_{t-j} + \beta y_{t-n}^d + \delta c_{t-m} + u_t \quad (3.7)$$

where y_t^d denotes the logarithm of disposable income and c_t the logarithm of consumption, and both variables are I(1) in levels. The long-run multiplier between consumption and income can be deduced in any dynamic model. Consider the simplified model:

$$\Delta c_t = k + dt + \delta c_{t-1} + \beta y_{t-1} + u_t \quad (3.8)$$

Although the individual t -ratios are asymptotically normally distributed, the distribution of the Wald statistic, used for testing the joint null hypothesis $\beta = \delta = 0$, is a functional of a Wiener process and its distribution is non-standard. Furthermore, if we re-parameterise it as:

$$\Delta c_t = k + dt + \gamma_1 c_{t-1} + \gamma_2 s_{t-1} + u_t \quad (3.9)$$

where $s_{t-1} = y_{t-1} - c_{t-1}$, $\gamma_1 = \beta + \delta$, $\gamma_2 = \beta$ and s_{t-1} may be shown to be I(0) under the assumptions of the permanent-income hypothesis, then $t(\gamma_1 = 0)$ would be a functional of a Wiener process whereas $t(\gamma_2 = 0)$ would have an asymptotically normal distribution.

⁵ They mainly deal with the Weak Efficiency and Semi-Strong Efficiency Tests. They find that the asymptotic and small sample theory explain the poor performance of the former; and the asymptotics of the 'semi-strong efficiency test' with the asymptotic theory for integrated processes gives results that the individual coefficients and their t -ratios are normally distributed, but an F -test of their joint significance does not follow a standard distribution.

Again, from the general model the above results may be proved, using theorems 1 and 2 in Sims *et al.* (1990).

Stock and Watson (1988) deal also with the dangers involved in not properly taking account of the orders of integration of the regressors and the regressand. However, a general to specific method of econometric modelling would have overcome many of the problems of spurious inferences and non-standard distributions.

Since and Davidson, Hendry, Srba and Yeo (DHSY)'s work (1978) on the dynamic modelling of the consumption function, the equilibrium correction⁶ formulation has been widely used in applied econometrics. Furthermore, it has been shown that while many time series are individually non-stationary, there may exist stationary linear combinations of such variables which are candidates for an implementable equilibrium concept.⁷ The concept of equilibrium indicates that the error in the equilibrium relationship should tend to fluctuate around its mean value. This requirement will be satisfied for linear combinations of variables which are $I(0)$. Granger also establishes an isomorphism between cointegrated systems and equilibrium correction.

Importantly, *cointegration* ties together several apparently disparate fields. *First*, cointegration links the economic notion of a long-run relationship between economic variables and a statistical model of those variables. If a long-run relationship exists, the variables involved are *cointegrated*. *Second*, the statistical theory on unit-root processes provides the basis for statistical inference about the

⁶ The notion of equilibrium correction replaces the previously used notion error correction since Hendry (1995).

⁷ See Granger (1981, 1983) and Engle and Granger (1987) for the early developments, and Stock (1984) and Phillips and Durlauf (1986) develop a distributional theory of non-stationary time series and cointegration.

empirical existence of cointegration. *Third*, cointegration implies and is implied by the existence of the 'equilibrium correction' (EC) representation of the relevant variables. *Fourth*, through that isomorphism with EC models, cointegration brings together short- and long-run information in modeling data. *Fifth*, via the distributional theory of integrated processes, cointegration clarifies the 'spurious regressions' or 'nonsense-correlations' problem associated with trending time-series data.

Stock (1984) shows that the estimator of the cointegrating vector(s) β in the first stage regression in the Engle and Granger procedure was not only consistent but would converge in the probability limit to the true value of the parameter faster than the standard OLS estimator - *super-consistency*.

Banerjee *et al.* (1986) find that the biases in static estimates of the equilibria built into DGPs as in Engle and Granger (1987) may be large and may decline slowly as the sample size increases. The following are the basic reasons for treating static regressions as being in general sub-optimal. First of all, the estimate $\hat{\beta}$ is biased for the cointegrating parameter β and, although that bias is $O_p(T^{-1})$, it can be substantial in finite samples. The bias is likely to be a function of some parameter such as the mean lag of the dynamic adjustment process relating $\{y_t\}$ to $\{x_t\}$. In some circumstances, therefore, a return to dynamic modelling would seem to be the appropriate response to the problems of static-regression biases. Second, the distributions of coefficient estimates will typically be non-standard functionals of the Wiener processes, but dependent on nuisance parameters. However, some of the standard asymptotic theory may be restored in dynamic models.

Banerjee *et al.* (1993) also argue that for two I(1) cointegrating time series, the

bias of the cointegrating parameter will be reduced if a general dynamic EC model is estimated, and the power of the t test in the dynamic model is better than the Durbin-Watson in the static model. EC models combine the advantages of long-run theory with Box-Jenkins' differenced models. In this type of model the dynamics both of short-run (changes) and long-run (levels) adjustment processes are modelled simultaneously. The idea of cointegration tends to make the EC model generic in the sense that the validity of a static equilibrium implies the validity of this dynamic representation.

3. COINTEGRATION AND ECONOMETRIC MODELLING METHODOLOGY

Hendry (1985, 1986a, 1987, 1995) considers the implications of cointegration for model evaluation and design. The analysis of the long-run properties of equations is one of Chong and Hendry's (1986) four proposals for research into means of evaluating models.

i) Model Design and Cointegration:

The question of *research efficiency*, rather than of *validity* is the central issue, since a model's validity is independent of how it is arrived at. Its validity or otherwise is the sole preserve of model evaluation. For *model design* Chong and Hendry (1986) argue that:

a) Cointegration allows the researcher to address at the outset the question of whether a model consisting of a certain set of variables (suggested by economic theory) has a long-run equilibrium, and hence whether it is well-defined. Cointegration is only interesting in this regard when the variables of interest are non-stationary, so that an

I(0) linear combination does not exist trivially. Cointegration can be a useful guide as to whether the set of variables under consideration should be augmented. That is, whether the original delineation of the set of variables was too narrow. Therefore, cointegration is both a pre-test of the existence of there being a well-defined model and a guide to variable selection.

b) Cointegration can also be used as a simplifying device in model design, allowing the separation of cointegrations of the long-run solution from the short-run dynamic structure. Cointegration may also help in the identification of economic relations from the various long-run coefficient estimates that are generated.

ii) Model Evaluation and Cointegration:

Cointegration can at best only provide information on the long-run of the model. It is a less than comprehensive guide to model adequacy, suggesting the use of other tools to evaluate the short-run or dynamic structure of the model. It is also possible that the adjustment to equilibrium may be so slow that the equilibrium relationship itself is of peripheral interest.

There are various ways in which tests of cointegration could be applied in order to evaluate models. The Maximum Likelihood (ML) procedure delivers up tests of the number of cointegrating vectors that there are between a set of variables, as well as providing estimates of the vectors. Using the ML procedure one can then test restrictions on the cointegrating space and test hypotheses of the type that particular variables do not enter in the cointegrating relationships (by testing a null that the coefficients on such variables are zero).

4. EXOGENEITY⁸

Exogeneity can be described as 'given' without losing information for the purpose at hand. The exogeneity status of variables is critical for economic analysis and tests of both weak and super exogeneity should be conducted as a part of a general research strategy for obtaining a congruent and economically interpretable empirical model. The role of exogeneity tests in evaluating the Lucas critique and the re-interpretation of exogeneity in cointegrated systems have been especially important. The distinct purposes of statistical inference, forecasting and policy analysis define the three concepts of weak, strong and super exogeneity. Invalid exogeneity assumptions may lead to inefficient or inconsistent inferences and result in misleading forecasts and policy simulations. I will briefly define the exogeneity concepts:

WEAK EXOGENEITY: This is required for efficient inference (i.e., estimation and hypothesis testing) in a conditional model. Weak exogeneity implies that inference about the parameters of interest can be conducted in the conditional density alone without loss of information. Engle, Hendry and Richard (1983) define a variable z_t as weakly exogenous over the sample period for the parameters of interest ψ if and only if there exists a re-parameterisation $\lambda = (\lambda'_1, \lambda'_2)'$ such that:

- i) ψ is a function of λ_1 alone, and
- ii) the factorisation in (3.10) operates a sequential cut, that is

$$F_x(x_t; \theta) = F_{y|z}(y_t | z_t; \lambda_1) \cdot F_z(z_t; \lambda_2) \quad (3.10)$$

⁸ For the development of the concept of exogeneity, see Aldrich (1989) and Hendry and Morgan (1995).

where $\lambda \in \Lambda_1 \times \Lambda_2$. Thus, the parameter space of λ must be the Cartesian product of the parameter spaces of the component vectors, so that parameter space of λ_1 does not depend on λ_2 .

Weak exogeneity requires that λ_1 and λ_2 from the factorisation of (3.10) are *variation free* (which implies *the sequential cut of a density function*) and that all the parameters of interest (ψ) can be obtained λ_1 from alone.⁹ That the parameters λ_1 and λ_2 are variation free is not enough to ensure valid inference about the parameters of interest, using the conditional model alone. If weak exogeneity holds, then the efficient estimation and testing can be conducted by analysing only the conditional model, ignoring the information of the marginal process.

STRONG EXOGENEITY: Weak exogeneity with Granger noncausality¹⁰ implies strong exogeneity, and it ensures valid conditional forecasting. Consider the joint density of x_t , conditional on the past of x_t (denoted X_{t-1}) using a first-order vector auto-regression (VAR) in model form:

$$x_t = \pi_1 x_{t-1} + \varepsilon_t \quad \varepsilon_t \sim IN(0, \Omega) \quad (3.11)$$

The conditional and marginal auto-regressive distributed lag (ADL) models are:

$$y_t = b_0 z_t + b_1 z_{t-1} + b_2 y_{t-1} + v_{1t} \quad v_{1t} \sim IN(0, \sigma^2) \quad (3.12)$$

$$z_t = \pi_{22} z_{t-1} + \pi_{21} y_{t-1} + \varepsilon_{2t} \quad \varepsilon_{2t} \sim IN(0, \omega_{22}) \quad (3.13)$$

⁹ The concept variation-free has the following meaning. If Λ_1 and Λ_2 denote the spaces over which the parameters λ_1 and λ_2 range, i.e., $\lambda_1 \in \Lambda_1$ and $\lambda_2 \in \Lambda_2$. Then λ_1 and λ_2 are variation-free if the parameter space Λ_1 is not a function of the parameter λ_2 , and the parameter space Λ_2 is not a function of the parameter λ_1 . Variation free implies that $(\lambda_1, \lambda_2) \in \Lambda_1 \times \Lambda_2$.

¹⁰ The 'causality' of one variable y_t for another z_t has no necessary connection with their respective exogeneity status in that z_t being 'exogenous' or endogenous is neither necessary nor sufficient for it to influence y_t , see Zellner (1979), for the concept of causality in econometrics.

Valid multi-step conditional prediction of y from its conditional model (3.12) requires that $\pi_{21} = 0$, or y does not Granger cause z . Strong exogeneity permits valid multi-step ahead prediction of y from (3.12), conditional on prediction of z generated from (3.13) ($\pi_{21} = 0$), where the predictions of z depend upon only their own lags.

SUPER EXOGENEITY: The conjunction of weak exogeneity and "invariance"¹¹ gives super exogeneity and ensures valid policy simulations. The parameter λ_1 is invariant [see Engle, Hendry, and Richard (1983)] to the class of interventions to the marginal process for z_t (i.e., to a set of changes in λ_2) if λ_1 is not a function of λ_2 for that class of interventions. Thus, two common tests for super exogeneity are as follows.¹²

1. Test the constancy of λ_1 (the conditional model) and the nonconstancy of λ_2 (the marginal process), to show that λ_1 must be invariant to λ_2 (Hendry 1988).
2. By adding dummies and/or other variables construct a constant marginal model for z_t in which λ_2 varies over time. Insignificance of those dummies and/or other variables in the conditional model shows invariance of the conditional model's parameters λ_1 to the changes in the marginal process (Engle and Hendry, 1993).¹³

¹¹ The parameter λ_1 is invariant to a class of interventions (i.e., changes) in λ_2 if λ_1 is not a function of λ_2 for the class of interventions. For invariance, lack of dependence between the parameters themselves matters, and not just lack of dependence between parameters and parameter spaces.

¹² The *generic refutation* of the Lucas critique by tests 1 and 2 above implies that a whole class of expectations-based models (where information available to agents is limited or incomplete) is inconsistent with the data evidence.

¹³ Rejection of invariance in the misspecified model provides some measure of power. F statistics correspond to a specific type of misspecification by variable; and the rejections reflect the power of the test and the high information content in the data.

Ericsson *et al.* (1990), Ericsson and Irons (1996) and Hendry (1995, 1996) consider the following important implications of super exogeneity for policy analysis: *First*, empirical presence of super exogeneity refutes the Lucas critique.¹⁴ If the conditional and marginal models represent agents' and policymakers' decision rules then under super exogeneity, the agents' parameter vector λ_1 is invariant to changes in policy-makers' rules via λ_2 , which is opposite to the implication of the Lucas critique. *Second*, "inverting" the conditional model is invalid. Hendry (1993) shows that inverting a money demand equation to obtain a price equation is invalid.¹⁵ Inversion does not obtain the correct parameter for the inverted equation and the parameter in the inverted model may be nonconstant even if the 'uninverted' conditional model is constant. *Third*, super exogeneity can identify parameters, in the sense of uniqueness, because any (nontrivial) combination of the conditional and marginal equations would be non-constant Hendry (1987). *Fourth*, Granger non-causality is neither necessary nor sufficient for policy analysis.

WEAK EXOGENEITY AND COINTEGRATION: Weak exogeneity conditions in cointegrated systems can be investigated in a first-order bivariate VAR as follows:

$$\Delta y_t = \pi_{11}y_{t-1} + \pi_{12}z_{t-1} + \varepsilon_{1t} \quad (3.14)$$

$$\Delta z_t = \pi_{21}y_{t-1} + \pi_{22}z_{t-1} + \varepsilon_{2t} \quad (3.15)$$

If there is one cointegrating vector ($r=1$), then α and β' are 2×1 and 1×2 vectors, and the normalised β' vector is $(1, -\delta)$.

Then, we have

¹⁴ see Richard (1980), Engle *et al.* (1983), Engle (1982), Hendry (1988, 1995, 1996, 1997), Engle and Hendry (1993), Ericsson and Hendry (1989), Favero and Hendry (1992), and Ericsson and Irons (1996).

¹⁵ See for the nonconstancy of the inverted model in Hendry (1985) and Hendry and Ericsson (1991a, 1991b).

$$\Delta y_t = \alpha_1(y_{t-1} - \delta z_{t-1}) + \varepsilon_{1t} \quad (3.16a)$$

$$\Delta z_t = \alpha_2(y_{t-1} - \delta z_{t-1}) + \varepsilon_{2t} \quad (3.16b)$$

where $\alpha_1 = \pi_{11}$, $\alpha_2 = \pi_{21}$ and $\delta = -\pi_{12}/\pi_{11} = -\pi_{22}/\pi_{21}$. The cointegrating relation $\beta'x_{t-1}$ is $(y_{t-1} - \delta z_{t-1})$. Equations (3.16a) and (3.16b) can be factorized into the conditional distribution of y_t given z_t and lags of both variables, and the marginal distribution of z_t :

$$\Delta y_t = \gamma_1 \Delta z_t + \gamma_2 (y_{t-1} - \delta z_{t-1}) + v_{1t} \quad (3.17a)$$

$$\Delta z_t = \alpha_2 (y_{t-1} - \delta z_{t-1}) + \varepsilon_{2t} \quad (3.17b)$$

where $\gamma_1 = \omega_{12}/\omega_{22}$ and $\gamma_2 = \alpha_1 - (\omega_{11}/\omega_{22})\alpha_2$.

The parameters in the conditional and marginal models (3.17a) and (3.17b) are $(\gamma_1, \gamma_2, \delta, \sigma^2)'$ and $(\alpha_2, \delta, \omega_{22})'$ respectively, and have been denoted by λ_1 and λ_2 previously. For cointegrated variables, λ_1 and λ_2 are linked via δ and α_2 . The parameter δ enters both λ_1 and λ_2 directly; α_2 enters λ_2 directly and λ_1 via γ_2 , which is $\alpha_1 - (\omega_{12}/\omega_{22})\alpha_2$. Thus, z_t is not weakly exogenous for the cointegrating vector β' , or (hence) for δ .¹⁶ Weak exogeneity of z_t for β' is obtained when $\alpha_2 = 0$, in which case (3.17) becomes:

$$\Delta y_t = \gamma_1 \Delta z_t + \gamma_2 (y_{t-1} - \delta z_{t-1}) + v_{1t} \quad (3.18a)$$

$$\Delta z_t = \varepsilon_{2t} \quad (3.18b)$$

¹⁶ In multivariate VAR models, if the same cointegrating combination $\beta_i' z_t$ where β_i' is the i^{th} row of β' and z_t is I(1), the j and k equations, then the contemporaneous values of the z_t with nonzero coefficients in $\beta_i' z_t$ cannot be weakly exogenous for the parameters of the i equation, since the resulting parameters cannot be variation free. When weak exogeneity is violated due to the presence of common cointegrating vectors, the limiting distributions are no longer linear mixtures of normals and inference can be distorted, see for the effect on the validity of inference Phillips (1991, 1994), Phillips and Loreton (1991), Watson (1994) and Hendry (1995).

where $\gamma_2 = \alpha_1$, $\lambda_1 = (\gamma_1, \gamma_2, \delta, \sigma^2)'$ and $\lambda_2 = \omega_{22}$. Then, the conditional model alone is sufficient for fully efficient inference about β' , that is, about δ . Changes in policymaker's 'rules' or reaction functions (3.18b) may change the cointegration and/or exogeneity properties of the system; if a policy maker reacts to the same cointegrating vector as that which appears in the economic agents' conditional model (3.18a), weak exogeneity for that cointegrating vector is lost. If a cointegrating vector appears in only the reaction function ($\gamma_2 = 0$ and $\alpha_2 \neq 0$ in (3.18)), and the policymaker decides to ignore that disequilibrium information (i.e., changing α_2 to zero), that cointegrating vector disappears from the system. Thus, changes in policymaker's rules may identify conditional models as structural by demonstrating the conditional models' invariance to switches in policy.

Johansen (1992a) shows that the asymptotic distributions of sub-system cointegration statistics vary, depending upon the presence or lack of weak exogeneity and tests $\alpha_2 = 0$, for weak exogeneity. Hendry (1995a) analyses the asymptotic distributions of estimators for a single-equation conditional linear relation and shows that Granger-causality does not seriously impede inference when weak exogeneity holds, so strong exogeneity is not necessary to sustain inference. However, in cointegrated processes the absence of weak exogeneity can have adverse effects on estimation in small samples, and on inference asymptotically as well, even when the model under analysis coincides with the conditional expectation. Tests for weak exogeneity do not necessarily coincide with tests for orthogonality between regressors and errors: the latter may reveal other forms of misspecification of the fitted model when it does not coincide with the conditional expectation, and may reveal no

misspecification when the fitted model coincides with the conditional expectation but weak exogeneity is violated.¹⁷

Invalid conditioning can result in parameter non-constancy when there are changes in the process generating the conditioning variables. Anderson and Mizon (1989) argue that apparent structural change in conditional sub-models can provide an indirect test of the weak exogeneity hypothesis.

Hunter (1992) describes his recent concept of 'cointegrating exogeneity', which has implications for long-run forecasting of cointegrated variables. Cointegrating exogeneity is the condition that the long-run cointegrating relations between a set of variables are block triangular. Under cointegrating exogeneity, cointegrating relations between a subset of those variables may feed back onto all variables, but cointegrating relations between all variables do not feed back onto the subset. Thus, for long-run purposes, the subset of variables may be forecast without considering long-run relations involving the remaining variables. Certain zero restrictions on the weighting coefficients correspond to weak exogeneity, and other zero restrictions on both the weighting coefficients and the cointegrating vectors imply cointegrating exogeneity. Hunter illustrates the tests of weak and cointegrating exogeneity with data on prices, interest rates and the exchange rate for the United Kingdom.

¹⁷ See for formulations of weak exogeneity conditions and tests for various parameters of interest in cointegrated systems Boswijk (1992, 1995), Dolado (1992), Hendry and Mizon (1993), Johansen 1992a, 1992c), Johansen and Juselius (1990), Urbain (1992) and Ericsson and Irons (1994, 1996).

5. CONSTANCY AND INVARIANCE - SUPER EXOGENEITY

Extending the information set over time, across regime shifts or by additional variables should not alter the knowledge achieved about structural parameters: when they are invariant and constant, such parameters satisfy all the testable attributes of structurality.¹⁸ Thus regression parameters could embody structure. Durability and robustness of nearly orthogonal parameters in conditional models are important: the original dynamic and 'equilibrium correction' parameters recur in greatly extended information sets and over longer time periods, possibly despite considerable regime shifts.

The distinction between *constancy* and *invariance* was reiterated by the analysis of exogeneity: parameters could vary over time but be invariant to policy changes, or be constant over time but alter for a class of interventions. The concept of invariance or *autonomy*¹⁹ is described in Engle *et al.* (1983) where z_t is defined as *super exogenous* for α if z_t is weakly exogenous for α and λ_1 is invariant to changes in λ_2 . Thus, super exogeneity could be violated by a failure of weak exogeneity or by a lack of invariance and tests of super exogeneity could be tests of either or both aspects.

Economic theory focuses on the invariants of the economic process *autonomy*, *deep* or *structural* parameters. Given the link between parameter constancy and predictive accuracy, valid forecasting also relies on constant parameters. Hence, recursive estimation and tests of parameter constancy and predictive accuracy are

¹⁸ Parameter constancy is important for model design, both from statistical and from economic perspectives. It is important to identify empirical models which have reasonably constant parameters and which remain interpretable when any of the underlying parameters or data correlations change for the coefficients of derived 'non-structural' or 'reduced form' equations.

¹⁹ It is more often called 'structural invariance'. See Aldrich (1989) for autonomy.

essential. Recursive estimation of an equation provides a useful tool for investigating constancy, both through the sequence of estimated coefficient values and via the associated Chow statistic for constancy.²⁰ The Chow statistics also play crucial roles a) for testing *weak exogeneity* indirectly through testing the conjunction of hypotheses embodied in super exogeneity and b) for testing feedback versus feedforward empirical models, Engle, Hendry and Richard (1983), Hendry (1988) and Engle and Hendry (1993).

6. INAPPROPRIATE ESTIMATION AND RESIDUAL ANALYSIS

Structure could be lost if inconsistent estimators are used instead of those which would have been obtained by more appropriate methods, since inconsistent estimators deliver different parameters. Campos *et al.* (1996) show that if the two step method in Engle and Granger (1987) is used when the imposed common factor restrictions are invalid²¹, structurality can be lost in the model despite its presence in reality.²²

One must be concerned that implementations of the resulting models could be non-structural even when the theory happened to capture some structural aspects of reality.

²⁰ These tests of constancy are intimately related to tests of forecast accuracy, see Phillips and Harvey (1974), Brown, Durbin and Evans (1975), Hendry (1979) and Kiviet (1986) and see Dufour (1982), Hendry and Neale (1987) and Hendry (1995) for recursive techniques and their implications.

²¹ Campos and Ericsson (1988), Kremers (1989), Hendry and Ericsson (1991a) and Kremers *et al.* (1992) show that an implicit common factor restriction imposed when using the Dickey-Fuller test remains consistent, but loses power relative to cointegration tests that do not impose a common factor restriction, such as those based upon the estimated equilibrium correction coefficient. Thus the Dickey-Fuller statistic ignores potentially valuable information and the loss of information occurs from invalid common factor restrictions and assuming error dynamics rather than structural dynamics.

²² Campos *et al.* (1996) examine the finite-sample properties of several cointegration tests when the marginal process of one of the variables in the cointegrating relationship is stationary with a structural break. They show that a stationary process with a break is virtually observationally equivalent to a unit root process with no break, and the break has little effect on the size of the cointegration tests. However, tests based on estimated equilibrium correction models generally are more powerful than Engle-Granger's two step procedure employing the Dickey-Fuller unit root test when the DGP does not have a common factor.

In addition, an emphasis on interpreting the unmodelled component in a model seems misplaced, as 'errors' could be structural only with the additional assumption of omniscience. Focusing on the unmodelled component in an analysis seems unlikely to be as productive as seeking to interpret what has been explicitly modelled. For example, in the presence of the serially correlated errors, the appropriate approach would be to check the adequacy of the dynamic specification of the model rather than adopting estimation methods that will allow for auto-regressive error processes.

7. EXPECTATIONS

Hendry (1995) argues that a theory, or class of models could be rejected by testing against a class of encompassing contenders which are mutual counter examples. Favero and Hendry (1992) show that the Lucas (1976) critique leads to an expectations' based counter example to any claimed invariant conditional model - a crucial test between them is feasible. The Lucas critique²³ is explicitly of the use of econometric models for policy analysis.

The point made by Lucas is that one cannot use conditional sub-models for policy simulation analysis when the parameterisation of the conditional sub-model is not constant over time. There can be different reasons for the non-constancy over time of the conditional sub-model. The most commonly argued reason is the use of a feedback econometric formulation when agents follow feed-forward behavioural rules. A typical example is the use of a feedback consumption function, when agents behave according to a life cycle-permanent income hypothesis. However, the Lucas

²³ Lucas's critique of econometric models simply focuses on how parameters in policy rules may enter parameterically into economic agents' optimisation rules.

critique is testable, and hence it is possible to discriminate between models affected by the critique and models which can be used under certain conditions for policy simulation analyses. Favero and Hendry (1992) propose three levels of applicability of the critique:

- a) agents' plans depend on the environment;
- b) agents' plans depend on the control rules of others;
- c) agents' plans depend on expectations.

A critique at level (a) entails that there may exist *a sufficiently large change* such that no previous empirical evidence is relevant. Thus, level (a) is 'generically conformable' since any given claimed instance could potentially be corroborated and by doing so reject the invariance. To that extent, level (a) of the critique is testable. Level (b) concerns the variation in parameters with changes in the distributions of variables which are outside the direct control of the agents being modelled. Super exogeneity may be violated by the dependence of model parameters on policy agency control rules or on the distributions of the conditional variables. Like (a), this level is generically conformable but only specifically refutable, since future changes in other variables may alter the parameters of interest. Level (c) is a critique of the use of a 'backward-looking' econometric specification when behaviour of economic agents follows forward-looking rules: in this case, the regression coefficients are not the parameters of interest, they are mixtures of the behavioural and expectations parameters. Encompassing comparisons are feasible as well as invariance generic refutation. Generic refutation of a level (c) critique entails that the Lucas critique can be refuted.

Policy analysis cannot be validly performed given a failure to model any feed-forward mechanisms. The estimated parameters are mixtures of expectations

parameters and plan parameters, and so vary when a new policy regime changes agents' expectations.²⁴ Thus, if an Equilibrium Correction Models (ECM) specification for the consumption function is a reduced form of a forward looking model (FLM), then the estimated parameters are bound to be mixture of 'deep' and 'expectational' parameters. The regressors in the model are not super exogeneous for the parameters of interest, the model is vulnerable to the Lucas critique. Thus, if economic agents base their decision on forward-looking expectations and empirical models fail to account for that, then those models will mispredict when policies change and so will generate misleading policy simulations. The Lucas Critique is empirically testable, being both conformable and refutable.

Favero (1993) investigates the relation between ECM and FLMs and establishes the conditions under which the ECM cannot be considered a reduced form of a forward-looking model. He shows that the equilibrium cointegrating relation for consumption has the feature that its parameters depend on the parameters of the process generating income, relative prices of durables to non-durables and the real interest rates. However, since the long-run solution of the ECM specification is the cointegrating vector, the parameters in this specification for consumption will alter every time the marginal processes generating real income, relative prices and the real interest rate are subject to structural breaks. Hence, he tests whether the ECM model has constant parameters when the marginal processes for real interest rates, real

²⁴ Favero (1993) argues that a forward looking Rational Expectations model is not affected by Lucas critique because it depends only on 'deep' parameters, which are not function of expectations and are 'policy invariant' and given the properties of the residuals these parameters can be estimated consistently. However, an ECM consumption function fits better than a forward looking Rational Expectation model, because it models the innovation. The cost of the reduction of the standard error of the equation is the inclusion in the parameters of interest of some 'expectational' parameters, which are not policy invariant.

income and relative prices are not constant, then the ECM model cannot be considered as a reduced form of the forward looking model. He argues that the stability of the ECM parameters can be consistent with an unstable process for income if, in a forward looking framework, agents form their expectations using data-based predictors rather than unstable econometric models. However, the stability of the ECM parameters cannot be reconciled with the instability of the process for the interest rate in the context of a Life-Cycle Model, and this result is independent from the specification of the mechanism used to generate expectations. This results can be explained by the existence of liquidity constrained agents or by the interpretation of the 'rule-of-thumb' behaviour as a near-rational alternative to inter-temporal optimisation.

However, Muellbauer (1996) shows that when the policymaker's preferences, and so their policy rules, shift such as the shift in fiscal policy in the late 1980's reflecting concern over the budget deficit and marked by the Budget Enforcement Act of 1990 in the USA, a corresponding shift should take place in the reduced form income forecasting and in the budget deficit forecasting equations at the same time.²⁵

Hendry (1988) considers two mutually inconsistent theories when expectations are involved: feedback and feed-forward models. A high degree of constancy in a contingent plan equation is inconsistent with the joint claim of an expectation interpretation and non-constant expectation formation.

²⁵ However, the observed non-constancy may arise from dynamic misspecification, omitted variables and incorrect functional forms; such as the failure of the weak exogeneity other than one involving expectations. Non-constancy can arise from an omitted variable bias, where the bias depended on a correlation with a policy variable and so would change when the associated policy rule changed, see Ericsson and Irons (1996). Muellbauer (1996) also suggests to estimate a full structural model of policy making, estimating the preference parameters and their shift from a full set of simultaneous equations imposing the cross restrictions.

Consider the following behavioural model of a variable y_{t+1} :

$$E(y_{t+1}|I_t) = \beta_t E(z_{t+1}|I_t). \quad (3.19)$$

It is assumed that (3.19) correctly characterises the behaviour of the relevant economic agents for some specification of the information set I , and that $\beta_t = \beta \quad \forall t$ for that choice of I . The rival hypotheses about expectations and conditioning are:

$$H_c: E(y_{t+1}|z_{t+1}) = \beta' z_{t+1} \quad (3.20)$$

$$H_e: E(y_{t+1}|x_t) = \beta' E(z_{t+1}|x_t) \quad (3.21)$$

If we allow the possibility that either hypothesis may be incorrect, then:

$$E_c(y_{t+1}|z_{t+1}) = \gamma z_{t+1} \quad (3.22)$$

$$E_e(y_{t+1}|x_t) = \delta E_c(z_{t+1}|x_t) \quad (3.23)$$

and can be also expressed in model forms:

$$H_c: y_{t+1} = \gamma z_{t+1} + v_{t+1} \quad E_c(z_{t+1}v_{t+1}) = 0 \quad (3.24)$$

$$H_e: y_{t+1} = \delta E_c(z_{t+1}|x_t) + \varepsilon_{t+1} \quad E_c(x_t \varepsilon_{t+1}) = 0 \quad (3.25)$$

The following equation shows regime shifts which sustain powerful encompassing tests for discrimination between feedback and feed-forward models²⁶:

$$z_{t+1} = \pi_{0t} + \pi_{1t} x_t + \omega_t \quad \omega_t \sim ID(0, \Omega_t) \quad (3.26)$$

describes the marginal process for z_t .

If (3.24) and (3.26) correctly characterise the sequential process generating (y_{t+1}, z_{t+1}) conditional on (Y_t, Z_t, X_t) then the conditional model sustains an expectation interpretation, though the converse does not hold. From (3.24):

$$E_c(y_{t+1}|x_t) = \gamma E_c(z_{t+1}|x_t) \quad (3.27)$$

²⁶ Favero and Hendry (1992) and Hendry (1996, 1997) show that intercept shift are more effective in discriminating between these two models.

and from (3.25):

$$E_c(y_{t+1}|x_t) = \delta'E_c(z_{t+1}|x_t) \quad (3.28)$$

so that both hypotheses anticipate a constant linear relationship between $E_c(y_{t+1}|x_t)$ and $E_c(z_{t+1}|x_t)$. If $(\pi_{0t}, \pi_{1t}, \Omega_t)$ in (3.26) are non-constant, then the projection of y_{t+1} on x_t is also non-constant:

$$E_c(y_{t+1}|x_t) = \gamma'\pi_{0t} + \gamma'\pi_{1t}x_t \quad (3.29)$$

and the error variance is non-constant since:

$$y_t - E_c(y_{t+1}|x_t) = v_t + \gamma'\omega_t = \xi_t \quad (3.30)$$

with $E_c(\xi_t^2) = \sigma_v^2 + \gamma'\Omega_t\gamma$.

Thus, the reduced form should fit worse than the behavioural model, since $\gamma'\Omega_t\gamma \geq 0$.

Favero and Hendry (1992) consider single shifts in the intercept π_{0t} (and hence long-run mean) and variance of the z_{t+1} process; and show the low power of the constancy test of the conditional model and the high power of the constancy test of the marginal model for expectations.²⁷

If (3.25) and (3.26) correctly characterise the DGP, then

$$E_c(y_{t+1}|z_{t+1}) = \alpha'_t z_{t+1} \quad (3.31)$$

The conditional model cannot be constant if π_{0t} and Ω_t are varying independently, then α_t must vary. Thus, z_{t+1} cannot be super exogenous for δ under H_c even though z_{t+1} does not even enter (3.25).

²⁷ The test powers of the conditional model are low for even large changes (twelve fold) in the error variance of the marginal process, and despite a fourfold change in the long-run mean, rejection rarely exceeds 20% and for a doubling of the intercept, the power barely exceeds the size. However, the marginal model was rejected over 90% of the time at the break point and the intercept shift led to a larger change in the marginal process.

The constancy²⁸ of a conditional model in the face of a changing marginal process entails that agents do not use expectations models to predict future values of relevant decision variables, because in practice contingent planning dominates forward-looking behaviour. Furthermore, agents may form expectations without using models, but use data-based predictors²⁹, perhaps because of high costs of information collection and processing.

Ericsson and Irons (1996), after investigating 513 articles on Lucas critique suggest that almost no test of the critique has ever rejected the conditional model, whereas several results are inconsistent with the critique.³⁰ They suggest that even with super exogeneity, *data-based* predictors are allowed, so equilibrium correction models are conditional and hence 'feedback' in an important statistical sense, so these models are interpretable economically as forward looking. That is, the predictor is data-based, not model-based. Conditional models imply trivial losses in utility relative to an expectational solution.³¹ Data-based predictors may be only slightly less accurate than model-based ones; and the information costs to agents may be high for achieving a model-based predictor that betters a data-based one, particularly in the presence of frequent regime changes to a complicated policy reaction function. A conditional equilibrium correction model thus may parallel an optimal decision rule by agents facing such information costs. Policy can and in general does affect agent

²⁸ See also for non-constancy of the coefficients of econometric equations under changed states of nature Robbins (1932), Frisch (1938), Keynes (1939), Haavelmo (1944), Marschack (1953), Hurwicz (1962), Aldrich (1989), Lucas (1976), Hendry (1979), Salmon and Wallis (1982) and Engle, Hendry and Richard (1983).

²⁹ If the lagged values of the predictor variables are relevant, so expectations and outcomes are cointegrated then the criticism of incomplete specification of the expectations formation processes of agents become irrelevant.

³⁰ They suggest that many papers fail to identify the Lucas critique, because they cited Lucas critique in defining a regime shift, rather than for using a regime change to investigate the importance of the Lucas critique.

³¹ See Akerlof (1979), Akerlof and Milbourne (1980), Cochrane (1989) and Hendry (1995).

behaviour when super exogeneity holds. Policy does so through the variables entering the conditional model, albeit not through the parameters of that model. Under super exogeneity, the precise mechanism that the government adopts for such policy does not affect agent behaviour, except insofar as the mechanism affects actual outcomes.

Favero (1989) shows that *an encompassing test* can discriminate between expectations and feedback provided there are regime shifts, a conclusion reinforced by the presence in the behavioural model of expectations about future events. Favero (1989) explains how the use of the feedback mechanism when agents are forward looking can be considered as a special case of a model subject to Lucas' critique. He applies the encompassing tests for discriminating between a feedback (ECM) consumption function and a Rational Expectations Hypothesis, either 'pure' or 'expectations augmented'. He concludes that it cannot be claimed that a feedback consumption function is useless for a policy simulation exercise, because it does not take into account the expectations. His results show that all the encompassing tests are in favour of the feedback formulation, and when performing the Davidson-McKinnon test, if the estimated value for the change in consumption from the feedback model is inserted among the regressors of the feed-forward mechanism, it is not only very largely significant but it also reduces dramatically the significance of all the other regressors.

Ericsson and Irons (1996) suggest that obtaining the smallest mean square forecast error in expectations-based models does not guarantee the evidence in favour of these models. If strong exogeneity is invalidly assumed, the models' ranking from multi-step ahead forecast criteria could be affected. Additionally, the forecasts themselves could be informative about misspecification and could be shown by

constructing *forecast-encompassing tests*.³² Forecast-encompassing test statistics have implicit null hypotheses that combine hypotheses of parameter constancy and complete parametric encompassing.

Hendry and Neale (1988) consider the implication of the joint application of *exogeneity* and *encompassing* on the role of expectations versus feed-backs in stationary processes. They show that the class of invalid inferences about long-run derived solutions described by Kelly (1985) results from an invalid exogeneity assertion. If actual values are used in place of expectations when the latter determine behaviour, then the associated variables will not be weakly exogenous for the parameters of interest. In such a situation, other inferences will also be invalid (e.g., the short-run parameters will be biased in general), but if the long-run is correctly conjectured with valid homogeneity assumptions then even in stationary processes the only biases will be about short-run dynamics. An error-variance ranking is developed to detect invalid conditioning by discriminating between feedback and expectational models, but in a *stationary world* testing is unlikely to be effective in rejecting models in either class. Hence, if the analysis is extended to consider the case where sets of $I(1)$ variables are cointegrated under (weakly) rational expectations, the long-run would be correctly estimated despite that weak exogeneity being violated. Moreover, even if a static solution was calculated by incorrectly assuming $I(0)$ behaviour for the levels of the variables, the resulting long-run levels coefficients remained correct and inferences about the short-run would still be invalid due to the inappropriate assumption of exogeneity. The point is that when the data are integrated of order one

³² See Fair (1985), Chong and Hendry (1986), Wallis (1989), Ericsson (1992b) and Lu and Mizon (1991) for forecast-encompassing.

and are cointegrated, the long-run solution is correctly estimated despite ignoring expectations.

8. EVALUATION AND DESIGN OF EMPIRICAL MODELS

An empirical model is associated with a set of transformations and reductions of the DGP, with those transformations and reductions producing the (reduced) parameterisation of the econometric model. The various steps from one to the other are *marginalization, sequential conditioning, distributional assumptions (e.g., normality), linearization, lag truncation, contemporaneous conditioning, and parameter constancy* as discussed in Ericsson *et al* (1990). Given the observed data and some formal model specification, the model's error process³³ is a derived function rather than an autonomous innovation. Thus, by construction, the error contains everything in the data which is not explicitly allowed for by the model.

Data based modelling (sometimes called *measurement without theory*) is feasible due to its dependence on low-level theories.³⁴ While *theory without measurement*³⁵ also occurs, a blend of theory and evidence is needed, which depends on the usefulness of the existing theories. The empirical model obtained is valid if its theoretical basis is a credible one.³⁶

³³ Likewise, parameters of the empirical model are derived and defined by the model's specification and the orthogonality conditions of the estimation technique.

³⁴ Congruence with economic theory such as the choice of variables to include in the model and of the functional forms (called *low level of theory*) are essential features for econometric models. However, theories that imply very tight and specific forms for econometric models are called *higher level theories* that embody testable hypotheses.

³⁵ Under the notion of theory without measurement, a model is derived from *a priori* theory and not even calibrated from data evidence.

³⁶ See Hendry and Richard (1982, 1983), Hendry (1983b, 1986, 1987, 1992, 1994, 1995), Hendry and Wallis (1984), Hendry, Pagan and Sargan (1984), Spanos (1986), Hendry, Leamer and Poirier (1990), Gilbert (1986, 1989), Phillips (1988), Hendry, Spanos and Ericsson (1989), and Hendry, Qin and Favero (1990) for econometric methodology.

The main controversies in applied econometrics include the following four issues: the validity of earlier (or rival) findings; interpreting salient data features; the status of empirical models and the role of test statistics in evaluation. However, a framework that builds on five major constructs can analyse and partially resolve all four issues:

1. Empirical models are reductions of a common data generation process and are not numerically calibrated theoretical models.
2. Since the error processes on empirical models are derived via the reduction operations and are not autonomous, models can be *redesigned* to achieve the *desired criteria*, and test statistics used in that design process are part of the *selection criteria*.
3. A successful model should be able to encompass the empirical evidence which involves previous findings, data graphs and even-data mined results.
4. The validity of constructs 1-3 leads to recursive estimation which assume constancy of the model for the whole historical period.
5. Non-stationarity of time series makes it easier to detect inadequate models.³⁷

Hendry and Richard (1982) describe empirical models as a *reduced* representation of data generation process for a given measurement system. Since the dependent variable is observed, the disturbance on any equation (i.e., the unexplained component) must be derived and not an autonomous process, defined by the specification of the model and its associated estimation procedure. Hence, error terms can be redesigned by model re-specification to satisfy predefined criteria.

³⁷ Hendry (1992) argues that data-mining entails important unencompassed data evidence; that genuine testing requires evidence unavailable at the modelling stage; that previous findings are interpretable despite being potentially invalid; and that recursive procedures are a more powerful method of testing both models and conjectures than full sample estimation alone.

An empirical model should satisfy a range of *criteria* to be credible. The main *criteria* in question relate to goodness-of-fit, absence of residual correlation and heteroscedasticity, valid exogeneity, predictive ability, parameter constancy, the statistical and economic interpretation of estimated coefficients and the validity of a *priori* restrictions.

Hendry and Richard (1982) consider a *taxonomy* in which *design criteria* are related to particular types of information available to the modeller. A *taxonomy* entails restrictions relative to five distinct sources of information, which are summarised as:

1. (*past data*) homoscedastic white-noise disturbances, which are an innovation against the available information and are approximately normally distributed;
2. (*present data*) weakly exogenous conditioning variables, which would comprise regressors in least squares, or instruments in instrumental variables methods;
3. (*future data*) parameters of interest, which are constant over relatively long time periods and invariant across regimes;
4. (*theory information*) relationships that are consistent with the theoretical framework;
5. (*rival model information*) results which explain the findings of other models of the same phenomena and explain additional phenomena.

Since empirical models are reductions of the common DGP, the structure of that DGP and the degree of reduction must interact to determine the extent to which any or all of these five criteria can be satisfied.

The basis for a test statistic can be constituted by decomposing each of the test criteria 1-5 listed above into a specific null hypothesis (e.g., homoscedasticity, serial independence etc.). However, lack of power in some tests when other

misspecifications are present (*implicit null*) cause a specific alternative to contain little information about the alternative model formulation as stated in Breusch (1986) and Mizon and Richard (1986). A more serious objection to testing is that tests statistics can be made insignificant by construction. *Rejection is not final*, since the correction procedure adopted is deliberately selected to ensure that the test criterion will not be significant after the re-specification, so such an outcome occurs *independently of the correctness of the selected solution*. Thus, the test merely reflects the design, not model validity. However, rejection on a test entails the invalidity of the current model (or a type I error). Moreover, if *repeated testing* causes rejection on some other test, then the entire modelling process must be discarded, since rejecting the predicating assumptions implies that earlier inferences must have been incorrect. In this case, Hendry and Mizon (1978), Sargan (1980b) and Hendry *et al.* (1984) suggest that for testing common factors, the validity of an auto-regressive error representation against a *general dynamic model* will not suffer from this difficulty, because the test outcome is not independent of the correctness of the solution. White (1990) and Hendry (1992) suggest that repeated testing needs to be formulated in a way that allows control over the size of the complete testing process which is consistent with general to specific methods and size must decline as the sample increases to ensure a consistent test sequence.

Sources of information 1-4 generate reasonably conventional criteria for selection and evaluation of models, however, such criteria are minimal in that they often can be satisfied simply by designing empirical models appropriately. Within-sample 'test statistics' become *selection criteria*, since 'large' values on such tests would have induced a re-designed model. While these criteria are necessary, they are not sufficient to justify a given model for inference, forecasting or policy analysis.

Genuine tests of a data-based formulation occur from 5 which often help *evaluate* a given model. The ability of a model to encompass a rival hypothesis, demonstrates that the information in 5 is irrelevant, conditional on 1 and 4.

The table in Appendix 3.B summarises the test statistics, which are arranged by the types of information generating testable null hypotheses: the data of one's own model, the measurement system of the data, economic theory and the data of alternative models.

A theory or a hypothesis is corroborated by evidence which is consistent with an implication of that theory, when the evidence could have refuted the theory.

However, corroboration is insufficient to 'verify' a theory, and in practice only offers weak support for a theory, especially when the theory is formed to explain evidence previously obtained. For example, a theory might have at least one corroborating instance. But if a second item of evidence is later discovered and by itself also corroborates the theory, nevertheless, these two items together could in fact refute the theory: see Ericsson and Hendry (1997). Thus, the requirements of corroboration and non-rejection are necessary but not sufficient. In that research strategy, the encompassing principle has the major role, by building on earlier findings and thereby trying to explain more with a given model.

To distinguish between the roles of model discovery and model justification in empirical model-building is important. In model justification, tests such as in Appendix 3.B are fundamental as *evaluation criteria*. They help detect whether or not a model is well-specified, i.e., whether or not that model entails valid restrictions against the various information sets considered. In model discovery, while 'failed' tests may indicate the sorts of misspecification present, most tests have power against a wide range of alternatives other than the one for which the test was designed.

9. ENCOMPASSING

A good model should be able to account for the results of any rival models. Encompassing seeks to implement this idea by requiring any given model to account for or explain the results obtained by other models, which was first proposed in Hendry (1974), Hendry and Anderson (1977), and Davidson, Hendry, Srba and Yeo (1978). However, the conceptual basis of encompassing has since been formalised and related to the theory of non-nested hypothesis testing (see *inter alia* Cox (1961, 1962), Paseran (1974), Hendry and Richard (1982, 1989), Dastoor (1983), Mizon (1984), Chong and Hendry (1986), Florens, Hendry and Richard (1987), Mizon and Richard (1986), Florens and Richard (1989), Mizon and Lu (1993), Ericsson and Hendry (1992), Govaerts, Hendry and Richard (1993), Florens, Hendry and Richard (1994)). In the case of a VAR, Monfort and Rabemananjra (1990), Clements and Mizon (1991), Palm (1986), Hendry and Mizon (1990, 1993), and Maravall and Mathis (1992) state that a well specified structural model should encompass the results obtained by a VAR model, hence an important way to evaluate a structural econometric model is to check whether it encompasses the appropriate VAR model.

Encompassing is essential in econometric analysis, because: first, when there are two or more contradictory explanations for a phenomenon, at least one of them must be wrong. This suggests an *invariance principle* for selecting tests, namely, to ensure that test properties are not influenced by features that are common to the models being compared. Secondly, because every model is a reduction of the data-generation process, empirical models are just reduced combinations of the data. Thus, if a model M_1 claims to explain the data, then M_1 ought to be able to explain the re-

combinations of that same data which are the rival models. The *encompassing principle* addresses the issue of whether any empirical model M_1 can explain why another model M_2 has found the results which M_2 reports. Thirdly, when the rival empirical models have prior theory-model bases, then either there co-exist competing theoretical paradigms between which testing is required, or the given theoretical framework does not have unique empirical implications. Fourth, the encompassing approach can be extremely useful for the *ex post* validation of M_1 , since a model M_2 that has been formulated by other investigators will typically incorporate features that were not specifically examined by the proprietor of M_1 and so M_2 provides 'fresh' evidence for evaluating M_1 .

Encompassing transpires to be a natural implication of the theory of reduction. Encompassing, denoted by \in , is reflexive and anti-symmetric, but not necessarily transitive. The absence of transitivity arises from the simple to general modelling inherent in extending information. Definition of encompassing does not necessarily satisfy non-transitivity requirement but a modification of encompassing does, namely parsimonious encompassing, denoted \in_p is transitive, and so supplants the original concept. Letting \notin denote 'does not encompass' we deduce that if $M_1 \notin M_2$, then M_2 reflects specific features of the DGP that are not included in M_1 .

Parsimonious encompassing, requires a small model to explain the results of a larger model M_m within which it is nested. Having reduced a model to the smallest representation that is not an invalid reduction, the final model must still explain the initial one and hence should parsimoniously encompass it. Let M_m denote the minimal nesting model for M_1 and M_2 . If $M_1 \in M_2$, M_2 provides no information beyond M_1 , and since M_m reflects the information of the DGP in addition to that in

M_1 only to the extent that M_2 does, then M_1 will also encompass M_m ($M_1 \in_p M_m$). In linear models $M_1 \in M_2$ if and only if $M_1 \in_p M_m$. Parsimonious encompassing is transitive in that no information is lost between model comparisons. The general to simple procedure using parsimonious encompassing involves testing the validity of any reduction from M_m to M_1 to check whether $M_1 \in_p M_m$ since $M_m \in M_1$ must hold because of nesting. Bontemps and Mizon (1996) argue that nesting is more than just one model being an algebraic simplification of another, that the congruence of a model is a sufficient condition for it to nest and encompass a simplification of itself. If $M_1 \in_p M_m$ and $M_m \in_p M_3$, then $M_1 \in_p M_3$: with parsimonious encompassing, later models explain the same evidence using fewer parameters. This also suggests that acceptable models explain more data information.

As a research *tactic*, encompassing provides a basis for model comparisons, as well as integrating a large and diverse literature covering nested and non-nested hypothesis testing.

The knowledge of the DGP entails knowledge of the model and hence the former must encompass the latter. A valid model M_1 ought to be able to predict the parameter values in other models $\{M_i\}$, because under the hypothesis that M_1 is congruent, the other models are reduced parameterisations of M_1 . Encompassing has a natural interpretation as a *test principle*, because if M_1 does not mimic the DGP, so the predictions from M_1 about the other models turn out to be wrong, in which case we learn that M_1 is incorrect. The encompassing question is whether or not M_1 can explain the parameter value of model M_2 .

Non-encompassing defines the limit to model reduction, because the point at which we can no longer encompass is the point at which reduction is no longer valid.

Mizon and Richard (1986) show that encompassing provides a test generating equation which is the mirror image in testing theory of the Estimator Generating Equation (EGE) in estimation, with power against different alternatives. Furthermore, encompassing supports inference in misspecified models. Encompassing is crucial in building congruent models because when we have exhausted the direct data evidence by a general to specific search procedure, it is a stringent check on a model, to test against outside models.

Level of Encompassing:

Hendry and Richard (1989) propose three different levels of analysing encompassing: *specification, misspecification and selection*: specification encompassing explains the results actually obtained by another model; see Hendry and Richard (1982), misspecification encompassing predicts features of another model of which its proprietor is unaware; see Hendry and Anderson (1977); and selection encompassing explains why an appropriate or inadequate model was chosen in preference to the encompassing model; see Davidson *et al.* (1978).

Test Types:

Mizon and Richard (1986) propose a Wald Encompassing Test (WET) which tests the parameters of the two equations and Cox (1961) compares the variances of the two equations which is a non-nested hypothesis. Thus, a model must variance dominate its rival as a necessary condition for encompassing; if M_1 is to encompass M_2 , it must begin by fitting at least as well as M_2 . Variance dominance is a necessary but not a sufficient condition for encompassing. Being best fitting does not guarantee that

a model will encompass rival evidence. Further, a success of variance-encompassing test does not entail parameter encompassing. However, if an encompassing model variance dominates its rival then it is the best fitting (see Hendry, 1995). A Simplification Encompassing Test (SET), Mizon and Richard (1986) and a Hausman Encompassing Test (HET), Hausman (1978) are amongst other tests for *parameter encompassing*. The SET and the WET are functions of the *F*-test in the linear regression analysis, but when there are weakly exogenous regressors, the SET is not the *F*-test. Encompassing tests are also residual diagnostic tests to test whether or not the encompassing difference is significant.

Test Invariance:

If $M_1 \in M_2$ and $M_1 \in_p M_m$, then it should be possible to add any subset of variables from M_1 to M_2 to create another rival model M_2^* and it is still necessary for M_1 to encompass M_2^* . In terms of a *testing principle*, tests of encompassing should be *invariant* to adding subsets of M_1 to M_2 . The *F*-test or the Simplification Encompassing Test is the only invariant test for linear models because it tests M_1 against $M_1 \cup M_2^\perp$ and is not concerned with the specification of M_2 beyond the fact that it contains M_2^\perp .

Conditional Models:

When *conditional models* are compared, a completing model M_c is needed to link their unmodeled variables in the rival claims. The specification of a completing model can affect the robustness of encompassing tests in conditional models. The completing model recovers the joint density of all the variables. Comparisons

between the models are possible in the case of a completing model only if they lie in a common probability space.

If we have two rival conditional linear single-equations:

$$M_1 : y_t = \alpha z_{1t} + \beta z_{2t} + \varepsilon_t \quad (3.32)$$

and

$$M_2 : y_t = \gamma z_{1t} + \zeta_t \quad (3.33)$$

An encompassing 'test' of the hypotheses that (3.32) encompasses (3.33) could check whether $\alpha = \gamma$ (via a Hausman-type test). However, if z_{1t} and z_{2t} are not orthogonal, then nesting is insufficient to ensure encompassing. Govaerts *et al.* (1993) and Mizon (1993) argue that nesting must be decided at the level of the joint density, and was defined to ensure a close relationship with encompassing. The auxiliary claim of the orthogonality of two exogenous variables does not alter the nesting relation but could affect encompassing, and such a misspecification leads to a non-robust and inconsistent encompassing test. However, commencing analyses with the joint density and checking encompassing by testing parsimonious encompassing of the initial general model by later reductions will solve this problem. Parsimonious encompassing can also avoid contradicting the baseline model when formulating local alternatives under which to derive powers of encompassing tests, since in some circumstances the encompassing test may have lower local power than the corresponding *F*-test.

In integrated systems with cointegrated relationships, Hendry and Mizon (1993) develop asymptotically valid encompassing tests for linear equations or subsystems against each other, or the VAR when the latter is the DGP. Parsimonious encompassing is the final check on a reduction sequence, by which stage, mapping to

I(0) variables will usually have occurred. Thus, two rival complete simultaneous equations models (SEM) with I(0) space H_a and H_b have error covariance matrices Σ_{aa} and Σ_{bb} , respectively so that H_a dominates H_b if $\det(\Sigma_{aa}) \leq \det(\Sigma_{bb})$ which is necessary but not sufficient for $H_a \in H_b$. Both H_a and H_b are nested in the VAR which is denoted by $H_i \subset VAR$. The issue is whether H_a or H_b encompasses the VAR. If H_a or H_b encompasses the VAR, so $H_a \in_p VAR$ or $H_b \in_p VAR$, then a reduced model is accounting for the results of the more general model within which it is nested, so we have '*parsimonious encompassing of the VAR*', denoted by $H_a \in_p VAR$. The main difficulty in establishing encompassing theorems about SEMs is that their exogeneity assumptions may differ so widely that models are not in a common probability space unless the systems are closed. Furthermore, the encompassing theorem in VAR models defines an equivalence class of mutually encompassing models, all of which could be identifiable by their *a priori* restrictions. However, testing for the Lucas critique can solve this problem because policy regime changes will induce changes in some of the parameter sets and only the actual structure of behaviour will remain constant, therefore the mutual encompassing will be avoided.

Maravall and Mathis (1992) evaluate a VAR model to see if the results obtained with a univariate analysis can be explained by the VAR, i.e., if the ARIMA models implied by the VAR are close to the ones found in univariate analysis. Since identification of univariate models is easier than identification of VAR models, if an implied ARIMA model is substantially different from an ARIMA model that fits the univariate series, the difference may well reflect misspecification of the multivariate model.

10. CONCLUSIONS

In this chapter I have tried to explain theoretical and applied modelling issues to construct a theory-consistent, congruent and encompassing model.

Chapter 4:

SMALL-SAMPLE PROPERTIES AND MONTE CARLO SIMULATIONS

1. INTRODUCTION

In this chapter, we investigate the small-sample properties of the statistical methods used by means of Monte Carlo¹ simulations. We look at the case of an unrestricted VAR and focus on what can we learn from a VAR with small-samples of noisy data combined with a high real growth rate and nominal inflation.

If the question is what can we learn by applying econometric methods in *open* models to small samples with low frequencies (annual data), then the concept of 'strong exogeneity' becomes important for defining informativeness. Thus, the variance of strongly exogenous variables determines as a percentage of total variance; the signal relative to the noise. In closed systems, signal-noise ratios are less clear.

The Monte Carlo experimentation here is designed to analyse I(1) closed systems, and so must take into account the effects of different ratios of intercepts (ϕ) relative to SDs (σ) (determining relative growth) and error co-variances (against zero as the baseline). Hylleberg and Mizon (1989) discuss the relative merits of the

¹ Monte Carlo is a general technique for solving a deterministic mathematical problem by substituting a stochastic problem which is known to have the same solution, then solving the latter by simulation, [see, Hendry (1984)]. Here, however, we only do distribution sampling. Such experiments begin by creating a set of data with known statistical properties. This is achieved by specifying every aspect of a data-generating process and replacing the random errors of the DGP by pseudo-random numbers. Pseudo-random numbers are numbers generated deterministically to mimic a random process with a particular distribution. Monte Carlo results are useful when analytical results are difficult to obtain. In particular, Monte Carlo experiments are often used to investigate the finite sample performance of statistical techniques, the analytical properties of which may be unknown.

alternative parameterisations of cointegrated systems.² In terms of informativeness of data, they argue that *the rate of growth of the data* matters relative to the equation error variance, not the variability of data. Campos and Ericsson (1990) note that even with a small sample size³, the coefficient estimates in a conditional model can be well-determined, and corresponding tests powerful, provided that the *per* observation variance of the data is large relative to the innovation error variance.⁴ However, they neither discuss the small sample distribution of the alternative estimators and test statistics which have been proposed for cointegrated systems nor the informativeness of the low frequency small-sample data in VARs. This chapter tries to fill this gap by analysing the small-sample properties of a cointegrated system and in the Monte Carlo simulations, two ratios ($\frac{\phi_a}{\sigma_a}$ and $\frac{\phi_b}{\sigma_b}$)⁵ will be investigated. This is to see how the relative drift dominates in explaining the informativeness of the data.

We use a simple bivariate model in the Monte Carlo simulation where there is:

- 1) A cointegrating vector in the bivariate system;

² They argue that the different parameterisations to be preferred depend on the particular problem being analysed. However, when estimating structural models, the equilibrium correction formulation provides a better alternative in terms of applying both the data information and the information obtainable from economic theory. The theory information seems to be especially important when estimating the cointegrated vectors.

³ The sample size is only one of several factors which determine how much information is in the sample.

⁴ This is apparent from the inverse of the information matrix for the coefficient estimate $\hat{\beta}$ in the following equation:

$$y_t = \beta'x_t + u_t$$

$\hat{\sigma}^2.(XX)^{-1} = \hat{\sigma}^2.(T[T^{-1}\sum x_t x_t'])^{-1}$. That is, three factors determine the standard error on a given coefficient: the estimated equation error variance, the sample size T, and the estimated average variance of a single observation x_t . Campos and Ericsson (1990) find that the sixteen years of annual Venezuelan data have about 10% more information than four decades of quarterly US data. Even though the Venezuelan sample size (T) is one tenth that for the US and $\hat{\sigma}$ is about three times that for the US, the *per* observation data variance is over eighty times that for the US.

⁵ When these ratios increase, unit root tests go to normality, because an increase in these ratios makes the deterministic trend dominate the stochastic.

- 2) One unit root;
- 3) And a growth rate of 5-10 % per period.

Also the initial conditions need careful treatment to ensure additional non-stationarities are not introduced.

The aim is to explore whether there is any sense in which we learn more from high variance data in a system, as against the single equation where their argument is valid (see, Campos and Ericsson (1990)).

We also look at the sample size effects for: T=40: 80 and T=500, the last to check for a close match with known asymptotic theory results.

We summarise the results by using response surfaces to relate the biases to sample size and we also look at the ratio of standard deviations to standard errors in each equation. The impacts of the system error variances in these response surfaces throw some light on the role of high variance in VARs.

In Section 2, we describe the econometric model. The Monte Carlo Design is specified in Section 3. Monte Carlo simulations and results are presented in Section 4. In Section 5 the main findings are discussed. Section 6 concludes.

2. THE ECONOMETRIC MODEL

We consider a bivariate case:

$$y_{at} = \beta y_{bt} + \varepsilon_{at} + \phi_a \quad (4.1)$$

where $\varepsilon_{at} \sim IN(0, \sigma_a^2)$ and $\sigma_a^2 > 0$.

$$\Delta y_{bt} = \alpha(y_a - \beta y_b)_{t-1} + \varepsilon_{bt} + \phi_b \quad (4.2)$$

where $\varepsilon_{bt} \sim IN(0, \sigma_b^2)$ and $\sigma_b^2 > 0$.

$E(y_{bt}\varepsilon_{at}) = 0$, $E(\varepsilon_{at}\varepsilon_{bt}) = \sigma_{ab}$, $\sigma_a^2 = (\omega_{11} - \omega_{12}^2/\omega_{22})$ and $\omega_{12}^2 < \omega_{11}\omega_{22}$.

$$\begin{pmatrix} \varepsilon_{at} \\ \varepsilon_{bt} \end{pmatrix} \sim IN_2 \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_a^2 & \sigma_{ab} \\ \sigma_{ab} & \sigma_b^2 \end{pmatrix} \right)$$

Then y_{bt} is weakly exogenous for β if and only if $\alpha = 0$ (irrespective of σ_{ab}). The

interesting ratios are $\frac{\phi_a}{\sigma_a}$ and $\frac{\phi_b}{\sigma_b}$ (which determine the relative roles of stochastic and

deterministic trends), and when $\sigma_{ab} = \alpha = 0$, σ_a/σ_b is the signal-noise ratio for the first equation.

The solved form of (4.1) and (4.2) is a VAR.

Consider two variables, y_t and z_t , which are jointly normally distributed and serially independent.

$$x_t = \begin{bmatrix} y_t \\ z_t \end{bmatrix} \sim IN(k + \pi x_{t-1}, \Omega) \quad (4.3)$$

$$k = \begin{bmatrix} k_1 \\ k_2 \end{bmatrix} \quad \Pi = \begin{bmatrix} \pi_{11} & \pi_{12} \\ \pi_{21} & \pi_{22} \end{bmatrix} \quad \text{and} \quad \Omega = \begin{bmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \omega_{22} \end{bmatrix}$$

The DGP can be written in a VAR form:

$$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{pmatrix} y_t \\ z_t \end{pmatrix} = \begin{bmatrix} \pi_{11} & \pi_{12} \\ \pi_{21} & \pi_{22} \end{bmatrix} \begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{bmatrix} k_1 \\ k_2 \end{bmatrix} + \begin{pmatrix} v_{at} \\ v_{bt} \end{pmatrix} \quad (4.4)$$

$$\begin{pmatrix} v_{at} \\ v_{bt} \end{pmatrix} \sim IN_2 \left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \omega_{22} \end{pmatrix} \right] \quad (4.5)$$

There are 9 parameters in (4.4) and (4.5):

$(\pi_{11}, \pi_{12}, \pi_{21}, \pi_{22}; k_1, k_2; \omega_{11}, \omega_{12}, \omega_{22})$ and their variation freeness will be set during the

Monte Carlo simulations. The contemporaneity⁶ will also be changed in the model

$\omega_{12} \neq 0$ so we have 9 parameters to estimate. The values taken by $(\pi_{11}, \pi_{12}, \pi_{21}, \pi_{22})$ determine whether the system is I(1) or I(0) or even I(2).⁷

When the system is the cointegrated VAR, we have:

$$\begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{pmatrix} \Delta y_t \\ \Delta z_t \end{pmatrix} = \begin{pmatrix} \delta_a \\ \delta_b \end{pmatrix} + \begin{pmatrix} \lambda \\ \alpha \end{pmatrix} (y_{t-1} - \beta z_{t-1}) + \begin{bmatrix} \varepsilon_{at} \\ \varepsilon_{bt} \end{bmatrix} \quad (4.6)$$

which is over-identified (eight parameters) with one overidentifying restriction. The validity of conditioning depends on the weak exogeneity of z_t for the parameters of interest and β is an invariant of the re-formulated system.

3. THE MONTE CARLO DESIGN

The parameter values selected for the baseline experiment are:

i) $\sigma_{ab} = 0$

ii) $\sigma_a^2 = 0.0004$; $\sigma_a = 0.02$

iii) $\sigma_b^2 = 0.0025$; $\sigma_b = 0.05$

iv) $\frac{\phi_a}{\sigma_a} = 1$, $\phi_a = 0.02$

v) $\frac{\phi_b}{\sigma_b} = 1$, $\phi_b = 0.05$

vi) $T=40$

vii) $\alpha = 0$

⁶ Hendry (1995b) shows that the diagonality of the long-run covariance matrix is not sufficient to sustain conditional inference, especially in small samples, although efficient inference may be possible asymptotically in some cases where weak exogeneity fails but the long-run covariance matrix remains diagonal. However, tests for weak exogeneity do not necessarily coincide with tests for orthogonality between regressors and errors: the latter may reveal other forms of mis-specification of the fitted model when it does not coincide with the conditional expectation, and may reveal no mis-specification when the fitted model coincides with the conditional expectation but weak exogeneity is violated.

⁷ The presence or absence of weak exogeneity conditions is not tied to the degree of integration.

We vary the following:

- a) (iv) and (v) to 2, 4 $\phi_a = 0.04, 0.08$ and $\phi_b = 0.10, 0.20$
- b) α to (0.1, 0.3) (vii) (Weak exogeneity fails)
- c) T to 80 and 500
- d) σ_a^2, σ_b^2 to 0.1, 0.2 and to 0.01, 0.02 (ii), (iii)
- e) σ_{ab} to $0.8\sigma_a\sigma_b = 0.0008$ and to $0.4\sigma_a\sigma_b = 0.0004$ (i) (The lack of contemporaneity fails).

The parameters of the DGP are, therefore, the design variables of the Monte Carlo and so become the regressors in response surfaces summarising the results as proxies for analysis. These response surfaces are not "regressions" but simply convenient summaries that highlight the main determinants of the Monte Carlo within the design variables analysed.

4. MONTE CARLO SIMULATIONS AND RESULTS

The detailed results are reported in the Appendix 4.A. Here, we focus on the main findings.

4.1. CONSTANT

We have conducted 39 Monte Carlo Experiments. When we look at the constants in the y_a and y_b equations, they are badly determined and the standard errors are very large, (the standard deviations are even larger). However, it would be disastrous to drop the intercepts from the econometric equations (see experiments 7, 10, 13). When we look at the general equation which is estimated for the Turkish Consumption function in Chapter 8, we see that the standard error for the constant is 0.34. Thus the

standard deviation is larger. This happens because the δ_i in (4.6) are made up of both the growth rates ϕ_i which are tiny numbers (0.05 etc.) and the means of the cointegrating relations, which can be huge, and are very collinear with that relation. In terms of better determination of the constant terms, the equilibrium correction model seems preferable to the VAR. This is equivalent to take deviations from means in regressors, to orthogonalize the intercept: such cannot be done in an I(1) VAR where the data do not have well-defined means.

4.2. THE RELEVANT VARIABLES

In the Monte Carlo simulations, when we look at the mean biases of y_{a-1} in the y_a and in the y_b equations, we see that they are well determined and their biases are very small. The inference will remain good if we drop these irrelevant variables and will generally improve. The standard errors of the y_{a-1} in the y_a and in the y_b equations are reasonable. The log of the ratio of the standard errors to standard deviations of the y_{a-1} in the y_a and in the y_b equations are again reasonable: there are biases but they are not huge. These findings are consistent with Abadir, Hadri and Tzavalis (1999)⁸ that adding irrelevant variables to a VAR has more serious negative consequences in integrated time series than in cross section analyses. On the other hand, incorporating stable relations in the VAR may have beneficial implications on the asymptotic biases of the parameters in general. Substantial biases can arise from starting with a model that is initially too large, so the marginalisation step must be taken. This suggests parsimonious modelling.

⁸ They do not include constant in their VAR and also do not look at the ratio of standard deviations to standard errors.

When we look at the coefficients of the cointegration relation which are the y_{b-1} in the y_a and in the y_b equations, we see that they are close to unity. Thus, both the unit root and the cointegrating vector are accurately determined. When we look at the mean and the standard deviations of the (y_{a-1} in the y_a equation plus y_{b-1} in the y_a) and the (y_{a-1} in the y_b equation plus y_{b-1} in the y_b), we find that means are close to unity and the standard deviations are very small for $T=40$.

When we look at the means and the standard deviations of the ratios of the standard errors to standard deviations of constants in the y_a and y_b equations, we find the means [*Mean* (SE/SD of Constant in y_a) = 0.967127 and *Mean* (SE/SD of Constant in y_b) = 0.946652] to be close to unity but the standard deviations [*Standard Deviation of* (SE/SD of Constant in y_a) = 0.157354 and *Standard Deviation of* (SE/SD of Constant in y_b) = 0.186426] to be very large for $T=40$.

Figures 4.1-4.3 show the Monte Carlo densities of the parameter estimates and the estimated standard errors across three experiments with changing error variances to illustrate the outcomes.

4.3. THE RESPONSE SURFACES

The results of the response surfaces are based on the general-to-specific modelling approach: the general models are presented in Appendix 4.A: the final equations are presented in the next sections. Regressors are scaled for ease of presentation of results: Thus σ_i and ϕ_i denote 100 times the original, or percentage standard errors.

The response surfaces for biases are normalised by \sqrt{T} for I(0) and T for I(1) variables. Thus, in the former, consistency requires no term of \sqrt{T} , and a constant

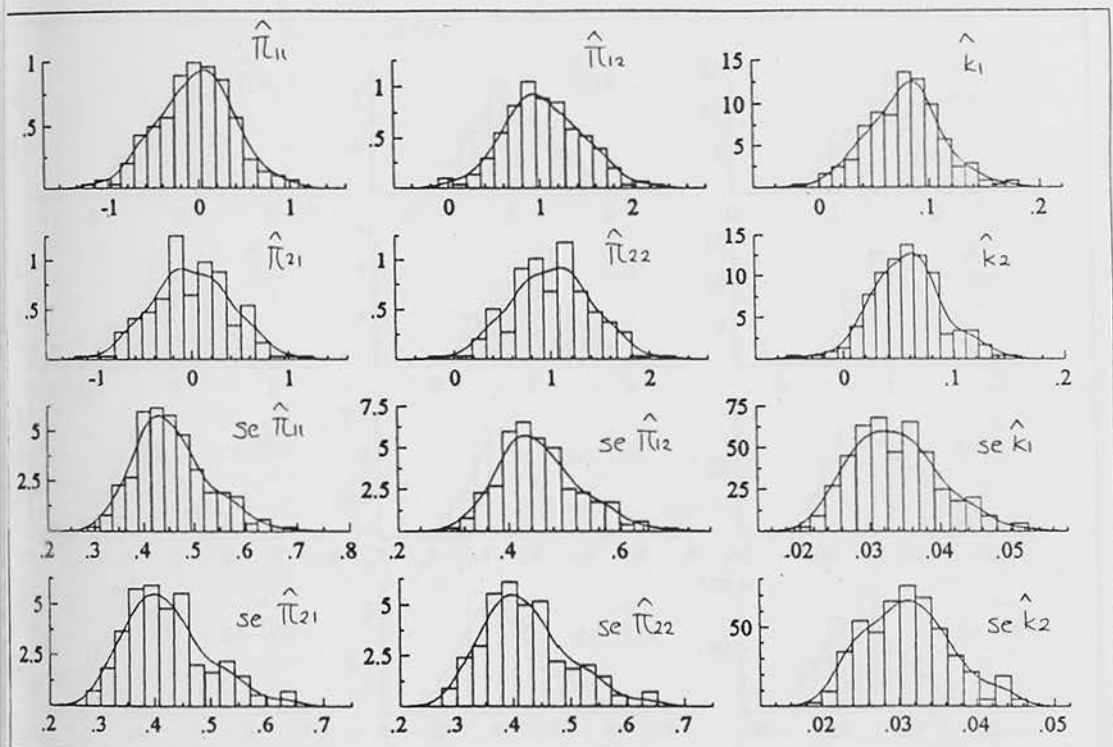


Figure 4. 1: $T=40$, $\sigma_a^2 = 0.0004$, $\sigma_b^2 = 0.0025$, $\sigma_{ab} = 0$, $\frac{\phi_a}{\sigma_a} = 1$, $\frac{\phi_b}{\sigma_b} = 1$, $\alpha = 0$

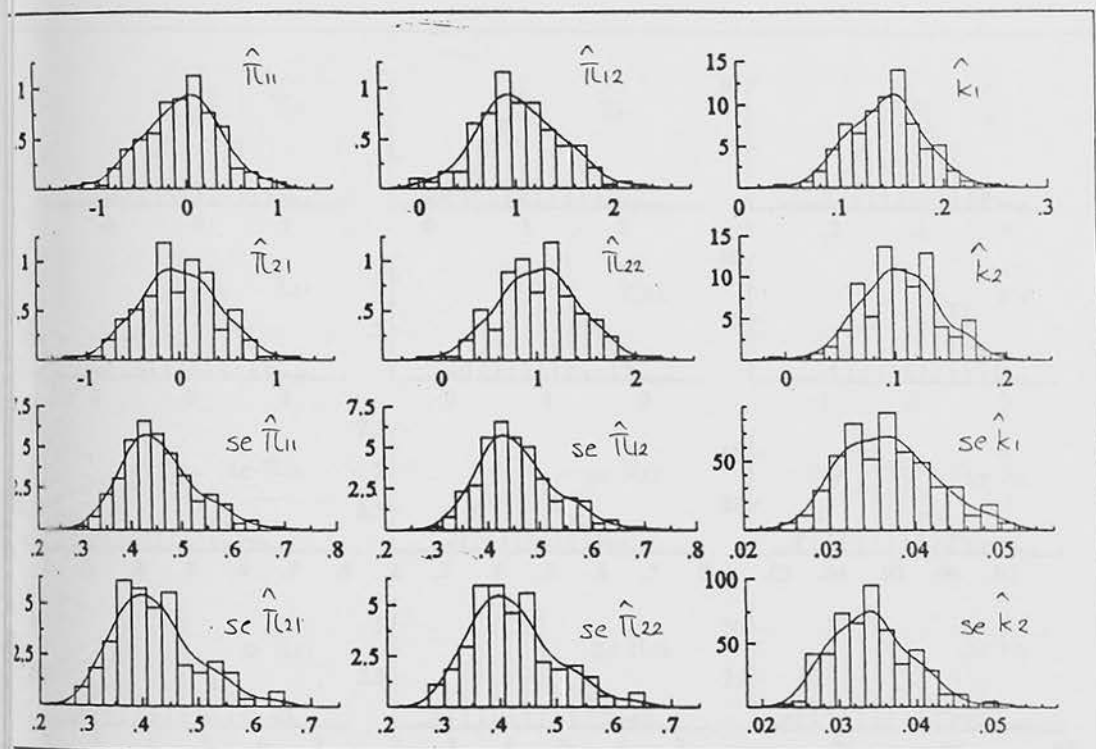


Figure 4. 2: $T=40$, $\sigma_a^2 = 0.0004$, $\sigma_b^2 = 0.0025$, $\sigma_{ab} = 0$, $\frac{\phi_a}{\sigma_a} = 2$, $\frac{\phi_b}{\sigma_b} = 2$, $\alpha = 0$

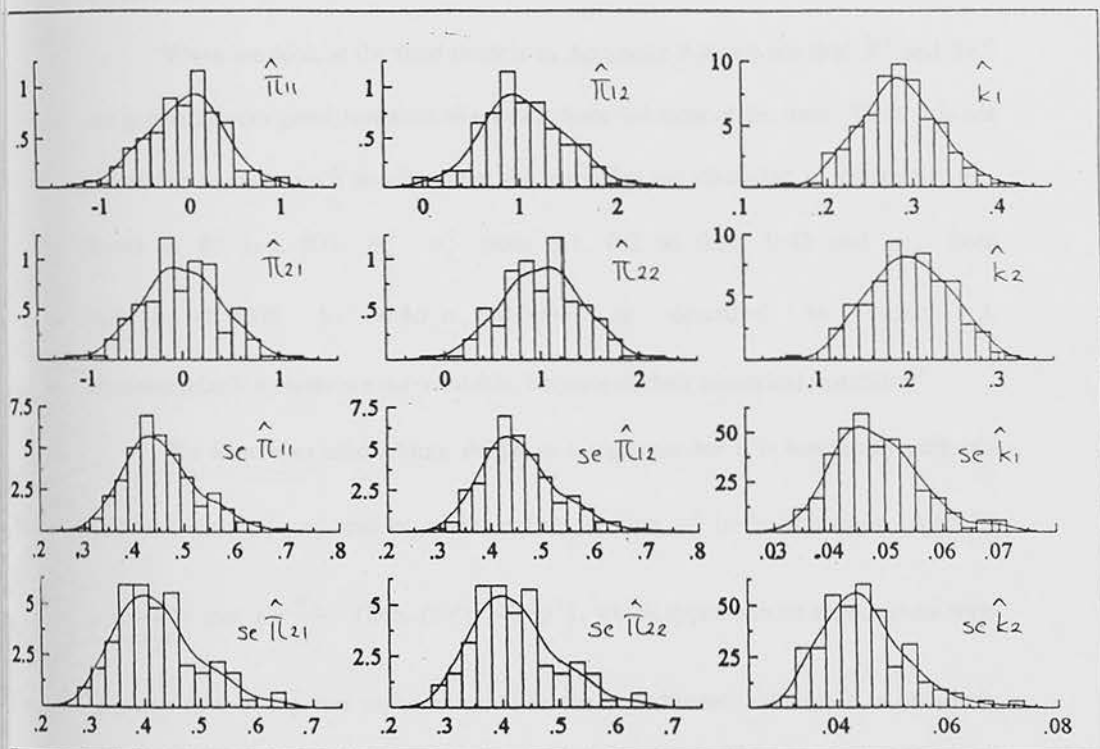


Figure 4. 3: $T=40$, $\sigma_a^2 = 0.0004$, $\sigma_b^2 = 0.0025$, $\sigma_{ab} = 0$, $\frac{\phi_a}{\sigma_a} = 4$, $\frac{\phi_b}{\sigma_b} = 4$, $\alpha = 0$

implies a bias, whereas in the latter, a constant (or any term not divided by T) implies a non-central limiting distribution. These normalisations will reduce heteroscedasticity across experiments at different sample sizes. Further, log ratios are used for estimated standard errors which should also reduce heteroscedasticity. Even so, the response surfaces are merely useful summaries, but should help guide future experiments.

When we look at the final models in Appendix 4.A, we see that R^2 and SEE are generally very good, however, diagnostic tests fail most of the time. Thus, it is not surprising to have such results when the variables are changing so discretely, eg., $T=40$ to 80 and 500; σ_a^2 , σ_b^2 from 0.1, 0.2 to 0.01, 0.02 and σ_{ab} from $0.8\sigma_a\sigma_b = 0.0008$ to $0.4\sigma_a\sigma_b = 0.0004$ as described in Section 3. Heteroscedasticity tests are not available, because of their numerical instability⁹.

We have also tried adding $\det[\Omega]$ as a regressor but it is essentially perfectly collinear with σ_a^2 , σ_b^2 and σ_{ab} and therefore we kept σ_a^2 in the equations. Also, let $r = \frac{\sigma_{ab}}{\sigma_a\sigma_b}$ and $s = \frac{\sigma_b}{\sigma_a}$. Then, $(1 - rs - 0.5s^2)$, which appears in an approximate form in many of the response surfaces, acts like the determinant, although it is obviously not equal to it, for the design used. This represents the "variance" influences, whereas α represents the dynamics, $\frac{\phi}{\sigma}$ the growth, and T the sample size.

Despite the very different nature of the coefficients, the response surfaces are very similar in form for each category.

⁹ The author found dramatic changes in reported statistics for heteroscedasticity on simply rescaling the regressors. This occurs despite the care taken in programming their calculations (see Doornik, 1995), so they are not reported.

4.4.1. BIASES:

This section looks at the biases in each equation.

4.4.1. a. Intercepts:

The main regressors in the response surfaces are functions of \sqrt{T} , error (co)variances, and growth rates:

$$\sqrt{T}(\hat{k}_1 - k_{10}) \equiv 0.72 + 1.6 \frac{1}{\sqrt{T}} [1 + 0.15\sigma_a^2(1 - 0.5s^2)]$$

$$\sqrt{T}(\hat{k}_2 - k_{20}) \equiv 0.10 + 2 \frac{1}{\sqrt{T}} [1 - 0.35\phi_b / \sigma_b + \sigma_a^2(1 - 0.5s^2)]$$

Intercepts in the response surfaces are nearly significant and so the econometric estimators of the constants are almost inconsistent: precisely, biases are of $O(1/\sqrt{T})$. There are four factors which are affecting the bias of the intercept in the y_a equation: the intercept of the response surface just noted; a bias of $O(1/T)$ from the econometric sample size; the effect of the signal to noise ratio which is reducing the bias, but its own variance (σ_a^2) is increasing the bias, jointly operating through $\sigma_a^2(1 - 0.5s^2)$. There are five factors which are affecting the bias of the intercept in y_b equation: the intercept of the response surface which is much smaller than in the y_a equation but closer to significance, a bias of $O(1/T)$; sample size; the growth rate (faster the growth in the marginal process, the better will be the intercept in the VAR equation) and the effect of the signal to noise ratio, s^2 , which is reducing the bias, but σ_a^2 is increasing the bias, so again $\sigma_a^2(1 - 0.5s^2)$ is operating but with a much larger coefficient. This suggests that increased noise in the marginal process reduces the biases in both equations, and growth in the second equation also reduces its intercept bias.

4. 4. 1. b. Coefficients of I(0) Effects:

The main regressors in the response surfaces are functions of T , adjustment parameters, error (co)variances, and growth rates:

$$\sqrt{T}(\hat{\pi}_{11} - \pi_{110}) \equiv 1.5 \frac{1}{\sqrt{T}} [-1 + 1.7[\alpha + 0.10(\phi_a / \sigma_a) + 0.06\sigma_a^2(1 - rs - 0.5s^2)]]$$

$$\sqrt{T}(\hat{\pi}_{21} - \pi_{210}) \equiv 2.5 \frac{1}{\sqrt{T}} [\alpha + 0.12(\phi_b / \sigma_b) + 0.06\sigma_a^2(1 - rs - 0.5s^2)]$$

The biases are $O(1/T)$ and coefficients are remarkably similar in the two equations. Note that the EqCM coefficient is -1 in the first equation, so this matches α in the second equation, although the lack of weak exogeneity also affects the y_a equation. The coefficient on α is almost the same in both the equations [(1.5*1.7=2.5) in the first equation and 2.5 in the second equation]. The impacts of growth and noise are nearly identical, and also positive cross-equation errors reduce the biases in both cases. However, the faster the relative growth, the larger the upward biases will be in both equations.

4. 4. 1. c. Coefficients of I(1) Effects:

The main regressors in the response surfaces are functions of T and error (co)variances:

$$T(\hat{\pi}_{12} - \pi_{120}) \equiv 0.97 - 0.004 \frac{1}{T} - 0.2\sigma_a^2(1 - 0.75rs - 0.5s^2)$$

$$T(\hat{\pi}_{22} - \pi_{220}) \equiv -(0.006 \frac{1}{T}) - 0.17\sigma_a^2(1 - 0.75rs - 0.5s^2)$$

There is a bias of $O(1/T)$ in the y_a equation, biases of $O(1/T^2)$ from the econometric sample in both (small but significantly negative) and a negative bias from

$\sigma_a^2(1-0.75rs-0.5s^2)$ akin to the I(0) effects. These effects match the observed outcomes of the cointegrating coefficients. Again the two equations are very similar, and also have many features in common with the I(0) effects.

The results confirm that there are biases from dynamics in lagged dependent variables: relative to say an I(0) AR(1) process where the bias is $\left[\frac{-1-3\rho}{T}\right]$, here we find approximately $\left[\frac{-1.5+2.5\alpha}{T}\right]$ in the first equation (plus other effects) and $\left[\frac{2.5\alpha}{T}\right]$ in the second. However, these results may reflect response surfaces misspecification.

4.4.2. LOG (SE/SD):

We now consider the ratio standard errors to standard deviations in each equation.

4.4.2. a. Intercepts:

The main regressors in the response surfaces are error (co)variances and sample sizes:

$$\log(SE/SD_{k_1}) \equiv -1.5\frac{1}{T}[1-0.17\sigma_a^2(1-0.5s^2)]$$

$$\log(SE/SD_{k_2}) \equiv -2.5\frac{1}{T}[1+0.125\sigma_a^2(1-0.5s^2)]$$

There is a negative bias in the $\log(SE/SD_{k_1})$ equation which is offset by a "variance" effect, but the negative variance is enhanced in the $\log(SE/SD_{k_2})$ equation.

Standard errors are poor estimators of the standard deviations as judged by their very large standard errors. $SD(\text{Log}(SE/SD))$ for intercepts are very large,

suggesting that great care is required for modelling intercepts. They should probably be broken into the growth rates and the means of the cointegrating vectors.

4. 4. 2. b. Dynamics:

The main regressors in the response surfaces are error (co)variances and sample sizes:

i) Coefficients of I(0) Effects:

$$\log(SE / SD_{\pi_{11}}) \cong -0.005 + 2.25 \frac{1}{T} [1 + 0.03\sigma_a^2(1 + 0.4rs - 0.5s^2)]$$

$$\log(SE / SD_{\pi_{21}}) \cong \frac{1}{T} [1 - 0.0005\sigma_a^2(1 - 120rs)]$$

ii) Coefficients of I(1) Effects:

$$\log(SE / SD_{\pi_{12}}) \cong -0.005 + 1.3 \frac{1}{T} [1 - 0.04\sigma_a^2(1 - 0.5s^2)]$$

$$\log(SE / SD_{\pi_{22}}) \cong -0.1 \frac{\sigma_a^2}{T} (1 - 0.57rs - 0.53s^2)$$

The results above suggest that in the $\log(SE/SD)$ equations for the conditional model (π_{11} and π_{12}) constants are significant, whereas for the marginal model (π_{21} and π_{22}) they are not. Thus, we see that there are possible inconsistencies in the SE for SD in the y_a equation, but these are very small (0.5%) and may reflect response surface mis-specifications. Surprisingly, the response surfaces for the two y_a equation SE's are similar to each other and not like those for y_b , where the biases of $(1/T)$ are the largest effect.

5. CONCLUSIONS

The Monte Carlo results show that actual biases are small for I(0) and I(1) effects, but SE's are large for intercepts, see Sections 4.4.1.a., 4.4.1.b. and 4.4.1.c.

The response surfaces highlight the effects of the design variables. Intercepts are badly biased and very uncertain, which indicates a flaw in levels I(1) formulations of VARs, see Section 4.4.2.a.

Irrelevant dynamics are close to zero and dropping them will not cause much distortion, see Section 4.2.

Cointegration effects are well determined, but SE's less good in the y_a equation for both I(0) and I(1) effects, see Section 4.2.

We found a large impact of the noise (σ_a) and of a function of the signal to noise ratio and cross-equation correlation, but less effect from ϕ_i/σ_i than we had expected, see Section 4.4.1. Overall, the main finding may be the very poor determination of intercepts in I(1) VARs, and the corresponding advantages of an EqCM formulation.

Chapter 5:

THE TURKISH ECONOMY

1. INTRODUCTION

In this chapter I present an overview of the Turkish Economy, especially during the sample period concerned 1960-97, by pointing out the lessons to be learned from the stabilisation experiences and their effect on the private sector saving decisions in Turkey. The year 1960 is used as a starting point in studying the consumption/saving behaviour, because reliable data on private consumption and disposable income is not available until the State Planning Organisation (SPO) was formed.¹ There was no conscious planning or co-ordination of economic policies in the 1950s, a new constitution was formulated under the revolutionary government in 1960-1961 and the SPO was established as the planning organ within this institution. The SPO was the only agent that constructed private sector consumption and saving data in Turkey until 1987; since 1987 the State Institute of Statistics (SIS) also collects quarterly data on GDP by expenditure.

In this chapter, the second section summarises Turkish economic policies before 1980, and the third section after 1980. The fourth section presents the effects of these policies on consumption and saving decisions in Turkey. The fifth section deals with the lessons to be drawn from the Turkish experience and concludes.

2. POLICY AND DEVELOPMENT BEFORE 1980

¹ See the Chapter 7 for the history of the Turkish National Accounts.

Turkish growth performance during the 1960s and most of the 1970s had been good compared with other developing countries (see, Figure 5.1). The relatively high growth rate in Turkey was achieved without the availability of oil or other valuable natural resources.² In the 1960s development occurred with reliance on foreign borrowings. In the 1970s it was supported by large amounts of workers' remittances, but after 1974 by an excessive reliance on foreign borrowings. This resulted in a very severe foreign exchange constraint. With tight restrictions on imports, which became harsher because of the continuous increases in oil prices, it is easier to understand very slow growth of output during 1978 and 1979 and negative growth in 1980.

2. 1. ECONOMIC POLICIES: 1960-1970

2. 1. 1. Growth:

The growth rate averaged 6.4% *per year* for the two planning periods (1963-1967) and (1968-1972). Growth in industry accelerated to 11.3% during the two planning periods of 1963-1972 (see Table 5.1). The growth of manufacturing accelerated sharply in the sixties, reflecting accelerated investment encouraged by incentives and by continued import substitution under heavy protection. Manufacturing output increased at about 13.3% during 1960-1970 and production became more diversified with a large development in consumer goods and assembling industries.³

Table 5.1: Sectoral Composition of GNP, 1960-1980, (% of GNP, in 1968 prices)

Years	1960	1965	1970	1975	1980
Agriculture	41	34	29	25	24
Industry	15	18	20	22	22
Services	44	48	51	53	54

Source: SIS, *Statistical Yearbook*, various issues.

² See Aktan (1964) and Okyar (1965).

³ See Alpar (1977) and Ebiri (1980).

The following subsections will deal with the public sector, financial developments, foreign trade, external payments and debt policy to help explain the results of Chapter 8.

2. 1. 2. Public Finance:

The government reformed the tax structure, tax collection and administration to assist finance of government spending including public investments, see Table 5.2.

Table 5. 2: Public Finance, 1960-1980 (As a share of nominal GNP)

Years	1960	1965	1970	1975	1980
Government Expenditure	20.4	19.6	22.0	21.6	25.2
Government Revenue	19.9	17.5	19.5	20.3	21.6
Government Deficit (+)	0.4	2.0	2.5	1.3	3.6

Source: IMF, *International Financial Statistics Yearbook, 1970 to 1980*.

2. 1. 3. Financial Markets:

During the two planning periods, there had been little development of financial assets outside the banking system. The security market in Turkey was almost non-existent, although the volume of the outstanding securities was quite high. The majority of non-monetary financial liabilities were issued by the public sector and consisted of bonds. Corporate bond finance was less than 5% of private manufacturing investment. Direct financial assets such as government bonds, corporate bonds and corporate stock fell from 38% to 29% of GNP from 1963 to 1971. Throughout the period 1961-69 interest rates on deposits in, and loans from, the banking system did not change, see Figure 5.1. However, the expansion of commercial bank credit to the private sector had been substantial in 1966 when economic activity was picking up.

2. 1. 4. Trade:

The Turkish Economy was defined as very little trade orientated during this period. High-cost import substitution industry, heavy protection and overvaluation of the lira also created a wide gap between domestic and world prices, thereby discouraging exports and investment in export industries. The balance of payments had been characterised up to 1970 by a chronic foreign exchange shortage. The deficit on the current account averaged about US\$ 75 million *per* year in the sixties (see, Figure 5.2).

The origin of the balance of payments disequilibrium depended especially on the rapid rise in the demand for imports of investment goods and raw materials resulting from growing investment requirements. Additionally, exports were sluggish, brought about by the rigidity of demand for Turkey's traditional exports and lack of manufacturing exports. This structural problem was compounded by the effects of inflation on the balance of payments. The attempt to force a trade equilibrium through quantitative restrictions rather than changing the exchange rate (see, Figure 5.2) to offset price movements, led to illegal capital movements, rapid expansion of the external debt and excessive resources to commercial sources of financing.

2. 1. 5. Debt:

During the sixties, official assistance came from the OECD consortium organised in 1962, which disbursed US\$ 2.5 billion during 1963-1972. In addition to that, a debt relief amounting to US\$ 198 million was granted during 1965-1967. At the end of 1972, Turkey's external medium-and long-term outstanding debt was US\$ 2.5 billion, compared to US\$ 730 million at the end of the 1960. Debt service reached US\$ 189

million in 1972 or 10% of exports of goods and services, with a peak of 24.5% in 1965.

2. 2. ECONOMIC POLICIES: 1970-1979

During the two years previous to 1970, the Turkish economy was subject to growing strains. Two main sources of imbalance were growing financial deficits in the public sector, an excessive rate of credit creation, particularly agricultural credits, increasing difficulties in financing a large investment programme from non-inflationary sources, and an over-valued exchange rate. The most outstanding feature of the economic development in Turkey in 1969-70 was the devaluation of the Turkish Lira (66.6% devaluation in 1970) and the announcement of a far-reaching stabilisation programme in August 1970. The key features of the programme are summarised below. 1) On the basis of the new foreign exchange rate, imports were liberalised and the foreign exchange restrictions on imports were lifted. 2) New measures were introduced to control money supply and the operation of banks in the monetary and credit fields by the Central Bank. 3) New fiscal and budgetary policies were aimed at reducing the consolidated budget deficit and the operational deficits of SEEs.

The following sub-sections provide a general overview of the period (1970-79) and summarise the overall economic adjustments following the 1970 stabilisation programme, the debt crisis and the preceding monetary developments. Then, measures taken in the 1978-79 stabilisation programme to solve the heavy balance of payment difficulties, and their influence on the economy, are discussed.

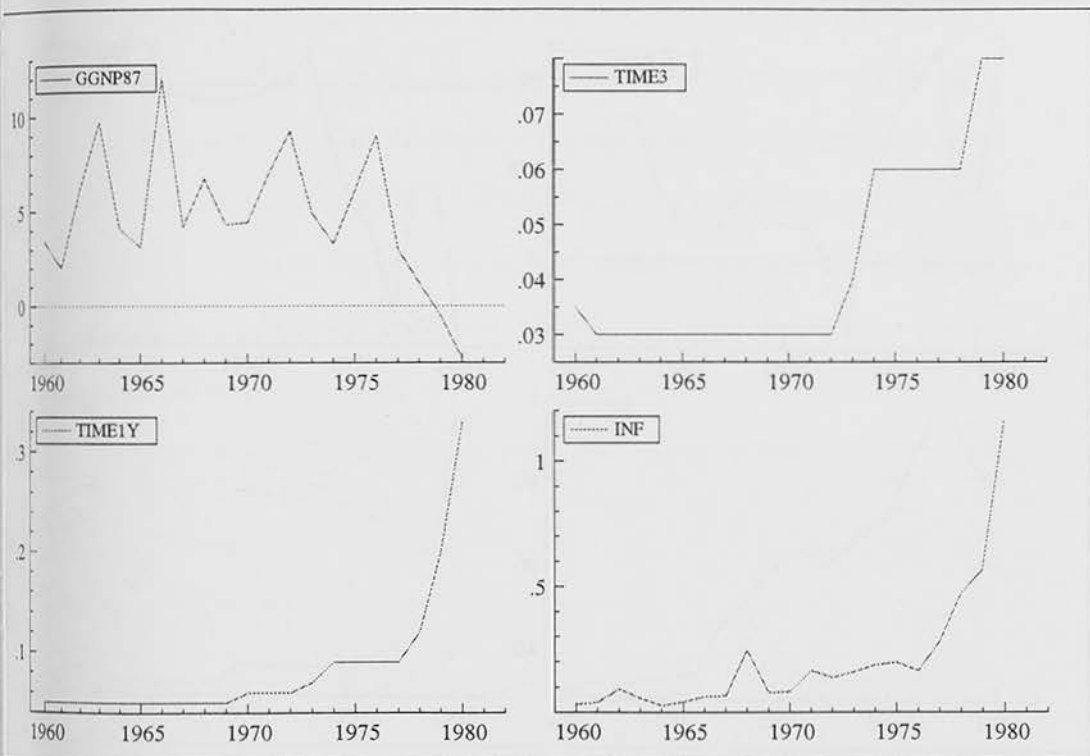


Figure 5. 1: Growth Rate of Real GNP (GGNP)(1987=100); The Three-Month Nominal Interest Rate on Time Deposits (TIME3); The One-Year Interest Rate on Time Deposits (TIME1Y) and Inflation Rate (INF).

Source: SIS, *Statistical Yearbook of Turkey (1928-1998)* and Central Bank of Turkey, *Annual Report*, various issues.

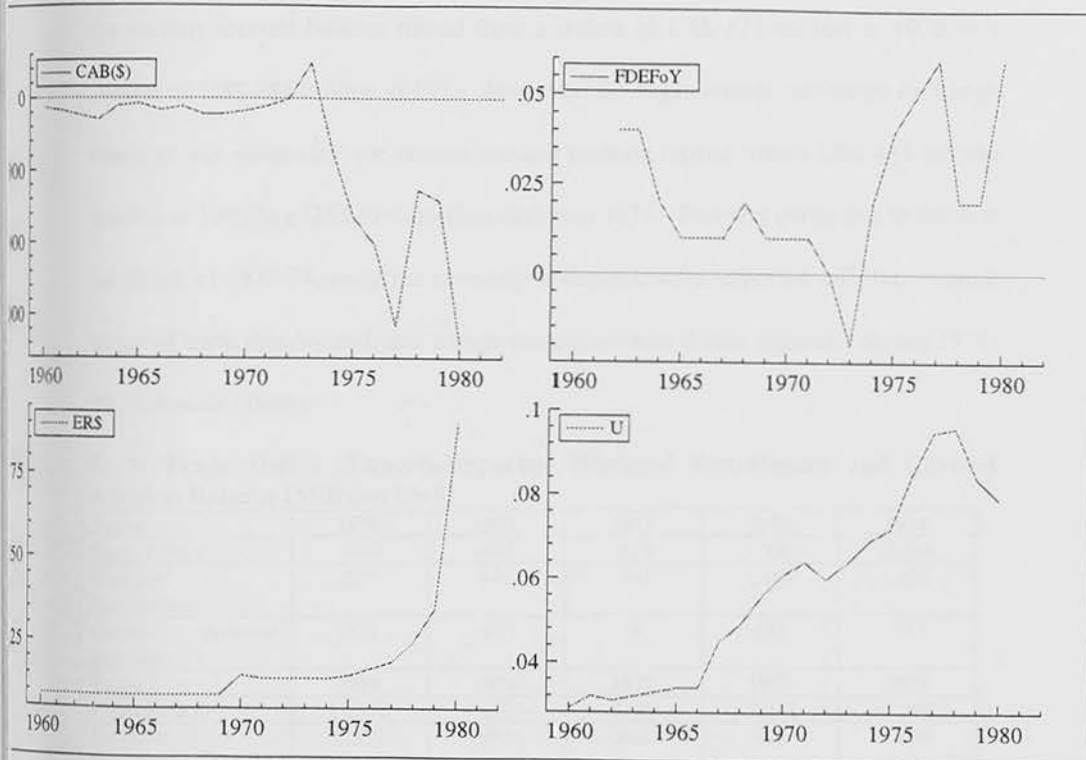


Figure 5. 2: Current Account Balance (Million \$) (CAB); Foreign Deficit to GNP ratio both in current prices (FDEFoY); Exchange Rate (TL/\$)(ERS) and Unemployment Rate (U).

Source: Central Bank of Turkey, *Annual Report*, various issues; SPO, *Economic and Social Indicators* (1950-1998) and SIS, *Statistical Yearbook of Turkey* (1928-1998).

2. 2. 1. Current Account:

As a result of both the good weather conditions in agriculture and devaluation, exports increased rapidly during the period of 1970-74 from US\$ 585.5 million in 1970 to US\$ 1532.2 million in 1974. As a result of devaluation, net workers remittances rose from US\$ 273 million to US\$ 1426 million between 1970 and 1974, the current account balance turned from a deficit of US\$ 171 million in 1970 to a surplus of US\$ 484 million in 1973. However, the improvement on foreign exchange earnings was temporary; the current account position moved from a US\$ 484 million surplus in 1973 to a US\$ 3140 million deficit in 1977. This was partly due to the first oil shock of 1973-74, since the economy is dependent on imported oil⁴, the external terms of trade deteriorated, and a huge current account deficit appeared during 1974-1977, Rodrik (1986).

5. 3: Trade Deficit (Exports-Imports), Workers' Remittances and Current Account Balance (Millions US \$)

Years	1970	1971	1972	1973	1974
Trade Deficit	-360	-494	-678	-766	-2,246
Workers' Remittances	273	471	740	1,183	1,426
Current Account Balance	-171	-109	-8	484	-719
Years	1975	1976	1977	1978	1979
Trade Deficit	-3,338	-3,169	-4,043	-2,311	-2,808
Workers' Remittances	1,312	983	982	983	1,696
Current Account Balance	1,648	-2,029	-3,140	-1,265	-1,413

Source: IMF, *International Financial Statistics Yearbook*, 1979.

⁴ The petroleum shock of 1973-1974 increased the petroleum import bill sharply. The investment drive was not given up until 1978; thus, imports of investment goods also continued to rise. On the other hand, the upward trend in remittances was reversed from 1975-1976 onwards, and US dollar exports stagnated in the face of real appreciation of the Turkish Lira: Yagci (1984).

2. 2. 2. Debt:

The military operation in Cyprus in 1974 and the resulting US embargo on Turkey increased the need for short-term borrowing from the international organisations. The share of short-term debt increased from 8.3% in 1973 to 24.5% in 1975, and to 54% in 1977. During 1975-78, Turkish short-term borrowing reached US\$ 3.6 billion. The CTLD (Convertible Turkish Lira Deposit) scheme played an important role in the phenomenal rise in short-term debt. The CTLDs rose to account for 48.9% of short-term debt and 21.7% of all debt by the end of 1977. This scheme was instituted in 1967 as a limited programme for residents and Turkish workers abroad whereby they could open convertible deposit accounts. In May 1975, the scheme was revitalised to attract foreign exchange, but this time non-residents were also allowed to open accounts with the commercial banks, Rodrik (1988) and Celasun and Rodrik (1989).

Table 5. 4: Turkish Foreign Debt and Debt Ratios, 1970-1980 (Millions US \$)

Years	1970	1975	1976	1977	1978	1979	1980
Total Debt	1,960	3,585	4,258	11,419	14,829	15,889	19,040
Long Term Debt (LTD)	1,886	3,342	3,867	4,917	7,021	11,660	15,496
IMF	74	243	391	409	622	633	1,054
Short Term Debt (1)	-	-	-	6,093	7,186	3,596	2,490
Debt Ratios							
Debt/Exports	3.33	2.56	2.17	6.51	6.48	7.03	6.54
LTD/Exports	3.21	2.39	1.97	2.80	3.07	5.16	5.44
Service/Exports (2)	0.30	0.21	0.19	0.24	0.25	0.34	0.38

(1) Short term figures before 1977 included within long term figures.

(2) Debt service is the ratio of payments of interest and of public and privately guaranteed principal to exports.

Source: Debt figures from World Bank, *World Debt Tables and Supplements, 1988-1989*. Exports from SIS, *Statistical Yearbook, 1988*.

2. 2. 3. 1978 and 1979 Stabilisation Programme:

The CTLD scheme effectively ended in July 1977 when foreign investors stopped opening accounts and started closing the existing ones. Efforts were increased to find foreign exchange funds from other sources, but the private and official lenders, including multilateral organisations such as the IMF, the OECD and the World Bank

were becoming increasingly unwilling. Unable to pay its debts, Turkey fell into international insolvency in 1978. Turkey attempted to reschedule her debt following the stand-by agreement with the IMF in March 1978. Between 1978 and 1981, the government undertook a series of debt negotiations, amounting to 70% of Turkey's total debt. During the period 1978-1980, the manufacturing industry was especially hard hit, investments declined sharply due to import reductions and unemployment increased (see, Figure 5.2). The rate of growth of the economy fell from 4% in 1977 to 3% in 1978, -0.4% in 1979 and -1.1% in 1980 (see Figure 5.1). During that time the rate of inflation rose from 15.6% in 1976 to 54% in 1979 (see Figure 5.1).

In both 1978 and 1979 Turkey undertook short-term stabilisation in order to control inflation and solve the balance of payments problem. The first stabilisation was begun in the second half of 1978 to cope with problems of exchange stringency, promotion of exports and workers' remittances and to increase the inflow of external resources through foreign investments international borrowing on a long-term basis. Furthermore, a number of exchange rate adjustments (see, Figure 5.2) and two major devaluations were implemented.⁵ The rapid inflation was accompanied by a corresponding acceleration of the rate of growth of money supply which was 45% in 1979. Inflation was one of the most important economic problems of the Turkish economy until the stand-by agreement signed in July 1979. The measures to tackle inflation were mainly implemented with dependence on price control through administrative means, increases in the prices of commodities produced by the state economic enterprises to reduce their losses, restrictions on public expenditure to keep the budgetary deficit as low as possible, tighter control of hire purchase transactions,

⁵ The dollar parity of the lira increased to 19.25 in September 1977, to 25 in March 1978, and to 47.10 in June 1979.

and encouragement of savings through increases in the real interest rates. However, the adjustments made were insufficient to make up for the erosion of the real rate through inflation.⁶

To summarise, in the 1960s and 1970s, foreign trade, foreign capital movements, the market for financial assets, agricultural and other commodities were all controlled.⁷ The fixed exchange rate regime ruled throughout the period together with import restrictions, import licences, rules for the allocation of import quotas and multiple exchange rates for different types of exports. Shortages of foreign exchange from 1976 onwards meant a burgeoning parallel market⁸ where the US dollar rate exceeded the official exchange rate by 18% in 1977 and by over 56% in 1979. Furthermore, a sizeable proportion of loanable funds and foreign exchange resources was diverted into unorganised markets. Premiums on import licenses also rose sharply in the second half of the 1970s. The authorities attempted to minimise losses from CTLD accounts, and fears of higher inflation resulted in the real appreciation of the Turkish Lira. On the other hand, the prices paid to the producers of agricultural products were increased faster than the market called for through support purchases of the agricultural SEEs. Furthermore, borrowing from the Central Bank to finance large scale public investment projects resulted in high rates of growth in the monetary aggregates.

In spite of all the price controls, the rate of inflation, which averaged about 5.5% in the 1960s and about 18% during 1970-1975, accelerated and reached 71% in

⁶ There were no measures to stimulate savings through an active interest rate policy. A first adjustment occurred in 1978 which raised the commercial banks' general rate from 11.5% to 16%. A further increase in interest rates was introduced in May 1979 which raised interest rates on time deposits to a range of 8 to 24%: Akyuz (1984a), (1984b), Akyuz and Ersel (1984), and Akyuz (1990).

⁷ See Ertuna (1986) for the Turkish Economic Policies between 1950-1979.

⁸ See Olgun (1984) for the Black Market Exchange Rates in Turkey.

1979; it peaked at an all time high, at just over 100%, in 1980. Government-controlled nominal interest rates were increased from time to time, but too late and too little. Throughout the 1970s, the after-tax real interest rates on deposits were negative; taxes on financial earnings, and liquidity and reserve requirement ratios were high. Overall, the financial markets suffered from a highly regulated and inefficient banking system, with consequent low quality portfolio management. From 1977 onwards, financial repression was so high that savings through financial instruments started to decline in real terms. In the case of money, for instance, the M2/GNP ratio was 0.24 in 1975; it fell, however, to 0.15 in 1980 implying an increase in velocity from 4.2 to 6.7. In the 1960s and 1970s the financial sector was dominated by the banking sector. The shares of the other financial assets such as public and private bonds, marketable equities and insurance policies were quite small. In 1979, for instance, M2 constituted 78% of the stock of financial assets. In the same year, the banking sector made 85% of the new issues of all the financial assets. The fiscal deficits were mostly financed by direct monetisation through the Central Bank. The financial system was not only repressed, but it also contracted between 1977 and 1980.

3. POLICY AND DEVELOPMENTS AFTER 1980

3.1. 1980 Stabilisation Programme:

On 24 January 1980 the government launched a structural adjustment programme to solve the high inflation, economic stagnation and unmanageable balance of payments deficits. The underlying strategy of the programme was directed at strengthening market forces and competition and reducing state controls in the economy, and at

opening up the Turkish economy to foreign investments and competition.⁹ The primary concern was the attainment of equilibrium in the commodity and trade markets and to lower the rate of domestic inflation. This involves implementing various price reforms, especially in the public industrial sector and also abolishing the existing system of multiple exchange rates. Secondly, sectoral priorities shifted in favour of export-oriented manufactures and commercial services. The TL devalued sharply and a crawling-peg regime of foreign exchange was adopted.¹⁰ A direct export promotion scheme was introduced which consisted of income tax rebates, preferential credit arrangements and duty-free allowances for immediate inputs. The third objective was financial liberalisation, with having positive interest rates under the presumption that in due course higher savings and hence investment would be achieved, and the need for external finance lessened. Finally, the role of the public sector in the economy was to be reduced by privatisation of the state enterprises.

3. 2. Financial Liberalisation:

A series of reforms were therefore undertaken to develop the financial system in Turkey.¹¹ Liberalisation attempts began in July 1980 with the deregulation of interest rates on loans and deposits, and followed by a switch to a crawling-peg exchange rate regime of continuous mini-adjustments (see Figures 5.3 and 5.4), elimination of price

⁹ Boratav, Turel and Yeldan, *BTY* (1996) divide the policy and developments after 1980 into 4 groups: 1981-1983; is the military phase characterised by income policies, deregulation of internal commodity markets and movement into financial liberalisation. 1984-1988 are the 'Golden Years' of the Motherland Party. The steps were taken toward trade and liberalisation. 1989-1992 is characterised as a 'return to populism' plus external financial liberalisation. 1992-1999 is the recent period.

¹⁰ The TL devaluated immediately vis-à-vis the US\$ by 33%; for the year as a whole devaluation was 89.5%.

¹¹ See Senses (1981, 1984, 1991), Kopits (1986), Nas and Odekon (1988), Kazgan (1989), Aricanli and Rodrik (1990a, 1990b), Ekinci (1990), Ersel (1991), Bayazitoglu, Ersel and Ozturk (1991) and Yeldan (1991a) for the 1980s structural adjustment and a through assessment of the post-reform performance of the economy.

controls and phasing out of subsidies, and the gradual removal of trade restrictions towards full trade liberalisation. Major commercial banks, however, decided to set interest rates collectively through a 'gentleman's agreement' and prevented further increases in interest rates. With a tight monetary policy and an excess demand for credits, the self-imposed ceiling on deposit rates increased the competition of the smaller banks and the brokers. After a while, the latter offered interest rates on time deposits and the newly introduced certificates of deposits (CDs) at levels so high that the larger banks started to pressurise them. On the other hand, several companies found themselves in financial difficulties because of high interest rates and poor earnings performance due to the demand-restriction policies. The process ended with the collapse of many of the brokers and some smaller banks in mid-1982. This development triggered some relaxation in monetary policy as well as changes in some regulations, Artun (1985), Cosan and Ersel (1987), and Ersel and Sak (1987).

Deregulation of restrictions on foreign exchange led to enormous pressures toward currency substitution (see Figure 5.5 (M2/M2Y) for currency substitution). Such pressures led to very high real interest rates throughout the reform period, as the monetary authorities tried to defend the TL by increasing the real interest rates to improve the capital account. However, with full liberalisation of the Lira in 1989, there has been a massive inflow of the short-term capital into the economy, Boratav, Turel and Yeldan (1996). The total appreciation between January 1989 and December 1989 was 22%. That year is marked as Turkey's first brush with 'hot money' (see Figure 5.6). This appreciation continued in 1990, but at a slower speed than experienced in 1989. Since 1989, the government seems to use the exchange rate as the nominal anchor in trying to control inflation.

5. 5: Speculative Short-term Capital (Hot Money) Flows and Financial Indicators (Millions US \$)

Years	1988	1989	1990	1991	1992
Return on Hot Money (a)	-0.073	0.236	0.293	-0.038	0.154
LIBOR	0.077	0.091	0.082	0.058	0.039
Inflows (1)	-	-	-	57116	81389
Outflows (2)	-	-	-	56633	76885
BOP Errors & Omissions (3)	515	971	-468	948	-1190
Aggregate Net Flows (1-2+3)	-1766	2646	1627	1431	3314
Inflation rate (%)	75.4	64.3	60.4	71.1	66.1
Annual Depreciation Rate (\$, %)	66.1	49.2	22.9	59.9	64.7
Current Account Balance	1596	961	-2625	250	-974
Reserves at Central Bank	2307	4831	5972	4918	6116
Years	1993	1994	1995	1996	
Return on Hot Money (a)	0.045	-0.316	0.293	0.171	
LIBOR	0.034	0.051	0.066	0.070	
Inflows (1)	142501	97892	101190	46963	
Outflows (2)	134242	103575	97766	44963	
BOP Errors & Omissions (3)	-2222	1769	2354	-802	
Aggregate Net Flows (1-2+3)	5997	-3914	5778	1198	
Inflation rate (%)	71.1	125.5	76.0	84.9	
Annual Depreciation Rate (\$, %)	59.9	170.4	53.8	77.5	
Current Account Balance	-6433	2631	-2339	-4393	
Reserves at Central Bank	6213	7112	12390	16272	

Source: Boratav, Turel and Yeldan (1996), Central Bank Balance of Payments Statistics May 1995, SPO Main Economic Indicators.

(a) $[(1+R)/(1+e)-1]$ where R is the highest rate offered by the banking system or on government debt instruments and E is the rate of depreciation of nominal exchange rate.

3. 3. Tax:

Under the condition of rapid inflation, Turkey's tax revenue had become increasingly inelastic with respect to nominal output and income. The new Tax Laws were implemented aiming to rationalise and widen the revenue base of the tax system. In 1981, personal income tax brackets and tax rates were adjusted upwards. In January

1985, Turkey substituted a 10% Value Added Tax (VAT) for nine production taxes and other duties that had been imposed at various rates on specific groups of commodities and services. Thus, Turkey's overall tax structure shifted to a primary reliance on indirect taxation (see Figure 5, for the share of indirect taxes in total taxes). Between 1990 and 1996 the major increase in tax revenues came from indirect taxation. In real prices, fiscal income from indirect taxes increased by a total of 20% in the same period. In the meantime the share of indirect taxes in the total rose to 65% in 1996 (see Figure 5.5). Celasun (1990) argues that the elasticity of both direct and indirect taxes increased considerably after the introduction of the VAT in 1985.

3.4. Trade:

During the 1980-1984 period, the government directed the exchange rate movements to promote exports. Export growth until 1987 was one of the best achievements of the adjustment programme. Between 1980 to 1987, exports more than tripled, and the share of manufacturing exports increased from about 36% to about 79%. Export growth slowed considerably after 1987, coinciding with the poor performance of other macroeconomic indicators.

5.6: Trade Balance (Exports-Imports), US \$ Millions

Years	1980	1981	1982	1983	1984
Trade Balance	-4,999	-4,230	-3,097	-3,507	-3,623
Years	1985	1986	1987	1988	1989
Trade Balance	-3,383	-3,648	-3,968	-2,673	-4,167
Years	1990	1991	1992	1993	1994
Trade Balance	-9,343	-7,454	-8,156	-14,080	-5,164

Source: SIS, *Statistical Yearbook*, 1995.

The adjustment programme approached import liberalisation in a gradual and cautious manner. There were minor changes in 1980 and 1981, but the major change came at the end of 1983 with the replacement of the 'positive list' by a 'negative list'

approach. Alongside the removal of the quantitative restrictions on a large proportion of imports, tariffs were lowered in December 1983 and again in January 1984, especially on raw and intermediate materials and some capital goods. The import to GNP ratio rose from 14% in 1980 to almost 22% in 1986. Over the 1980-88 period, total imports grew at an average rate of 11.5% annum, then fell by 6% in 1986, when the cost of oil imports declined by more than US\$ 1.6 billion.

3.5. Monetary Programmes:

In order to implement monetary policy on well-defined grounds to fight inflation, the Central Bank started to implement monetary programmes and set monetary targets for the first time in 1986. However, the Bank did not prepare a programme for every year, since the targets were exceeded by substantial margins due to the inability to control the financing needs of the public sector. In 1993, a short-term foreign capital inflow was realised via banks as foreign exchange credits. The share of the credits in foreign currency in the financing of their balance sheets increased. The tendency of banks leaning toward sources other than deposits, beginning at the end of 1992, especially foreign currency sources, complicated monetary control by the Central Bank in 1993.

The Turkish economy entered a process, starting in the early 1980s, in which inflation became a chronic problem (see Figure 5.3). The average annual inflation rate, as measured by the consumer price index, was about 30% between 1981 and 1983. The inflation rate, which began to accelerate in the early months of 1984, reached 48% by the end of the same year, but began to decline in 1985 and returned to the 30% level in 1986, and remained at that level in 1987. The economy entered the process of rapid price increases at the beginning of 1988, in which the substantial rise

of public sector prices in December 1987 played the most dominant role. The inflation rate, which was about 36% in the last quarter of 1987, accelerated as a result of this shock and increased to 80% in a period of six months. The most crucial point observed in this process is the potential of inflation to jump suddenly to a higher level after a significant shock. In the following 1989-1997 period, the inflation rate has been around 75%.

3. 6. 1994 Stabilisation Programme:

At the beginning of 1994, the growing public sector deficit and the resulting increase in the public sector borrowing requirement together with the speculative demand for foreign currency, culminated in the increased cost of borrowing for the Treasury, see Table 5.8. In addition, the lowering of Turkey's credit rating by international rating agencies reduced the possibility of getting foreign loans, leaving the Central Bank as more or less the only source of finance for the Treasury. Furthermore, high interest rates and exchange rates (see Figure 5.3 and 5.4), by increasing the banking sector's costs, gradually raised the sector's open position.

Table 5. 7: Public Sector Borrowing Requirement (PSBR) (as a percentage of GNP)

Years	1980	1981	1982	1983	1984	1985	1986	1987
PSBR/GNP	8.8	4.0	3.5	4.9	5.4	3.6	3.7	6.1
Years	1988	1989	1990	1991	1992	1993	1994	
PSBR/GNP	4.8	5.3	7.4	10.2	10.6	12.0	7.9	

Source: SPO, *Economic and Social Indicators*, (1950-1998)

These developments, together with the speculative demand for foreign exchange to close the open positions, played an important role in the decrease in foreign exchange reserves.

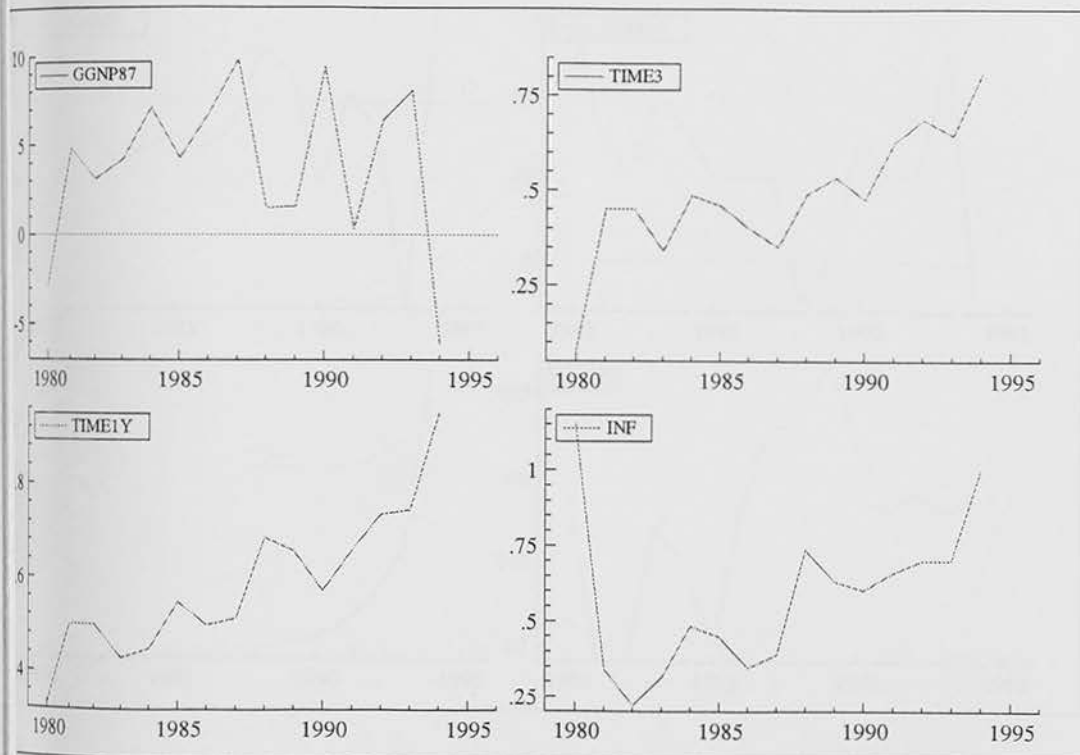


Figure 5. 3: Growth Rate of Real GNP (GGNP)(1987=100); The Three-Month Nominal Interest Rate on Time Deposits (TIME3); The One-Year Interest Rate on Time Deposits (TIME1Y) and Inflation Rate (INF).

Source: SIS, *Statistical Yearbook of Turkey (1928-1998)* and Central Bank of Turkey, *Annual Report*, various issues.

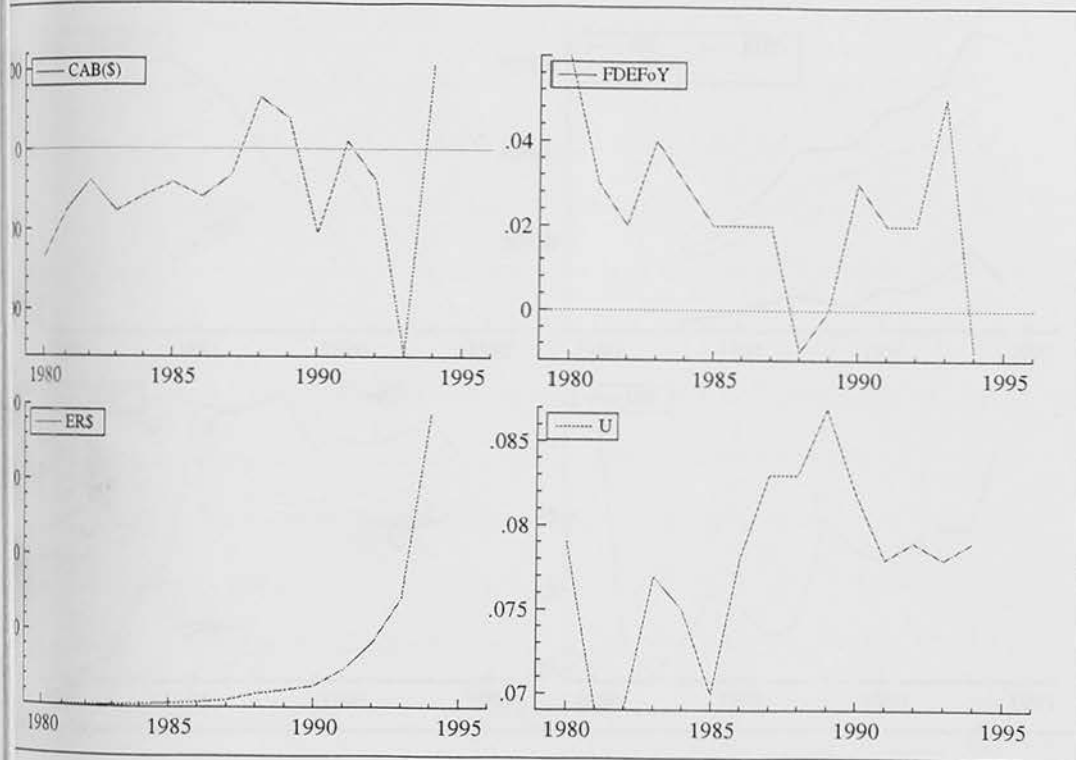


Figure 5. 4: Current Account Balance (Million \$) (CAB); Foreign Deficit to GNP ratio, both in current prices (FDEFoY); Exchange Rate (TL/\$)(ERS) and Unemployment Rate (U).

Source: Central Bank of Turkey, *Annual Report*, various issues; SPO, *Economic and Social Indicators* (1950-1998) and SIS, *Statistical Yearbook of Turkey* (1928-1998).

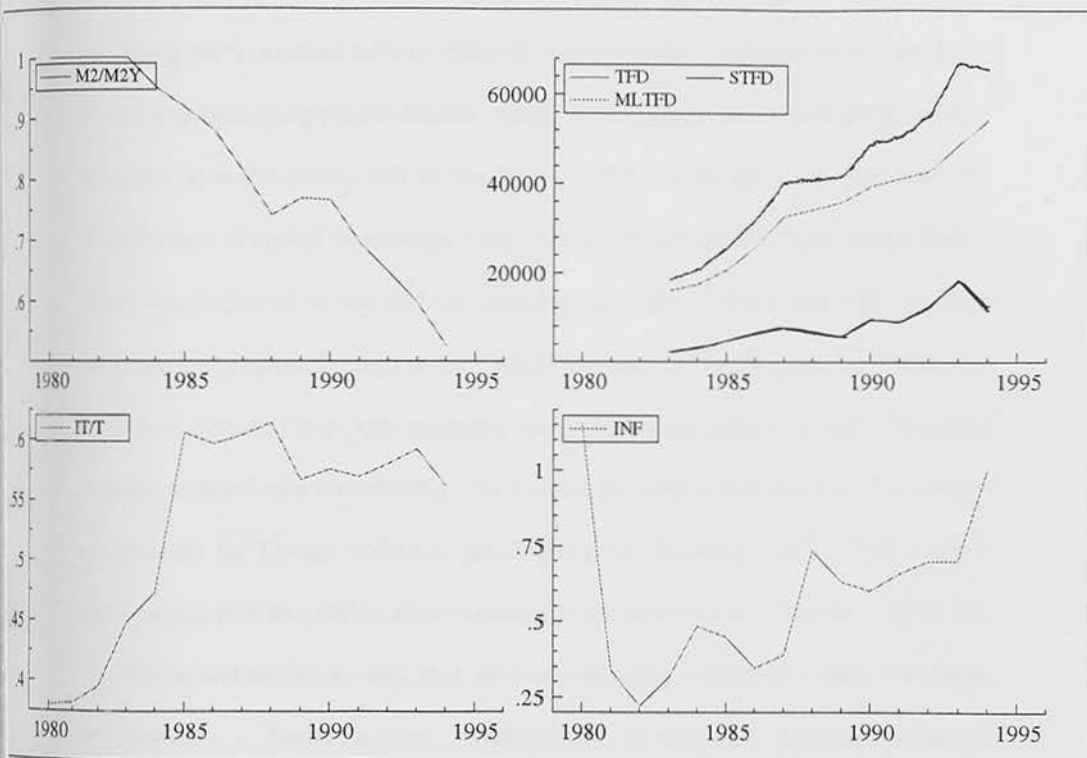


Figure 5. 5: Currency Substitution (M2Y equals M2 plus Domestic Foreign Exchange Deposits) (M2/M2Y); Foreign Debt (Million \$): Total (TFD), Short-Term (STFD) and Medium and Long Term (LTD); The Share of Indirect Taxes in Total Taxes (IT/T) and Inflation Rate (INF).

Source: Central Bank of Turkey, *Annual Report*, various issues; SPO, *Economic and Social Indicators* (1950-1998) and SIS, *Statistical Yearbook of Turkey* (1928-1998).

Real GNP growth, which was influenced mainly by domestic demand in 1992 and 1993, decreased by 6% in 1994 (see Figure 5.3). In 1994, total investment, private and public consumption expenditures decreased by 15.9%, 5.4% and 3.5% in real terms respectively. There were two essential interrelated factors behind the economic decline observed in 1994. *Firstly*, the high growth rates realised in preceding years occurred without domestic macroeconomic balances being provided. Constantly increasing public deficits, owing to the deterioration of macroeconomic balances since the second half of the 1980s, raised interest rates. In this situation, liberalisation of capital movements resulted in an increase in short-term capital flows. These developments accelerated the appreciation of the Turkish Lira which in turn weakened the competitiveness of the Turkish economy in foreign markets. Moreover, additional demand for imports stemming from a high level of income caused the trade balance to deteriorate considerably. As a result, the current account deficit increased the demand for foreign exchange, precipitating the financial crises. High interest rates, which rose to stabilise foreign exchange markets, led to a decline in industrial production and service sectors, thus adversely affecting consumption and investment expenditures. These adverse developments in financial markets increased uncertainties which interrupted production, consumption and export decisions to some extent. *The second* basic factor which led to economic decline was that, in recent years, economic growth had been stimulated by a rise in demand and especially in consumer expenditures. Private sector savings decreased while the public sector was continuously in deficit, which increased the requirement for external financing. In 1994, these adverse developments, which began in financial sectors and were reflected in real sectors, were the culmination of the two essential factors.¹² In

¹² See Yeldan (1996b) for an account of the crisis.

January 1994, concerned about sustainability of the prevailing policies, the international credit rating agencies Standard and Poor's and Moody's lowered Turkey's sovereign debt rating to below investment grade, see Table 5.8. The government, already pre-occupied with an upcoming local election campaign, did not take any significant action for three months with the exception of increasing overnight interest rates. Between January 20 and April 5, the overnight interest rate was never less than 120%, at one point it was a recorded 700%.

5.8: Foreign Debt Indicator

Years	1983	1984	1985	1986	1987	1988
Total Debt / GNP (%)	29.6	34.0	37.4	42.0	46.1	44.8
Years	1989	1990	1991	1992	1993	1994
Total Debt / GNP (%)	38.4	32.2	33.2	34.7	37.0	50.1

Source: SPO, *Economic and Social Indicators*, (1950-1998).

On 5 April 1994, the government launched a stabilisation program in order to rescue the economy. The Turkish Lira was depreciated in real terms by 30% between December 1993 and April 1994. A high level of interest rates on 3 month T-bills (yearly compounded 406% in nominal terms) right after the April 5th program helped the government to borrow from the market and roll over the existing debt stock.

The current situation is that the Turkish economy is very dependent on short-term capital inflows. The two instruments of the Central Bank - interest rates and the exchange rate turned out to be exogenously determined by the external financial markets. The gross inflows grew rapidly from \$50 billion in 1991 to \$165 billion in 1995 (the size of the overall GNP). Thus the domestic financial system is not independent from external financial markets as high levels of interest rates in dollars terms attract short-term capital. The current account balance is worsened by the appreciation of the Turkish Lira. However, short-term speculative foreign capital

flows have destabilising consequences for both asset markets and commodity markets in Turkey.¹³

4. THE EFFECT OF THE TURKISH ECONOMIC POLICIES ON PRIVATE SAVING BEHAVIOUR

A growing number of countries, developing and developed alike, have embarked on liberalisation programmes by deregulating the ceilings on interest rates since the second half of the 1970s. These liberalisation programmes can have several effects on the consumption function. In general, financial liberalisation could reduce the share of the credit-constrained and can make illiquid assets more spendible by making asset-backed credit more easily available. Moreover, during credit rationing, intertemporal substitution, which is partly represented by the real interest effect, is less likely to be operative. Thus, we would expect more powerful real interest effects after financial liberalisation. It is also possible that the coefficients on expected income growth would increase with financial liberalisation, since part of the uncertainty discount factor applied to future expected income growth rests on the possibility of future credit rationing.

While in the first half of the 1980s, the private savings rate declined and stagnated, it increased substantially in the second half of the decade. One important factor behind this latter development is attributed to the housing boom that started after 1985 with the help of subsidised credits particularly to housing co-operatives, (see, Figure 6.7). The availability of low-cost housing credits stimulated housing

¹³ See Yeldan and Kose (1997).

starts, and this process in turn encouraged savings. Private housing investment appears to be an important variable in the saving decision.¹⁴

Akyuz (1990) explains that in the first half of the 1980s, interest earnings were treated as disposable income and used partly for consumption, particularly by small savers; the portfolio shifts from real to financial assets implied erosion of the real wealth of this group and their real savings declined.

The financial liberalisation which began in 1980 was followed by large increases in the real interest rate (among other changes), and an upward movement in financial asset holdings. There was a sharp increase in time deposits and a considerable rise in M2 as a proportion of GNP in the first half of the 1980s, with the implication that there was a portfolio shift towards these monetary variables. There was a strong re-monetisation in the 1980-1983 period, as measured by M2/GNP and Central Bank Money to GNP ratio. Yet simultaneously there was a fall in the private savings rate, which means that there was a larger fall in other asset holdings than the rise in the bank money holdings. These other assets may have included deposits with non-bank intermediaries as well as 'unproductive' assets such as cash, commodity stocks and gold. The prevailing opinion on the effect of interest rates in Turkey is that the change in interest rates does not affect the savings rate but affects the composition of the savings: Treasury bills and bonds, securities, foreign currency, real assets and gold.

¹⁴ There were two upward spurts in private investments: the first was due to the boom in housing investments which attained a 36 *per annum* growth rate 1985-88 and the second was a one-year 'explosion' in real manufacturing Gross Fixed Capital Formation (GFCF) by 64% in 1990. Despite the 1990 boom in private manufacturing investments, dramatic declines in public GFCF pushed real total manufacturing GFCF 20% below its 1977 level. In 1992, total real GFCF was below the 1977 level in agriculture, mining, manufacturing and energy sectors. Boratav, Turel and Yeldan (1996) argue that there are trade-offs between private investments in housing versus manufacturing rather than the public/private dichotomy.

In the second half of the 1980s, private savings and investment increased when after-tax real interest rates changed from positive to marginally negative values. One important factor of the developments during this period was housing investment encouraged by low cost housing credits extended by public agencies. Another important factor in the second half of the 1980s was the rising public sector deficits financed by domestic borrowing. This was achieved by higher interest rates on public securities as compared to bank deposit rates, and brought about a further portfolio shift, this time towards public bonds and treasury bills from time deposits. The increase in the domestic debt stock ratio from 13.6% in 1980 to 22.95% in 1987 indicates heavy public sector borrowing from the financial markets. The growth of private securities also exhibits a strong trend after 1988. Time deposits shifted towards foreign exchange deposits, when residents (and non-residents) were allowed to open foreign exchange deposits from 1984 onwards. Thus, the already existing process of currency substitution was institutionalised in the form of foreign exchange deposits. The growth of foreign exchange denominated financial assets and the change in the financing patterns of the public deficits can be underlined as the most important factors affecting the financial asset composition of the economy.

Thus, in addition to the housing-boom, the rise in public securities and foreign exchange deposits must have helped the private savings rate to increase to some degree.

5. CONCLUSIONS AND THE LESSONS TO BE LEARNED

Boratav, Turel and Yeldan (1996) discuss the *allocational* and *technical efficiency* impact of financial liberalisation. In terms of the *allocational efficiency*, they look at

the rate of return differentials between firms and industries and the rates of non-performing credits, loan defaults and bankruptcies of financial institutions. During the 1980s, the reallocation of credits of the banking system away from agriculture and industry toward construction, housing, transport, tourism and domestic trade do not signify a move in response to differentials in social rates of return between sectors. Thus, neither the financing behaviour of corporate firms, nor the banking system as a whole, seems to be much affected after the financial reforms. Furthermore, the data shows "a crowding in" type of a relationship between the private and public sector's use of the banking sector's credit facilities, because the banks could expand the size of the aggregate money stock in the broader sense of M2/GNP so their credit allocation scheme towards the public sector would not necessarily crowd out private initiatives. However, the domestic financial markets required a continued inflow of foreign exchange; in Turkey this is made through short-term foreign capital inflows. The evidence also shows that financial liberalisation was accompanied by higher rates of default. Furthermore, cases of bankruptcies or government-enforced mergers to prevent failures are common in Turkey. They propose two indicators for measuring the *technical efficiency* of the financial system: costs of intermediation and real costs of the borrower. The net spread shows that it is not labour costs but rather the upward movement in management costs and net profits of the banking system. They conclude that Turkish financial liberalisation did not correspond to a move toward a more competitive environment.

The post-reform performance of the Turkish economy has been one of boom-and-bust cycles. The rate of growth of GDP is meagre in 1988 and 1989, increases to 7.9% in 1990 and then 1.1% in 1991, and fluctuates thereafter. Concomitant with this is the cyclical behaviour of consumption and investment. Since 1988, growth and

development of the economy parallel import availability. The slow-downs in GDP are associated with the decline in the volume of import demand. Therefore, the growth of the economy is financed by foreign savings rather than the domestic savings. The positive correlation between foreign savings and the growth of GDP is striking. The short-term capital inflows are not only used to finance the government deficit via foreign savings but also to expand consumption and imports. Furthermore, the developments in the financial markets are hindered by the short-term capital inflow, since ISE index shows that there is a very close correlation between short-term capital inflow and the operational volume of the Stock Exchange.

The high interest rates in Turkey due to the high government budget deficit have an adverse effect on production and employment. However, it is impossible to reduce interest rates without reducing the government deficit. Thus, privatisation and an effective tax policy have an important role in this process.

Chapter 6:

THE HOUSING SECTOR IN TURKEY

1. INTRODUCTION

The housing sector is one of the fastest growing sectors in Turkey. Since the 1950s, a 6% annual average urbanisation rate is the one of the major factors generating housing need. Although, during the planning periods, the share of housing investments in total investments reached 40%, Turkey still suffers from a lack of housing. When we add other factors such as high population growth and an increasing number of family units, reflecting a socio-economic preference for rearing smaller families, the situation becomes serious.

Housing is an important economic sector since it not only satisfies the need for shelter but also creates direct and indirect multiplier effects on different production sectors which boost employment opportunities. Moreover, the sector uses large quantities of labour and inputs, and its expansionary impacts on related industries, especially durable consumer goods industries, have made it as an important barometer of economic conditions in Turkey. Furthermore, housing investment depends on domestic resources rather than imported resources, so its need for foreign exchange is low, which makes the sector attractive to economic policymakers.

Housing is both a consumption and an investment good. The separation of the concepts of housing stock and housing services is made between the demanders of the

housing stock, who can be viewed as investors and the demanders of housing services, who can be viewed as consumers, though they may be one and the same.

The share of construction investment in total investment is 50%, whilst 80% of the construction investment is in housing investment in Turkey. Thus housing investment has a big share in total investment. When we investigate fixed capital formation in the last 10 years, we see that housing investment is the third highest of all investments. Historically, housing investment increased steadily until 1980, but between 1980-1983 it decreased. Figure 6.7 shows that from 1983, housing investment has increased continuously.

Since 1984 government policies for housing needs have taken the form of transferring large funds to the housing sector, the provision of credits, and the allowance of tax reductions to housing co-operatives and households. However, housing co-operatives and households need to be eligible for these credits and tax allowances. Eligibility depends on the type of housing and only applicants for social housing are considered. This encouragement of home ownership has created a kind of forced savings in Turkey. The number of building societies has not only increased over the recent period, but also their operations have taken different forms in order to provide houses for a large proportion of the population. For example, for every occupation a co-operative society has been established (e.g., Teachers' Co-operative, Artists' Co-operative), and these co-operatives make it easier for people in these particular occupations to own a house. Although the co-operatives play an effective role in determining the supply of housing, they are unable to provide accurate data on house prices. Due to high inflation, co-operatives have the authority to change the payments in accordance with the inflation

rate. Furthermore, households prefer to buy a house from the owner or through co-operatives rather than estate agencies. This effectively eliminates another possible data source.

Overall, the demand for housing is increasing in Turkey; however, it is important to note that households are trying to buy a house in order to own it, and not to let it, even though the tax rate is very low for a landlord (3%). This is unsurprising, given a minimum contract length of six months, and laws that are very supportive of tenants' "rights". Recently, in the big cities, owners began letting their houses on the proviso that they be paid in foreign currency in order to offset inflation losses.

High population and urbanisation growth, the trend towards smaller families, high inflation, migration from the Southeast region, the possibility of a new law against illegal housing, and will close existing squatters' houses, will keep the demand for housing buoyant. This will affect house prices as well as housing wealth in Turkey. House prices and housing wealth in turn will have important impacts on households' saving decisions.

One of the main concerns of economists interested in the housing sector is the lack of data for Turkey. The only available information is the housing stock variable that has been published every five years since 1960. Along with an examination of the housing sector's operation, the other main aim of this chapter is to generate nominal housing wealth and housing price data from the available data, such as the nominal private disposable income, the nominal private investment in the housing sector, and the CPI index.

Section 2 discusses the housing policies during the development plans. Section 3 investigates Turkey's housing credit and finance system. Section 4 examines the share of

the housing sector in the Turkish GNP compared to that in other countries. Section 5 discusses the effects of the housing sector on other sectors of the economy. Section 6 investigates housing costs in Turkey. Section 7 deals with housing demand and supply. Section 8 discusses population and urbanisation. Section 9 describes the problems that households face relative to the housing sector. Section 10 calculates housing wealth and creates an index of house prices in Turkey. Section 11 gives conclusions.

2. HOUSING POLICIES DURING THE DEVELOPMENT PLANS

Turkey adopted the planned approach to developmental problems in 1960 and established the State Planning Organisation (SPO), directly under the Prime Ministry. The SPO assists and acts as an advisory body to the Government in determining economic and social objectives, and formulates long and short-term plans for the realisation of Government Policy. The first National Development Plan was drafted in 1963. Thus, since 1963 the whole implementation process has taken place within the framework of the Five Year National Socio-Economic Development Plans. Each Plan in turn is divided into Annual Programs on a sectoral basis which remain imperative for the public sector and indicative for the private sector.

Institutionalisation was the main response to the housing credit problem in the pre-planning period, which saw the establishment of the Social Security Organisation, the Emlak Etyam Bank¹ in 1926, and the Ministry of Construction and Housing in 1958.

2. 1. 1963-1967 (FIRST FIVE YEAR DEVELOPMENT PLAN): The aim was to

¹ The Bank was renamed as Turkish Property Credit Bank in 1948.

reduce the share of housing investment in total investments and at the same time produce more housing units by producing social rather than luxury housing; and while the share in 1965 was 22%, it went down to 19% in 1968. To solve ownership and land registration (kadastro) problems in connection with squatter² housing and develop infrastructure in these areas, to create opportunities for rental housing at low cost, and to prevent land speculation by implementing a new tax on land appreciation were key objectives during this period.

Table 6. 1: Housing Investment (1963-1967)

YEARS	1963	1964	1965	1966	1967
Tot.Hous.Inv./Tot. Inv. (%)	15.79	17.54	21.54	20.50	19.90
Priv.Hous.Inv./Priv. Inv. (%)	25.76	30.00	37.68	36.14	33.02
Priv.Hous. Inv./Tot.Hous.Inv. (%)	94.44	90.00	92.86	90.91	89.74
Private Saving Ratio (%)	7.10	10.3	10.80	12.80	12.20

Source: The First Five Year Development Plan, SPO (1962)

Table 6.1 shows that the share of private housing investment in total private investment decreased from 37.68% in 1965 to 33.02% in 1967 and to 32.26% in 1968. This was due to the introduction of a new property-income tax and rent-law, which affected demand for housing for rent and speculation purposes. Housing credit policies were also effective in reducing the share of housing investment in private investment. 14% of the private sector housing investment was financed through housing credits in 1964; this ratio dropped to 7.9% by 1967, because The Turkish Housing Bank reduced its share in credits from 11.4% in 1964 to 2.7% in 1967, and to 1.2% in 1968. However, at the same time, the Social Security Organisation (SSK) and Army Support Association (OYAK) increased their credit share to build social rather than luxury houses.

During the first development plan, the capital market was not operative, hence savings could go to either the banking system or to direct investments. The

² Squatter Housing is not the same as in the UK. It is an unauthorized building on government land.

unattractiveness of housing investment directed private savings to time deposits. The share of time deposits in savings increased from 4% in 1964 to 13% in 1967. During the same period annual inflation was 5.4%, the interest rate on 1-year time deposits was 6%, and the interest rates on 2-year time deposits was 6.5% - which indicates small but positive real interest rates. Furthermore, during the same period, rental income increased by only 4.7% annually.

2. 2. 1968-1972 (SECOND FIVE YEAR DEVELOPMENT PLAN): The attitude towards the housing sector changed in this period, since the proportion of squatter housing in cities was 13.5% in 1960 and increased to 21.8% by 1965, in the previous plan period. Therefore, the share of credits in housing finance increased from 7.9% in 1967 to 14.9% to 14.9% in 1972. The provision of cheap land, the provision of credit possibilities, site preparations, and constructing infrastructure for squatters were the main targets of this period.

While the growth of housing investment was 3% annually during 1963-67, this increased to 6.3% in 1968, to 11.6% in 1969 and to 18.9% in 1970. However, changes in regulations in 1970 affected this trend. In September 1970, the interest rates on time deposits increased from 6% to 9%. Previously the share of households' savings in time deposits was 12-13% and this increased to 25% in 1970, to 40% in 1971 and to 41% in 1972. In real terms returns on time deposits were positive only in 1970 (2.3%). In 1971 and 1972 they were negative, but the nominal increase in 1970 was still attractive for savings in 1971 and 1972, despite the inflationary erosion of asset returns. Furthermore, rental income growth of 6% in 1971 and 1972 was far behind inflation, so asset

substitution was not very attractive. Thus, between 1970 and 1972 interest rate policies affected private housing investment. The share of private housing investment in total private investment (see Table 6.2) decreased from 35.52% in 1970 to 32.26% in 1971 and to 31.23% in 1972. In July 1970 the Finance Law³ became valid, and this law changed the rules concerning property-income tax; estate tax and estate commission tax. The idea was to limit luxury housing and to prevent housing purchase for speculative purposes. The Building Research Institution and the Land Office were also established in this period. Thus, these changes not only affected the demand for housing, but also housing supply. Overall they did little to improve the housing problem.

Table 6. 2: Housing Investment (1968-1972)

YEARS	1968	1969	1970	1971	1972
Tot.Hous.Inv./Tot. Inv. (%)	18.64	20.71	22.02	20.05	19.76
Priv.Hous.Inv./Priv. Inv. (%)	33.26	34.21	35.52	32.26	31.23
Priv.Hous. Inv./Tot.Hous.Inv. (%)	90.91	89.66	90.28	92.11	94.95
Private Saving Ratio (%)	12.10	11.9	13.60	13.00	13.90

Source: The Second Five Year Development Plan, SPO (1967)

Private savings were also affected by changes in policies related to the housing sector. Table 6.2 suggests a strong correlation between private sector savings and housing investment. Furthermore, interest rate policies did not seem to have much impact on private savings as private savings were expected to grow more vigorously during 1970-1972.

2. 3. 1973-1977 (THIRD FIVE YEAR DEVELOPMENT PLAN): It was planned to decrease the share of private housing investment in total housing investment and to construct small social houses. The government took an active role in helping low-income

³ The Finance Law was introduced to divert private investment from the housing sector to the manufacturing sector.

groups, and to provide them with social housing. During this period Public Housing Credit Co-ordination was established and the Ministry of Construction and Housing started to oversee social housing operations in less developed areas. Nevertheless they were not successful in stopping rising rent and land prices.

The government, in order to get a high stock of housing despite scarce resources, put restrictions on luxury housing, gave priority to low-income groups by providing cheap land and low rent housing, and supported private co-operatives. Land speculation was prohibited and plans were made to tackle the 'squattering' problem.

Table 6. 3: Housing Investment (1973-1977)

YEARS	1973	1974	1975	1976	1977
Tot.Hous.Inv./Tot. Inv. (%)	20.29	16.13	15.47	16.22	16.64
Priv.Hous.Inv./Priv. Inv. (%)	32.63	27.27	27.02	28.59	30.33
Priv.Hous. Inv./Tot.Hous.Inv. (%)	96.88	96.18	91.62	93.66	92.78
Private Saving Ratio (%)	14.60	13.50	14	18.10	16.50

Source: The Third Five Year Development Plan, SPO (1972)

Between 1972-1977 the average rental income index rose 21%, which was more than the increase in the Wholesale Price Index (average real interest rates were -19%). Negative real interest rates since 1972 decreased the share of demand deposits in households portfolios, which fell to 16% from 41% in 1976 and 6% in 1977. However, the increase in saving rates in 1976 and 1977, shown in Table 6.3, can be attributed to housing investment.

2. 4. 1978-1983 (FOURTH FIVE YEAR DEVELOPMENT PLAN): The housing problem was becoming more serious and in 1982 the annual housing need was set at 250,000 units. Hence, squatter housing increased. High land prices, poor infrastructure, high material input prices and lack of finance were typical problems of the housing sector during this period.

Table 6. 4: Housing Investment (1978-1983)

YEARS	1978	1979	1980	1981	1982	1983
Tot.Hous.Inv./Tot. Inv. (%)	20.53	23.57	21.47	13.32	13.24	13.11
Priv.Hous.Inv./Priv. Inv. (%)	35.90	43.77	42.94	28.46	27.86	27.46
Priv.Hous. Inv./Tot.Hous.Inv. (%)	93.27	93.44	94.07	89.31	93.98	92.33
Private Saving Ratio (%)	10.40	13.30	12.09	11.90	9.20	10.20

Source: The Fourth Five Year Development Plan, SPO (1977)

The negative real interest rates continued (-36.6% in 1978; -41.9% in 1979; -73.2% in 1980), but the increase in rental income index (52.2% in 1978; 61.2% in 1979; and 113.6% in 1980) was reflected in the increased private housing investment in 1978 and 1979, illustrated in Table 6.4, and directed household savings to the housing sector [Housing' 81].

The 1980s stabilisation policies aimed to slow down the rate of inflation. Structural change in the whole economy had negative impacts on the housing sector. Investment started to decrease because of the positive real interest-rates. People began to invest in alternative investment instruments like interest-earning deposits in commercial banks, etc. The developments in the 1980s affected credits which were channelled to the export sector, so the housing sector with limited access to new credits shrank.

Moreover, due to rapidly decreasing real wages, and the changing structure of income distribution, housing demand had sharply declined in those years, while costs and prices of housing were increasing (Türel, 1989). Housing supply was also affected by the general economic conditions through increasing construction costs and interest rates.

These developments had negative impacts on the input sectors of housing and on the labour sector. Labour demand decreased a great deal, the construction materials sector which provided inputs to the housing sector collapsed, and the sectors which are complementary to the input sectors were affected one after the another.

This reformulation of policies affected housing investments [see Table 6.4]. The decrease in housing investment after 1980, due to the Stabilisation Programme, started to reverse itself by 1983, due to the Mass Housing Fund, and investment continued to increase from then on. The reasons for the increase in investment may be attributed to the 'Mass Housing Fund', 'Reconstruction Amnesty'⁴ and 'Tax Regulations'⁵. These three sets of regulations were all attempts to create new incentives for building and speeding up the rate of production in the sector.

Out of the three sets of regulations, the most influential is the Mass Housing Fund. The Housing Development Administration was established as a department attached to the Prime Ministry. Substantial amounts of money accumulate in the Fund through tax-like deductions imposed on certain goods and services, including petroleum products, tobacco and alcoholic drinks.

2. 5. 1984-1989 (FIFTH FIVE YEAR DEVELOPMENT PLAN): In 1984, with the establishment of the Mass Housing Fund, the public sector increased its activity in the housing sector. To prevent squatter housing, a land registration certificate was made requisite. Law No: 3320 was introduced to help current and retired officials and workers to own a house. By 1989, housing production had covered 78.8% of the housing need⁶,

⁴ Reconstruction Amnesty is a legalization process for unauthorized buildings via a process of improvement planning.

⁵ Tax Regulations aim to reduce the rate and change the forms of taxation on the existing building stock.

⁶ The following factors were effective for this increase:

- 1) Households were able to save more out of *per capita* income. *Per capita* GNP was \$1269 in 1984, \$2021 in 1985 and \$2671 in 1992.
- 2) Housing cooperatives became very common and effective in directing households' savings. Cooperatives produced 16.6% of private sector housing in 1984 and this increased to 27.8% in 1991.
- 3) Improvements in infrastructure in the urban areas.
- 4) Housing incentives given to private sector by the government.

as the share of housing investment in total private investment increased to 54.22 %, as shown in Table 6.5. However, rent and land prices were still rising during this period.

Table 6. 5: Housing Investment (1984-1989)

YEARS	1984	1985	1986	1987	1988	1989
Tot.Hous.Inv./Tot. Inv. (%)	14.40	18.83	21.38	27.86	35.83	36.70
Priv.Hous.Inv./Priv. Inv. (%)	28.29	32.34	37.03	47.72	53.32	54.22
Priv.Hous. Inv./Tot.Hous.Inv. (%)	90.26	93.62	95.72	97.70	98.31	98.32
Private Saving Ratio (%)	11.00	11.20	14.00	20.00	23.60	20.10

Source: The Fifth Five Year Development Plan, SPO (1983)

The Mass Housing Fund, functioning as the main source of credits extended to house-purchasers, to self-builders and to the members of house-building co-operatives, was instrumental in achieving a sharp recovery in the 1984-87 period.

2. 6. 1990-1994 (SIXTH FIVE YEAR DEVELOPMENT PLAN): Housing need continued to increase in this period, although Table 6.6 indicates that the share of total housing investment in total investment increased to almost 40% in 1994. Moreover, house prices showed an increasing trend, because of the increase in housing credits given by the commercial banks. During this period the goals of the squatters changed. Previously squatting was done for shelter by low-income families, but during this period it was identified with land speculation. Thus, homes for low-income groups continued to be an ongoing social and political problem for Turkey.

Table 6. 6: Housing Investment (1990-1994)

YEARS	1990	1991	1992	1993	1994
Tot.Hous.Inv./Tot. Inv. (%)	33.46	33.79	31.46	33.28	38.92
Priv.Hous.Inv./Priv. Inv. (%)	46.57	48.28	44.99	40.03	47.74
Priv.Hous. Inv./Tot.Hous.Inv. (%)	96.36	98.04	97.46	98.06	98.19
Private Saving Ratio (%)	21.50	23.40	24.07	27.10	27.20

Source: The Sixth Five Year Development Plan, SPO (1989)

2. 7. 1995-2000 (SEVENTH FIVE YEAR DEVELOPMENT PLAN): During the Seventh Plan period, an additional housing need emerged, caused by demographic changes in population centres. For small towns with a population of less than 20 thousand, 148 thousand extra homes were needed. For larger towns and cities, 2.142 million new homes were required. In addition to this, about 50 thousand houses *per year* will be needed in the future for other reasons like renewals and natural disasters. In less developed areas, principally in eastern and southeastern Anatolia, housing production needs to be increased. Consequently, the total housing requirement for the Plan period is 2.54 million.

3. EVALUATION OF TURKEY'S HOUSING CREDIT AND FINANCE SYSTEM

The housing finance system is supported by the central authority (government), local authorities, the Social Security Organisation, and housing co-operatives. In 1958, the central authority started to give financial support to housing through the Ministry of Reconstruction and Development, and has become even more active, since 1984, through the Housing Development Administration. Local authorities and housing co-operatives cannot contribute much to housing finance. The Social Security Organisation, the Bagkur and the OYAK support housing finance with small projects.⁷ The functions of the

⁷ Housing credits have been provided by the Housing Credit Bank since 1926, the SSO since 1950, and the OYAK since 1963, while Bagkur provided credits between 1976 and 1980. These four sources supplied 16% of total housing credits in Turkey.

SSO continued up to 1984 until the formation of the Mass Housing Fund⁸. Now only OYAK is continuing to function.⁹

Before 1979, no commercial banks were active in the field of housing finance except the Turkish Property Credit Bank, because it was not profitable to provide cheap, long-term housing credits in return for real estate mortgages. At the beginning of the 1990s, commercial banks started to become active in providing housing credits to individuals. Housing-credit interest rates were higher than deposit interest rates, initial capital payments were higher, and the possibility of simultaneous repayments of capital and interest created new sources of business for commercial banks after 1990. So housing credits with high interest rates and shorter terms became attractive for commercial banks. However, the commercial banks attract high-income families and so the Mass Housing Fund tries to direct its credits to low-income families.

However, housing credits in Turkey do not cover a significant portion of the overall sources of housing purchase. When we examine alternative ways of purchasing a house in Turkey, we find that 35.6% of houses are bought by cash, 27% by inheritance, 22.7% by taking loans, 7.9% by housing co-operatives, 2.7% by housing credits and 4.1% by other methods, (Hasekioglu [1996]).

The implementation of a housing finance system similar to a deposit finance system or mortgage banking has never been realised in Turkey, because the Mass

⁸ Mass Housing is an act supported by the central authority. The reason why the central authority is preferred to the local authority in solving the housing problem lies in the structure of housing policies. The tools of housing policy had been greatly reduced to a simple credit system to be controlled by the central authority instead of local authorities. Housing finance system is supported by central authority, local authorities, social security institutions and housing co-operatives.

⁹ There has been a strong positive correlation between credits to the housing sector and private investment in housing since 1988 in Turkey.

Housing Fund is not an institution which gathers household savings and then lends them to credit demanders, like building societies in England, or savings and loan associations in the USA, or co-habs in Brazil. The current institutional structure and market significance of mortgage finance institutions is completely different. Housing finance in Turkey, in contrast to a mortgage system, cannot be active in the capital markets and mostly credits are provided through public institutions. The dominant type of housing finance in Turkey is therefore that of the Mass Housing Fund.

Public institutions provide credits with fixed interest rates over long periods, so demand emerges in periods of high inflation. However, high inflation rates in the period between 1975-80 were influential in diminishing funds of SSO and Bag-Kur. Housing finance sources became more limited and the housing sector entered a crisis. Housing credits, which are important tools in helping the housing sector out of a crisis, need to be overhauled to function efficiently. The Mass Housing Fund developed from this approach. In the period between 1984-89, credits with fixed interest rates were used, but in 1989 the Mass Housing Fund started to use the 'indexed credit system',¹⁰ which is the first example of credits with variable interest rates.

¹⁰ This was 'a two index credit system' first that aimed to index credit debt to inflation and repayments to the official wage. However, this became 'a one index credit system' later on where official wages were used as an index variable.

4. THE SHARE OF THE HOUSING SECTOR IN THE TURKISH GNP COMPARED TO THAT IN OTHER COUNTRIES

The ratio of housing investments to the GNP reached a high level in the period between 1977-79 and started to decrease quickly between 1979 and 1982. This situation was the reverse of that in other OECD countries¹¹, as their ratio tended to fall at an accelerating rate after 1973. The tendency of housing investments to fall in Turkey and the average in the OECD countries was similar at the beginning of the 1980s.

In OECD countries, the financial reforms responding to the 1970s crisis were effective when compared with those in Turkey. In Turkey, the stabilisation program was realised later than planned and a crisis occurred in the early 1980s. After the creation of the Mass Housing Fund in 1984, the increase in housing investments speeded up. The share of housing investment in the GNP in 1987 and 1988 reached the developed countries' level.

In most of the developed countries, the share of housing investment in the GNP in the period between 1980-90 was 4 to 6%. In the same period Turkey had an average rate of 3.8%. When the UK is examined, this rate dramatically decreased to a level below 4% on account of policies adopted in the 1980s.

In Turkey, for the period between 1979-86, the share of housing in the GNP was approximately 3% and did not quite reach the level of housing investment in developed

¹¹ At the earliest stages of economic development, the share of housing in total output is low. A relatively small share of total resources is allocated to housing because other investments presumably yield higher expected returns. With development, the share of housing in total output rises as housing outbids many of the types of investment seen as critical during the earliest development stage. Past some point on the development continuum, the share of housing in total output falls as alternative investments outbid housing. The share of housing in total output changes systematically as nations move up the development ladder.

countries. But in 1987, this ratio reached a higher level of 5.8% and surpassed the rates of developed countries. Of course, when the situation is evaluated within the framework of rapid urbanisation in Turkey, and a substantial housing supply gap, this ratio does not seem so impressive.

5. EFFECTS OF THE HOUSING SECTOR ON OTHER SECTORS OF THE ECONOMY

The housing construction sector is distinguishable from other sectors of the economy by its strong 'backward linkages', in the sense that it uses up large amounts of various raw materials. Besides this, a number of finished and semi-finished products of related industries are inputs in large quantities to the production process of the sector. From the input-output tables of 1973 and 1990, when coefficients for cement, wood and iron-steel industries, which are the main industries in the construction sector, are compared, it is seen that the rank order of the percentage shares in the total construction sector changed completely. The rank order of the 1973 table was; cement, wood and steel-iron industries respectively, whereas 1990 data indicated a completely different composition - steel-iron, cement and wood industries respectively. This difference may originate from the developments in the reinforced concrete and steel construction technology which have become popular in recent years.

Eraydin *et al.* (1996) find that the production multiplier of housing construction was 2.526 in 1985 and 2.126 in 1990; and the housing infrastructure sector's was 2.149 in 1985 and 2.084 in 1990. The contribution of the housing sector to the national economy has been calculated as 7,100 billion TL in 1985, 12,200 billion TL in 1986, 18,300 billion

TL in 1988, 22,000 billion TL in 1990 and 19,700 billion TL in 1992 at 1988 prices. The employment generated by the housing sector was 1,239,000 in 1985 and peaked in 1990 at almost 2 million. This means that approximately 12% of the total jobs are generated within the housing sector.

6. HOUSING COSTS

The State Institute of Statistics (SIS) provides data on the population census and the construction industry in Turkey and also an index for the square-metre unit cost of housing. However, these statistics are not detailed; and they do not provide information about occupancy permits, ownership of houses, physical situation of houses, etc.

The SIS constructs square-metre unit cost for housing which only includes the cost of labour and materials. Table 5.7 indicates that between 1984 and 1993 the increase in metre square unit cost was above the increase in the consumer price index most of the time. The lack of data on land prices is the main reason for not having accurate data on house prices in Turkey.

Table 5. 7: Cost of Housing

Years	% Increase in cost	% Increase in CPI
1984
1985	56.7	44.0
1986	60.9	30.7
1987	34.8	54.8
1988	90.8	61.5
1989	52.7	63.9
1990	58.5	60.0
1991	67.3	71.3
1992	64.4	66.0
1993	71.6	45.3

Source: SIS

Housing'96 evaluated house prices for seven cities in Turkey and showed that house prices do not depend on labour and construction costs but on other factors such as

land prices. The share of land prices constitute 35-40% of house prices in Turkey according to Turel (1989). Again the differences between the house prices in the cities are attributed to land prices. Thus, there is a need for a house price/land broker in Turkey, a sort of auctioneer whose role is to try and bring supply and demand into line, and hopefully prevent speculative house price movements.

7. HOUSING DEMAND AND SUPPLY IN TURKEY

The developments in the housing sector correlate with those in the construction sector. The construction sector's share in the GNP during the third development plan (1973-1977) was 5.8%. It increased to 6-7.2% between 1978 and 1981. However, the growth in the construction sector's share slowed down until 1986. Since 1986, the share has been increasing again steadily.¹² After the 24 January 1980 austerity package, the resulting decrease in public and private sector investments caused housing construction to decrease by 30% and negatively affected the growth rate of the construction sector. In fact, the growth rate of the construction sector was 4.2% in 1979, 0.8% in 1980 and 0.4% in 1981. The growth rate increased after 1982: it was 0.5% in 1982, 0.6% in 1983, 2% in 1984 and 3% in 1985. The early 1980s witnessed a decrease in domestic demand due to anti-inflationary policies; and an increase in the cost of intermediate inputs as a result of financial bottlenecks.

¹² The housing production level was affected by the negative results of the crisis in 1980 and only returned its old level by the mid 1980s (reaching a maximum level in 1987). Construction permits were taken for 250,000 housing units in 1979 and almost doubled in 1987. When 1987 (which is the maximum level of post-1980 period) is compared to 1979 (which is the maximum level of third period [1960-80]); it can be clearly observed that the volume of housing sector's production increased two fold in a period of not more than 10 years.

The share of rented houses increased compared to the rate in the previous years. The share was 22.8% in 1985 and rose to 29.7% in 1990. While this share was 4.4% in small towns and villages in 1985, it rose to 10.7% in 1990.

The 1980s showed important characteristics not only of the quantitative aspect of the housing sector but also of the variety of housing provision types according to different income groups. On the other hand, an apparent change in the structure of housing demand can be observed. People started to demand much more varied housing types with the advantage of more choices in the housing provision portfolio. Pulat (1992) compares the quality of housing and the changing composition of the housing stock with that in the developed and developing countries and shows that, although Turkey's situation has improved over the years and is much better than that in other developing countries, she has not caught up with the developed countries yet.

8. POPULATION AND URBANISATION

The ratio of the urban population to the overall population is estimated to have risen to 60.9% by 1995. Due to the speed of urbanisation, which is estimated at 4.4% annually for the period 1990-1995, infrastructure and structural investments in cities are insufficient to respond to the needs of the continuously increasing population.

Problems of rent seeking in an illegal way in the cities have increased and problems concerning infrastructure and transport in the larger cities have become difficult to surmount; and squatter areas have increased.

It is estimated that between the years of 1995 and 2000, the population of rural settlements under 5,000 people will fall to 13.7 millions with an annual average decrease

of 8.7%. The population of semi-rural settlements with 5,000-20,000 people will increase to 9.5 millions at an annual average increase of 2.7%. The population of urban settlements of over 20,000 people will reach 47.6 millions at an annual average increase of 4.7%.

It is also estimated that in the same period, the total population of bigger cities with 1 to 5 million people will rise from 7.7 million to 12.5 million at an annual average increase of 10.2%. It is expected that the population of Istanbul, the biggest city in Turkey, will increase to 11.5 million by the year 2000. The share of its population in the total urban population will be around 24%, while the population growth rate *per* year will be about 4.5%. In the 1995 to 2000 period, policies to slow down the migration to bigger cities of over 1 million population will be introduced.

Table 6. 8: Urbanisation Rate and Urbanisation Ratio

Years	Average Annual Growth Rate of Urbanisation	Percentage of Total Population in Urban Areas
1990	5.5	54.0
1995	4.4	60.9
2000*	4.7	70.6

*Estimated
Source: SPO

Table 6.8 indicates that the urban share in total population estimated to be 60.9% in 1995, will go up to 70.6% by 2000, and the urbanisation growth rate, which moved at a slower pace in the 1990-1995 period, will speed up again in the period 1995-2000, having been affected by internal and external socio-economic factors.

The reasons can be classified into two main groups: The first group includes urbanisation and industrialisation, which require a great deal of investment. Housing investment was low when compared with other types of investment as the resources of the country were limited. A second group of reasons includes political preferences on housing and land. The solution to the housing problem by small-capital, speculative

builders (yap-satci) was accepted by government. The reason why the government accepted these solutions was due to the single-sided credit mechanism of housing which only consumers could benefit from, and the non-existence of legal arrangements for land activities. Central and local authorities could not succeed in developing a land policy to prohibit land speculation and to turn back the invasion of government land, Eraydin *et al.* (1996).

9. HOUSING SECTOR AND HOUSEHOLDS

While three-fifths of households in Turkey earn only 29% of total income, two-fifths earn 71%, as shown in Table 6.9.

In the urban areas 69.5% of households are below the average urban income level, while share in urban income by the highest income 30.5% of households' is 62.9%, (see Table 6.10). This has important implications for housing in Turkey. Middle, upper-middle and upper income families can own or buy a house without government support, whereas low and low-middle income families need government support; hence housing policies should take into account these family groups.

Table 6. 9: Income Distribution According to Household Groups

Households Groups (20% each)	Its Share from Total Income (%)		
	Turkey	Big Cities	
	1987	1987	1978
I One Fifth (Lower Income)	5.24	5.43	6.37
II One Fifth (Lower Middle Income)	9.61	9.33	10.45
III One Fifth (Middle Income)	14.06	13.60	15.04
IV One Fifth (Upper Middle Income)	21.15	20.71	21.56
V One Fifth (Upper Income)	49.94	50.03	46.62

Source: 1978 and 1987 Households' Expenditure and Income Survey Results (SIS)¹³

¹³ Although the 1994 Households' Expenditure and Income Survey is also available, it is not compatible with the previous surveys and hence I could not use it in these tables.

Households' propensity to consume and save not only differs in urban and rural areas but also differs according to the population of the urban areas. The highest saving occurs in towns with a population between 10,000 and 20,000. The decrease in the savings rate from 28% in 1978 to 14.5% in 1987 in the urban areas with populations above 10,000 affected the housing sector negatively.

Table 6. 10: Distribution of Urban Households' Monthly Income

Income Groups (000 TL)	Households (%)	Share in Total Income
0-199	41.2	15.5
200-349	28.3	21.6
350-599	17.7	22.9
600-999	8.5	18.2
1000+	4.3	21.8
TOTAL	100	100

Source: 1987 Households' Expenditure and Income Survey Results (SIS)

With all the savings put down on housing in towns with a population between 10,000-20,000 (see Table 6.11), a household can own a house of 84 square metres in ten years¹⁴ [Housing' 94]. Housing' 94 also shows that while low-income families cannot afford to buy a house at all, low-middle income families can buy a house of 72 square metres over forty years. So affordable housing is a serious problem for low-income families in Turkey.

Table 6. 11: Average Propensity to Consume and Save in Urban Areas by Population

Population Size	Propensity to Consume	Propensity to Save
10001-20000	75.9	24.1
20001-50000	87.1	12.9
50001-100000	88.9	11.1
100001+	85.8	12.2
1987 Urban (10001+)	85.5	14.5
1978 Urban (10001+)	72.0	28.0
1987 Urban (20001+)	86.2	13.8
1987 Rural (-99000)	67.1	32.9
1987 Turkey	78.4	21.6

¹⁴ A middle income family can afford a house of 88 square metres in ten years in Turkey.

Source: 1978 and 1987 Households' Expenditure and Income Survey Results (SIS)

Table 6.12 shows that the ownership of housing did not change much since 1978.

Table 6. 12: Ownership of Housing

Ownership of Housing	1978	1987		
	Urban (%)	Urban (%)	Rural (%)	Turkey (%)
Own	58.9	60.6	82.9	71.2
Rent	35.9	35.5	9.6	21.9

Source: 1978 and 1987 Household Expenditure Survey (SIS)

Table 6.13 shows that ownership of housing is positively correlated with income levels. While only 52% of low-income families own a house, 77% of upper income families do.

Table 6. 13: Ownership of Housing in accordance with Income Level (%)

Income Level	Households	Own	Rent	Government Housing	Others
Low	41.2	51.6	42.2	1.8	4.4
Low-Middle	28.3	62.9	30.6	2.6	3.9
Middle	17.7	67.4	24.9	4.2	3.5
Upper-Middle	8.5	74.8	19.3	3.1	2.8
Upper	4.3	76.8	21.4	0.6	1.2

Source: 1987 Household Expenditure Survey (SIS)

The change in type of housing between 1977 and 1981 indicates that demand for housing was created by the upper-middle and upper income families. The number of one room houses decreased from 2% to 1%, and the number of two room houses decreased from 14% to 9%. Whereas the number of four room houses increased from 30% to 36%, and the number of five room houses increased from 12% to 16%.

10. CALCULATION OF HOUSING WEALTH IN TURKEY

10.1. A THEORETICAL MODEL OF HOUSING WEALTH:

A theoretical model is necessary in order to calculate the housing wealth in Turkey. The only available information is the housing stock or total number of households (which has been published by the SIS every five years since 1960), the CPI index (P), nominal private disposable income (Y), and nominal private investment in the housing sector (I_t).

Let the initial housing stock $ho = \frac{N}{F}$ where

N = Population in the initial year

F = Family size

ho = The initial housing stock, i.e. Total number of households. The resulting series is bound to be crude, but may offer a first approximation.

In 1990 SIS did a survey on ownership of dwellings in Turkey. The results are shown in Table 6.14:

Table 6.14: Number of Households in 1990

Total no of households	Households (hhs) which currently own their present home				Households (hhs) which do not currently own their present home			
	Total	No of hhs which own another home	No of hhs which do not own another home	Unknown	Total	No of hhs which own another home	No of hhs which do not own another home	Unknown
11188636	7864544	1198037	6666348	159	3324092	526091	2797422	579

Source: SIS

The idea is to develop a model that will give a housing stock series (h_t) which is consistent with the published data. The generated series use several identities and a

recursive calculation assuming various ratios for the initial conditions and growth rates. Combinations of these are selected to match the observable time series.

In the calculation of housing wealth ($P_{ht} h_t = H_t$), the key variable is the initial value of the House Price Index P_{h0} ($P_{h0} = \frac{I_0}{i_0}$) which will be determined by the initial real private housing investment (i_0). Therefore, the choice of the correct proportion of the initial housing stock to the initial private housing investment greatly matters. The depreciation rate is the inverse of the average 'life' of a house, and several values were tried, namely $i_0 = \delta * h_0$ yielding 100 years and 30 years for the average life of a house respectively as $\delta = 0.01$ to 0.03 . The real private housing investment series (i_t) is obtained by dividing the nominal private housing investment series (I_t) by the House Price Index (P_{ht}), constructed from

$$\log(P_{ht}) = \log(P_{ht-1}) + \Delta P_{ct} + \alpha$$

where P_{ct} is the Consumer Price Index and $\Delta P_{ct} = \log P_{ct} - \log P_{ct-1}$, see Figures 6.1, 6.2, 6.3 and 6.4.

We assumed 2% and 5% real growth on average for α . So real house prices rise by 2% or 5% *per annum* relative to other prices. How the P_{ht} series is calculated directly affects the real private housing investment ($i_t = \frac{I_t}{P_{ht}}$) and the constructed housing stock series ($h_t = (1 - \delta)h_{t-1} + i_t$), as the latter provides the check (δ is the same as above).

10. 2. EMPIRICAL FINDINGS:

The following set of Tables, 6.15 to 6.17, give a summary of the results. Bold face denotes the best match.

If we take the initial investment to be 0.015 of the initial housing stock for the initial year, and the constant increase in $\log P_{ht}(x)$ to be between 0.03 and 0.04, then the housing wealth to income ratios (H_t/Y_t) between 1962 and 1994 are increasing or almost constant, but the calculated housing stock [h1994(calcul.)] and the official housing stock [h1994(offic.)] series are not close (Table 6.15).

Table 6. 15: The Additive Model I

io=0.015*ho	LnPht=lnPt-1 +inflation+x	h1994(calcul.)	h1994(offic.)	H/Y(1962)	H/Y(1994)
Calculation (1)	x=0.04	10073928.60	13342055	2.19	2.40
Calculation (2)	x=0.0375	10394180.57	13342055	2.19	2.29
Calculation (3)	x=0.035	10735452.99	13342055	2.19	2.18
Calculation (4)	x=0.0325	11099215.88	13342055	2.19	2.08
Calculation (5)	x=0.03	11487045.56	13342055	2.19	1.99

Source: The Author's Own Calculations

Table 6. 16: The Additive Model II

io=0.017*ho	LnPht=lnPt-1 +inflation+x	h1994(calcul.)	h1994(offic.)	H/Y(1962)	H/Y(1994)
Calculation (6)	x=0.04	10835048.34	13342055	1.93	2.28
Calculation (7)	x=0.0375	11198000.57	13342055	1.93	2.18
Calculation (8)	x=0.035	11584775.99	13342055	1.93	2.08
Calculation (9)	x=0.0325	11997040.59	13342055	1.93	1.99
Calculation (10)	x=0.03	12436580.90	13342055	1.93	1.90
Calculation (11)	x=0.0275	12905312.82	13342055	1.93	1.82
Calculation (12)	x=0.025	13405291.21	13342055	1.93	1.75

Source: The Author's Own Calculations

If we increase the percentage of the initial housing stock for the initial investment from 0.015 to 0.017, then we need to decrease the constant term in $\log P_{ht}$ from 0.03 to 0.025 in order to have a housing stock series which is consistent with the published data. However, this time the housing wealth to income ratios (H_t/Y_t) between 1962 and 1994 decrease, as shown in Table 6.16.

The most sensible result is obtained when the proportion of the housing stock for the initial investment is 0.02 and the constant term in $\log P_{ht}$ is 0.0325. Only then does H_t/Y_t increase from 1.64 in 1962 to 1.88 in 1994 (Table 6.17). Calculation (18) is the preferred outcome. Here, housing lasts 50 years on average and the real price increases at 3.25 % *per annum*. As this exceeds the average real interest rate, H_t/Y_t rises slowly. The interpolated data closely match the official measures, see Figure 6.5.¹⁵

Table 6. 17: The Additive Model III

io=0.02*ho	lnPht=lnPt-1 +inflation+x	h1994(calcul.)	h1994(offic.)	H/Y(1962)	H/Y(1994)
Calculation (13)	x=0.02	16297805.58	13342055	1.64	1.54
Calculation (14)	x=0.0225	15628106.65	13342055	1.64	1.60
Calculation (15)	x=0.025	15000543.10	13342055	1.64	1.66
Calculation (16)	x=0.0275	14412333.22	13342055	1.64	1.73
Calculation (17)	x=0.03	13860883.91	13342055	1.64	1.80
Calculation (18)	x=0.0325	13343777.66	13342055	1.64	1.88 **
Calculation (19)	x=0.035	12858760.48	13342055	1.64	1.96
Calculation (20)	x=0.0375	12403730.58	13342055	1.64	2.05
Calculation (21)	x=0.04	11976727.96	13342055	1.64	2.14

Source: The Author's Own Calculations

¹⁵ We also tried entering inflation in a multiplicative form, but this did not give any satisfactory results.

I used data constructed by using values in Calculation 18 (see Figures 6.5 and 6.6) for consumption estimation for the housing wealth data.

11. CONCLUSIONS

Housing is the most important aspect of rapid urbanisation in Turkey. The growth of the urban population creates a rapidly increasing housing demand, especially in the large cities, and makes the solution of the housing problem very difficult. Housing problems encountered by people migrating from villages to cities are of special importance. The fact that the housing demand of migrants and low-income families in cities cannot be met according to supply and demand within the market mechanism results in a housing shortage and the illegal construction of squatter housing. Housing provision is presently directed towards meeting the demand of high-income groups. The situation continues to be serious since financial resources are not being channelled into the construction of utility housing. There is a lack of organisation to divert resources from the construction of squatter houses into utility housing, and establishments that can supply inexpensive houses are non-existent. Construction regulations and their supervision, which play a great role in housing construction, are insufficient for implementation of a successful housing policy.

As it is stated in [Housing' 96], although housing investment has shown strong growth, it has not been enough to meet housing needs (demand). There exist two main factors that affect negatively the supply of housing in Turkey. One is that the increase in input prices of the construction sector is greater than that of the general price index, and the other is the lack of land for housing, especially in the urban areas.

In this chapter, we constructed a housing price index and a nominal housing wealth data series for Turkey from the available statistics, such as the housing stock or total number of households, nominal private disposable income and nominal private investment in the housing sector. The generated series suggests that house price inflation exceeds consumer price inflation, and indicates the importance of housing wealth for private sector saving decisions in Turkey.



Figure 4.1. The Housing Price Index (1980=100)



Figure 4.2. The Changes in Log of the Three Price Indexes

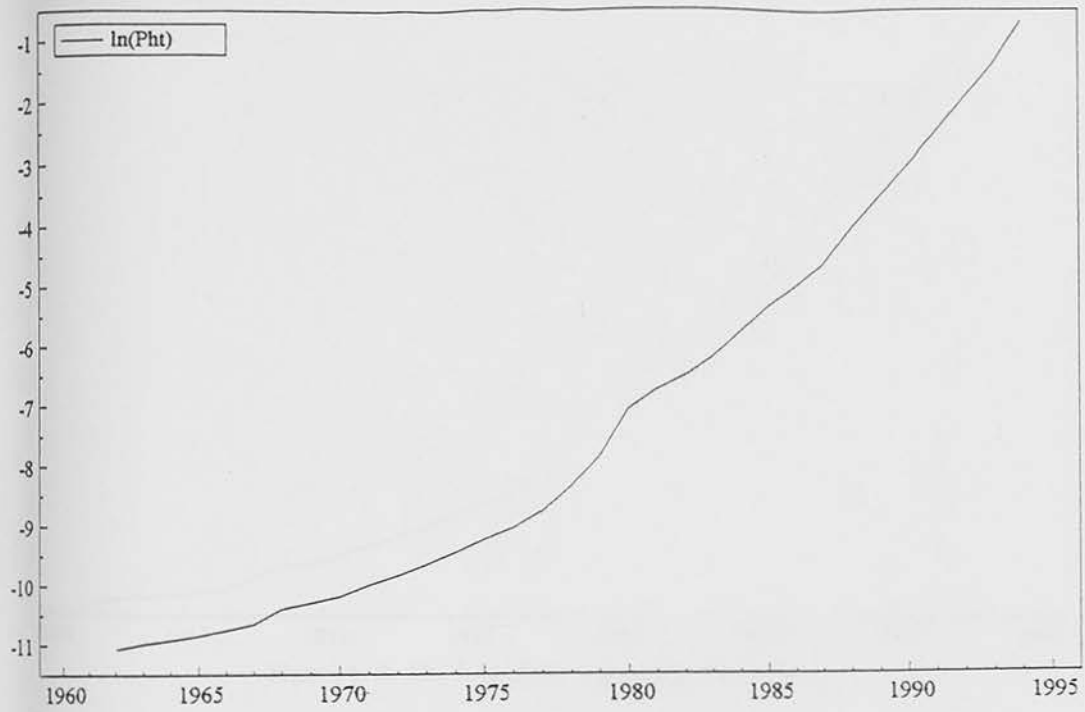


Figure 6. 1: The Log of the House Price Index

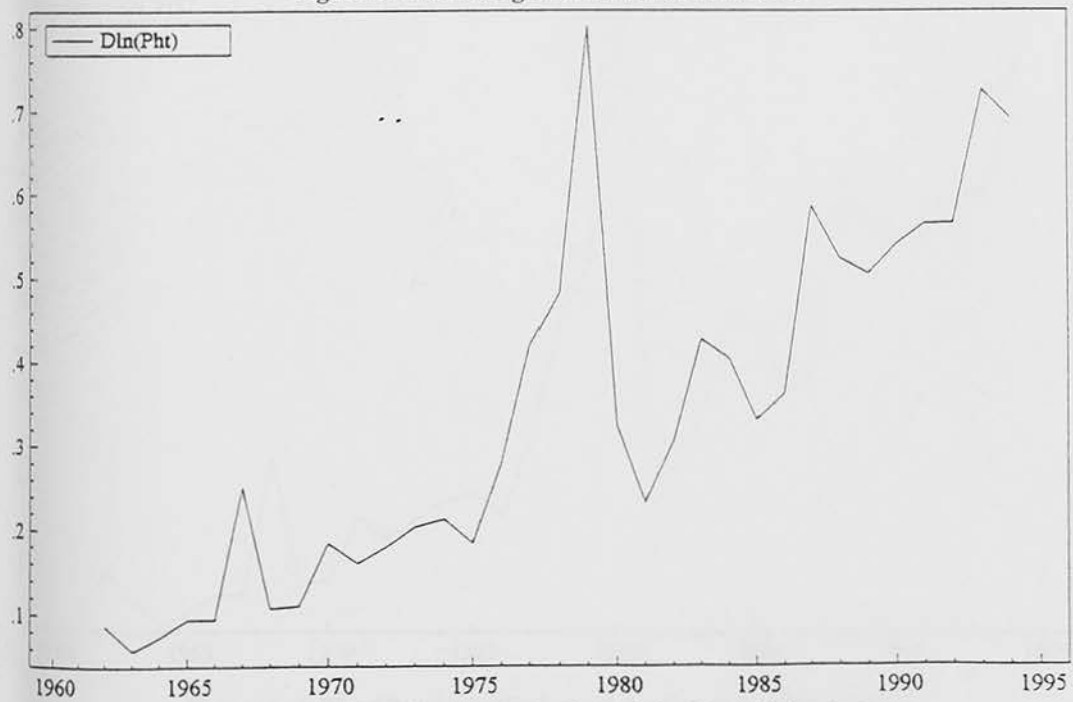


Figure 6. 2: The Change in the Log of the House Price Index

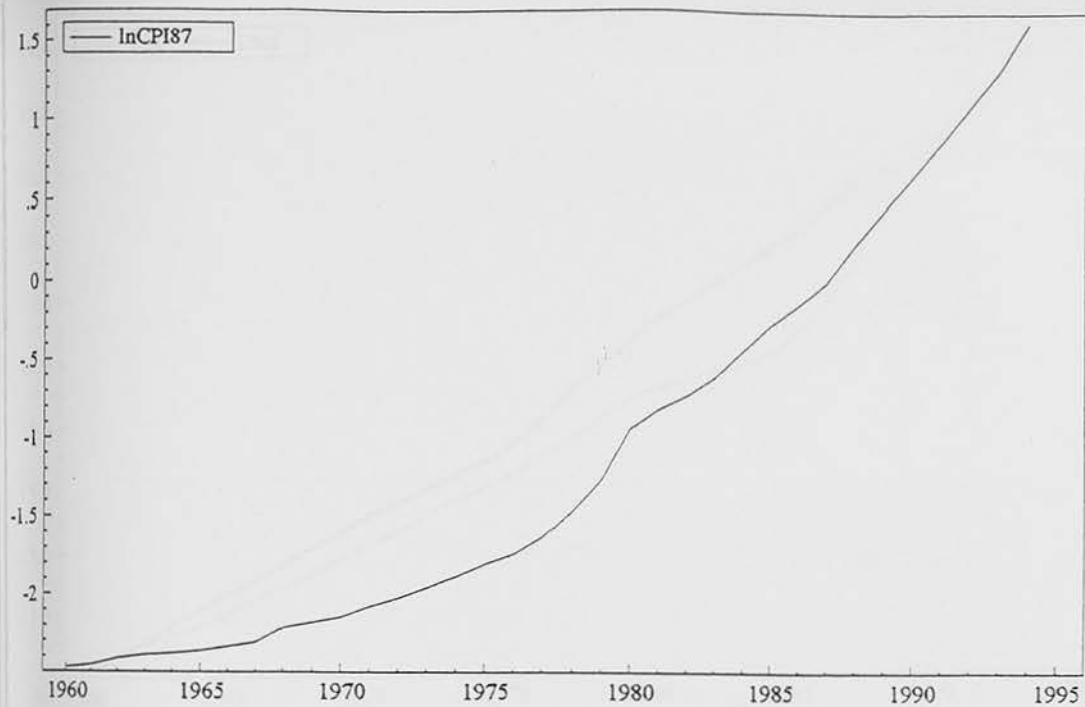


Figure 6. 3: The Log of the Consumer Price Index

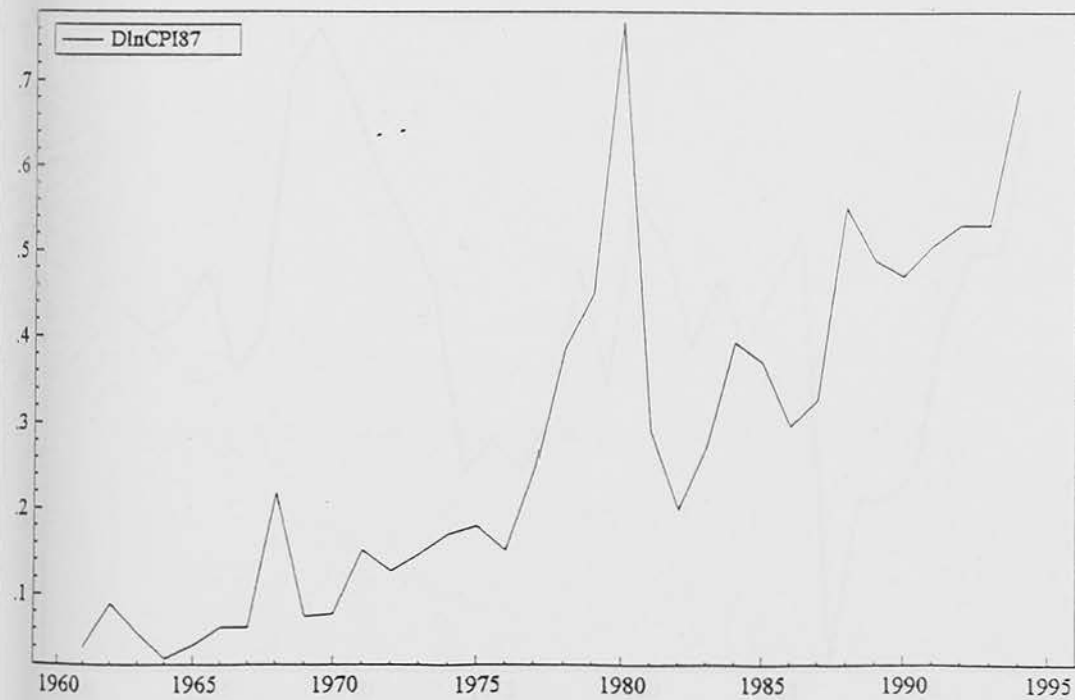


Figure 6. 4: The Change in the Log of the Consumer Price Index

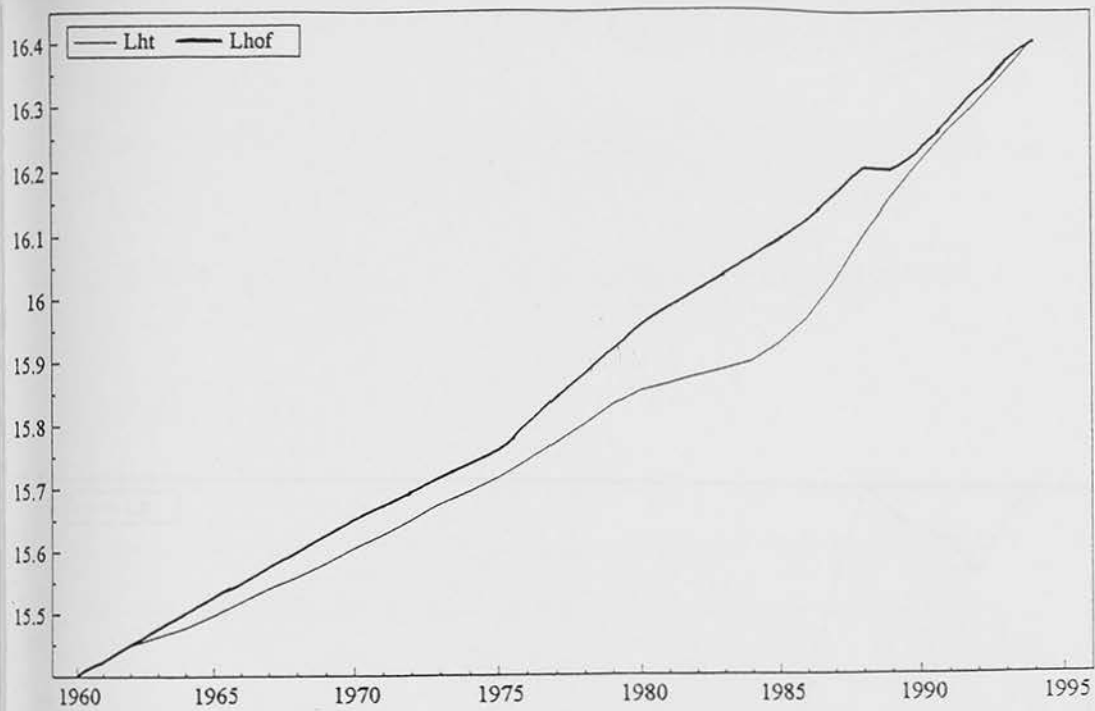


Figure 6. 5: The Log of the Calculated Housing Stock Series (Lht) and the

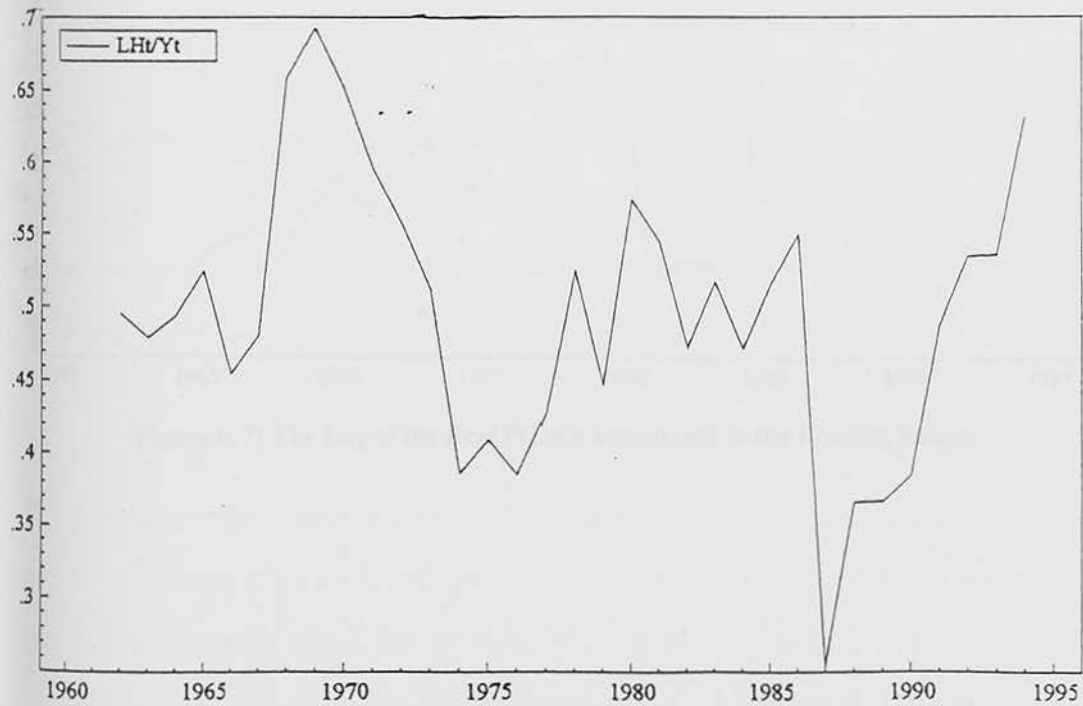


Figure 6. 6: The Log of the Housing Wealth to Income Ratio

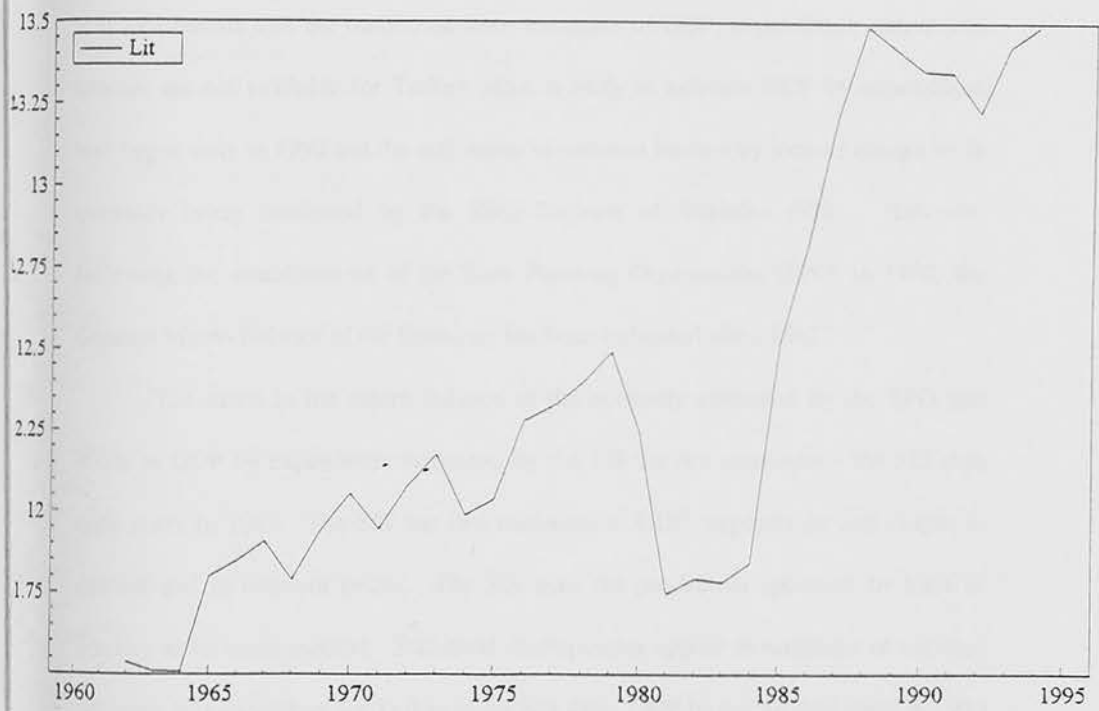


Figure 6. 7: The Log of the Real Private Investment in the Housing Sector

Chapter 7:

TURKISH NATIONAL ACCOUNTS: THEORY AND PRACTICE

1. INTRODUCTION

It is unfortunate that the traditional three measures of GDP, expenditure, output and income are not available for Turkey, since a study to estimate GDP by expenditure was begun only in 1990 and the estimation of national income by income categories is currently being continued by the State Institute of Statistics (SIS). However, following the establishment of the State Planning Organisation (SPO) in 1960, the General Macro Balance of the Economy has been estimated since 1962.

The items in the macro balance of the economy estimated by the SPO and items in GDP by expenditure estimated by the SIS are not consistent - the SIS data only starts in 1987. The SIS has two measures of GDP: expenditure and output in current and in constant prices. The SIS uses the production approach by kind of activity as its main method. Statistical discrepancies appear in estimates of national accounts by expenditure for Turkey in the SIS data. GDP by output data starts in 1923 in current and constant purchasers' prices (GNP also starts in 1923 in current and constant producers' prices) whereas GDP by expenditure starts in 1987 in the SIS data. However, it is possible calculate GDP by expenditure from 1962 by using the SPO Macro Balance of the Economy and the Balance of Payments tables. I calculated GDP by expenditure for the period 1962-1990 with an old data set in current and 1988 prices; constant price data is obtained by deflating the components of GDP with their

implicit deflator by using Wijnbergen *et. al.* (1992), Uygur (1987, 1991), the SIS and SPO data sets.

Section 2 provides a History of Turkish National Income Accounts. Section 3 discusses the main measurement error problems and econometric solutions. Section 4 explains the basic logic behind the reconciliation of national accounts based on the work of Sefton and Weale (1995). Section 5 estimates the allocation of the residuals with the OLS approach. Section 6 concludes.

2. THE HISTORY OF TURKISH NATIONAL INCOME ACCOUNTS

The first attempts to estimate national income in Turkey began in 1928. In 1929, Camille Jacquart was put in charge of the preparation of national income estimates. Due to the difficulties of compiling data, however, the work in this direction did not yield satisfactory results. In 1935, the task was made the joint responsibility of German statistician, Dr. Franz Eppeinstein, and the Ministry of Economy. As a result of their studies, national income estimates for 1927, 1933 and 1934, and later for 1935 and 1936, were prepared and published. In 1947, the General Directorate of Statistics prepared and published a national income series for 1942, 1943 and 1944. A number of individual studies followed these attempts. These were the estimates prepared by Sefik Bilkur for 1943, by Sefik Inan for 1949 and Vedat Eldem for 1929 and 1945.

National accounts studies were not carried out regularly up to 1950 due to the absence of a special unit responsible for the task. In 1950, the National Income Study Group was formed within the General Directorate of Statistics and this unit began its studies in 1951. The national income estimates for 1938 and 1948-51 were produced

by the Group. These estimates were revised later in accordance with the recommendations of Milton Gilbert. Estimates for 1952-1953 were obtained in the same manner.

In the ensuing years, these studies continued and the estimation of national income accounts gained greater importance especially with the start of five-year plans. In 1960, the SPO was formed and between 1961 to 1971 produced separate national income series. In the second half of 1971, experts from the SIS and the SPO formed a study group in order to eliminate the differences and make use of newly improved methodologies and recommendations of the 1968 Standardised System of National Accounts (SNA). The study group reorganised national income accounts methodology at current and constant prices and prepared a new national income series for 1962-1971. The studies and calculations made by this group were discussed in detail in the National Income Colloquium organised by the SIS in January and June of 1972. As a result of this co-operation, a single set of national income series for the period 1948-1972 were produced and published.

Starting in 1980, GNP was estimated four times a year to reflect annual growth on the basis of up-to-date data. However, due to difficulties in the computations at 1968 constant prices and current producers prices, the number of estimates was reduced to three times a year in 1985. The first estimate of GNP was based on the data available for the first six months, the second one for nine months and the third one for twelve months.

The SIS again started to produce quarterly GNP estimates in 1990 in order to follow changes in the economy at shorter intervals. In addition, the base year was shifted from 1968 to 1987 in order to base the accounts on wholesale price indices which was also set at 1987. The coverage of the quarterly GNP accounts was

extended and some items and economic sub-sectors that could not be included in the previous GNP accounts were incorporated into the system.

In the same year the SIS started a study to estimate GDP by expenditure. The earlier estimates calculated private consumption expenditures as a residual. In the more recent study, this item has been calculated on the basis of the commodity flow method. The results of this study were made available in 1993. The quarterly expenditure series go back to 1987. Recently, national income is estimated by income categories.

In Chapter 8 for the estimation of Turkish Consumption function, we use the SPO data from the Macro Balance of Economy tables. However, the National Accounts were revised by 30% in 1987 and a 30% shift occurs on the consumption and income data in 1987. Although the new data has been available since 1987, the old data set goes up to 1990. When we look at the common data set between the old and the new data sets, we see that there is not much difference in C/Y (the consumption to income ratio).

Private Saving Ratio	1987	1988	1989	1990
Old Data	18.9	21.2	20.7	23
New Data	20	23.6	20.1	21.5

Since we are interested in the long-run properties of the data, the ability to carry out the research by taking into account this shift and not being affected by this shift in modelling is important. Therefore, we constructed a new data set after 1987 by taking into account this shift. The adjusted data is obtained by multiplying the new data set by the ratio of the mean of the old series to the mean of the new series for the common

period ($\frac{\bar{D}_{old}}{\bar{D}_{new}} \times D_{ni}$). This leaves C/Y unaltered.

3. MEASUREMENT ERRORS

Measurement errors occur when variables are measured with errors [see Morgan (1989) and Koopmans (1937)]. The errors-in-variables include all deviations between latent variables and observables. However, more research has been done on the errors in equations. Frisch (1934) studied systems of economic relationships subject to errors of measurement with the method of Confluence Analysis. The difficulty of applying Frisch Confluence Analysis or the errors-in-variables model (EVM) may have resulted in ignoring measurement errors. However, Hendry and Morgan (1989) argue that it is inappropriate to ignore measurement errors merely because they are too awkward to handle.

Hendry (1995) considers four econometric measurement errors:

1) Errors-in-variables Model:

In the errors-in-variables model, the observed process $\omega_t = (y_t : z_t' : s_t')'$ differs from ϖ_t by a vector of measurement errors u_t . ϖ_t is assumed to be an m -dimensional stationary stochastic process with joint sequential density $D_\varpi(\varpi_t | \Omega_{t-1}, \rho)$ for $\rho_p \in \mathfrak{R}'$ given by :

$$\varpi_t | \Omega_{t-1} \sim N_m[r\varpi_{t-1}, \Phi] \quad (7.1)$$

and $\Omega_{t-1} = (\varpi_1, \dots, \varpi_{t-1})$ all the latent roots of r are inside the unit circle.

$$\omega_t = \varpi_t + u_t \text{ where } u_t \sim IN_m(0, \Gamma) \quad (7.2)$$

$$\varpi_t = r\varpi_{t-1} + \zeta_t \text{ where } \zeta_t \sim IN_m(0, \Phi) \quad (7.3)$$

$$E[\varpi_t | \Omega_{t-1}] = r\varpi_{t-1} \text{ and } E[\varpi_{t-1}\zeta_t'] = 0 \quad (7.3a)$$

$$E[\varpi_t u_t'] = 0 \quad \forall t \quad (7.4)$$

$$E[\zeta_t u_t'] = 0 \quad (7.5)$$

If $\omega_t' = (\eta_t : \delta_t' : \zeta_t')$, the dimensions of the sub-vectors δ_t and ζ_t are $n \times 1$ and $k \times 1$, so that $m = l + n + k$.

Factorize $D_\omega(\omega_t | \Omega_{t-1}, \rho)$ as:

$$D_{\eta|\delta,\zeta}(\eta_t | \delta_t, \zeta_t, \Omega_{t-1}, \mu_1) \cdot D_{\delta|\zeta}(\delta_t | \zeta_t, \Omega_{t-1}, \mu_2) \cdot D_\zeta(\zeta_t | \Omega_{t-1}, \mu_3) \quad (7.6)$$

$$\text{where } \mu = f(\rho) \text{ and } (\mu_1 : \mu_2 : \mu_3) \in M_1 \times M_2 \times M_3 \subseteq \mathfrak{R}^l \quad (7.7)$$

The linear model between η_t and δ_t is given by:

$$\eta_t = \beta' \delta_t + v_t \text{ with } v_t | \Omega_{t-1} \sim N[0, \sigma_v^2] \quad (7.8)$$

where δ_t is weakly exogenous for the parameter of interest β and $E[\delta_t v_t'] = 0$. If

$$\gamma' = (1 : -\beta' : 0')$$

$$\gamma' \omega_t = \eta_t - \beta' \delta_t = v_t \quad (7.9)$$

from (7.3) we have

$$\gamma' \omega_t = \gamma' r \omega_{t-1} + \gamma' \zeta_t = v_t \quad (7.10)$$

Since v_t is an innovation relative to Ω_{t-1} , $\gamma' r = 0'$, so $\gamma' \zeta_t = v_t$ and $\sigma_v^2 = \gamma' \Phi \gamma$.

Then equation (7.6) in terms of $D_\omega(\omega_t | \Omega_{t-1}, \rho)$ becomes:

$$D_{\eta|\delta}(\eta_t | \delta_t, \mu_1) D_{\delta|\zeta}(\delta_t | \zeta_t, \Omega_{t-1}, \mu_2) D_\zeta(\zeta_t | \Omega_{t-1}, \mu_3) \quad (7.11)$$

where $E(\eta_t | \delta_t) = \beta' \delta_t$ and $(\delta_t : \zeta_t)$ are weakly exogenous for β .

If any ω_t were measured without error, the corresponding row and column of Γ would be zero. From (7.2) and (7.3):

$$\omega_t = r \omega_{t-1} + \zeta_t + u_t - r u_{t-1} \quad (7.12)$$

which is a vector auto-regressive-moving average process for the observed data. If serial independence is assumed, the equations (7.4) and (7.5) still hold.

It will not be easy to calculate $E[y_t|z_t, s_t, W_{t-1}]$ and while δ_t is weakly exogenous for β , z_t in general will not be. The OLS estimator of β from regressing y_t on z_t is inconsistent. β cannot be obtained from only analysing the conditional model of y_t given z_t .

Errors-in-variables models decompose the observed data covariance matrix M_{obs} into two component covariance matrices; one is the systematic matrix (corresponding to Σ) and another is the error variance (corresponding to Λ). Then, γ and hence its component of β will be obtained by solving:

$$(M_{\text{obs}} - \Lambda)\gamma = \Sigma\gamma = 0 \quad (7.13)$$

The difference between the method of obtaining Σ via $\hat{\Sigma} = \hat{M}_{\text{obs}} - \hat{\Lambda}$ (7.14) from information $\hat{\Lambda}$ about Λ or from direct estimates $\hat{\Sigma}$ of Σ lies in the fact that while Σ must be singular because $\Sigma\gamma = 0$, $\hat{\Sigma}$ does not need to be singular. Thus the EVM estimator solves the following equation:

$$(\hat{M}_{\text{obs}} - \hat{\alpha}\hat{\Lambda})\hat{\gamma} = 0 \quad (7.15)$$

where $\hat{\alpha}$ is the smallest eigenvalue of $|\hat{M}_{\text{obs}} - \alpha\hat{\Lambda}| = 0$ subject to the normalisation $\hat{\gamma}'_1 = 1$. From (7.14) and (7.15) we have

$$(\hat{\Sigma} - (1 - \hat{\alpha})\hat{\Lambda})\hat{\gamma} = 0 \quad (7.16)$$

where the correction of $(1 - \hat{\alpha})\hat{\Lambda}$ to $\hat{\Sigma}$ ensures that the resulting $\hat{\gamma}$ minimises the variance ratio:

$$\hat{\alpha} = \frac{\hat{\gamma}' M_{\text{obs}} \hat{\gamma}}{\hat{\gamma}' \hat{\Lambda} \hat{\gamma}} \geq 1 \quad (7.17)$$

$\hat{\gamma}$ is the eigenvector corresponding to the smallest eigenvalue of $\hat{M}_{\omega\omega}$ in the metric of $\hat{\Lambda}$. When Λ is diagonal, the method of estimating γ by solving (7.15) is called Weighted Least Squares (WLS).

However, $\hat{\gamma}$ is generally consistent for γ if only if $\hat{\Lambda}$ is consistent for Λ . But the complete variance-covariance matrix Λ is rarely either known or consistently estimable, so it will prove difficult to consistently estimate γ by solving the EVM estimator generating equation. In this situation, instrumental variables approach is an alternative for tackling errors in variables in econometric model.

Instrumental Variables: This approach is based on using a set of additional variables as 'instruments' by which to obtain a solution to the EVM estimating equation. Since the simultaneous equations problem and error-in-variables problem both induce $E(z_t e_t) \neq 0$ in linear equations, then they both will have instrumental-variables solutions.

The two essential requirements of an instrument are that it should be a determinant of δ_t (and hence of z_t) but be independent of e_t (i.e. of $\gamma'\zeta_t$ and u_t). The key difference from EVM is not the presence of s_t , but the fact that the systematic variance (corresponding to Σ) is being modelled, not the error variance (corresponding to Λ). The difference between the implications of assumptions about Σ and Λ , is that knowledge of ϖ_t depends on k observables s_t such that $E(s_t e_t) = 0$ is sufficient for estimating β consistently, even when s_t is an incomplete subset of the determinants of ϖ_t . Furthermore, information about only a few determinants of Σ is enough for estimation with the IV.

2) Dynamic Latent-Variables Models:

DLV models include unobservable variables such as expectations, confidence, consumption and permanent income. Although the likelihood functions associated with DLV models may be intractable, the models themselves are often amenable to joint simulation of the latent and observable processes. Hence the Method of Simulated Moments (MSM) is applicable to DLV models, and Monte Carlo Methods can be used for estimation.

3) Revisions to I(1) Data:

When data are revised, one of either the initial or the final observation must be incorrect. Hopefully, the revised value will be closer to the desired latent variable, but if revisions alter the concept being measured, later measures may be worse. Nominal magnitudes get revised when new information appears, and price deflators also alter from changing the baseline basket of goods and services. If the original series are I(1), the revisions may be I(1) as well, which can pose serious problems for modelling cointegrated series. Altering the base year with a fixed reference point will produce changes in the price index which are due to changes in the relative weights, or the shares in total expenditure of the commodities in the basket, scaled by the price relative corresponding to that weight.

Hendry (1995) shows that when individual prices are random walks, and revisions to the weights are uncorrelated with the 'inherent inflation rates' of the individual price series, the revisions induce heteroscedastic white-noise errors in the difference between the measured growth rates of the price indices. He also found that the revisions to the US price levels are indeed a random walk so the two price-index

measures are not cointegrated with each other. Similarly, the data revisions to consumers' expenditure added a white-noise perturbation to the first differences of the annual changes in the original UK series. The unexplained standard error was 0.43% and residuals were nearly white noise so neither the two levels nor the two annual change measures were cointegrated each other. Applying the seasonality encompassing test in Ericsson, Hendry and Tran (1994), to the old and new data vintage in Hendry (1994) produced an inconclusive outcome.

4) The Impact of Measurement Errors on Equilibrium-Correction-Models

If z_t^0 is the observed value of a strongly exogenous variable z_t when y_t is generated by a homogenous AD(1,1) where the long-run parameter is $K_1 = 1$, and

$$z_t^0 = z_t + v_t \quad (7.18)$$

when the model has the correct form, but measured incorrectly:

$$\Delta y_t = \beta_1 \Delta z_t^0 + (\beta_2 - 1)(y - z^0)_{t-1} + e_t \quad (7.19)$$

then, the error term in (7.19) will have the following form:

$$e_t = \varepsilon_t - \beta_1 \Delta v_t - (1 - \beta_2)v_{t-1}. \quad (7.20)$$

Under strong exogeneity and assuming all errors are IID and mutually uncorrelated:

$$E(z_t^0 e_t) = -\beta_1 E(z_t^0 v_t) - (1 - \beta_1 - \beta_2) E(z_t^0 v_{t-1}) < 0 \quad (7.21)$$

in general and:

$$E(e_t e_{t-1}) = -\beta_1 (1 - \beta_1 - \beta_2) \sigma_v^2 \neq 0$$

so (7.19) is mis-specified both by (negative) residual auto-correlation and by correlations between the regressors and the error when formulated to have the parameters $(\beta_1; [\beta_2 - 1])$.

4. RECONCILIATION OF NATIONAL ACCOUNTS

Prior to adopting econometric solutions to measurements, much can be done to help improve data accuracy. However, a considerable amount of work needs to be done on the reconciliation of Turkish national income accounts so as to remove discrepancies and residuals.¹ The determination of the extent of the measurement errors seems to be difficult, but we often have an idea about the range or variance of such errors, as well as information about the extent of revisions or cross-comparisons. The method of least-squares was first suggested by Stone, Champernowne and Meade (1942) and then the maximum likelihood approach applied by Weale (1985; 1992) for the reconciliation of national income accounts. The main difference between the two processes is that the Stone, Champernowne and Meade estimator can be calculated in the case where reliabilities are known, whereas Weale (1992) represents an estimator for use with a sequence of observations when the data variances are not known.

If three measures of GDP - expenditure, output and income - are calculated independently, they do not have the same results due to the errors which creep in at the various stages of the calculations. However in practice, measures are reduced to two for each of constant and current prices. Factor incomes are not measured independently of the industries in which those incomes are earned. In constant prices, output and expenditure are measured separately, but the income measure is calculated by applying the expenditure deflator to current price income, and it does not offer a third independent measure of output. Thus, there are discrepancies between income

¹ We need stock levels in order to rebalance national income accounts (see Sefton and Weale (1995)), although changes in stocks data is available from the SPO and the SIS, the *initial* stock levels are not available, which makes re-balancing using the matrix approach impossible for Turkey.

and expenditure measured at current prices, and output and expenditure measured at constant prices.

The problem of data inconsistency can be solved using the arithmetic average, if income and expenditure data were of equal reliability. However, as Sefton, Solomou and Weale (1994) claimed, the concept of reliability can be applied to the income/expenditure components and used to allocate the corrections across the series which make up the national accounts. This then would lead to a fully-consistent set of income/expenditure data. They also argue that the reliability with which changes in data are measured is closely related to that with which levels are measured. The link between the two depends on the degree of serial correlation in the measurement error. They suggest that if there are large measurement errors in the output index, but they are strongly serially correlated, then it makes sense to put more weight on the output index in the short run than in the long run.

The most usual way of adjusting data with reference to reliability is to minimise the sums of the squared changes of the data: this gives balanced data which are a linear combination of the initial data. Thus, if the variance of expenditure were half that of income, $2/3$ of the adjustment would be borne by income and $1/3$ by expenditure. Therefore, the relative not the absolute variances of the data determine the allocation of the adjustments. If the original measurement errors are normally distributed, they are also maximum-likelihood estimators which is a general property of least-squares estimators.

4.1. Least Squares Estimation

The method of least-squares² can be applied as follows:

If there is a data set (vector) w which should satisfy certain linear restrictions (the accounting constraints) $Aw = s$, because of measurement error, these restrictions are not met $Aw = r$, where r is the accounting residuals. It is assumed that the observed data are distributed without bias around the true data ω with known variance matrix Γ , so that

$$w = \omega + u \quad \text{where } E(u) = 0 \text{ and } E(uu') = \Gamma \quad (7.22)$$

The least-squares problem is then one of finding a vector ω^* which satisfies the accounting constraints, $A\omega^* = s$ and is as close as possible to the observed data w . Thus, the sum of the squared deviation of each element of ω^* from w is weighted by the data reliability matrix, Γ .

Proposition 1: *The least-squares estimator, ω^* of the w which satisfy the accounting constraints $A\omega^* = s$ is*

$$\omega^* = (I - \Gamma A' [A \Gamma A']^{-1} A) w + \Gamma A' (A \Gamma A')^{-1} s \quad (7.23)$$

This estimator is unaffected by pre-multiplication of the variance matrix Γ by any scalar constant. This implies that the balancing process depends on relative, but not absolute, data reliability. Equation (7.23) indicates that this estimator is unbiased, since $E(w) = \omega$ and $A\omega = s$ and

$$E(\omega^*) = [I - \Gamma A' (A \Gamma A')^{-1} \Gamma] E(w) + \Gamma A' (A \Gamma A')^{-1} s = \omega \quad (7.24)$$

² See Stone, Champenowne and Meade (1942), Bryon (1978), Solomou and Weale (1992), Sefton, Solomou and Weale (1994), Sefton and Weale (1995) for more detailed analysis of the method of Least Squares estimation.

Proposition 2: *Balancing the data also leads to a reduction in the data variance.*

This can be demonstrated by evaluating the variance matrix of the balanced data.

The variance of ω^ , Γ^* is*

$$\Gamma^* = \Gamma - \Gamma A'(A\Gamma A')^{-1} A\Gamma \quad (7.25)$$

Since $\Gamma A'(A\Gamma A')^{-1} A\Gamma$ is a positive semi-definite matrix, it follows that the process of least squares balancing has the effect of not making the data less accurate and balancing will result in a gain in reliability. It is a property of estimators calculated by minimising the sum of squares that they are the linear estimators with the lowest variance (BLUE). This conclusion is dependent on starting with the correct data variances. If incorrect data variances are supplied it is no longer possible to be sure that the reliability of data is enhanced.

4.2. The Maximum-Likelihood Solution

The Maximum-likelihood³ estimator calculated on the assumption that the error vector u , is normally distributed, is the same as the least-squares estimator. For, with this assumption, the likelihood function of the estimate is given as

$$L = 1/(2\pi)^{\frac{T}{2}} |\Gamma| e^{-\frac{1}{2}(w-\omega)'\Gamma^{-1}(w-\omega)} \quad (7.26)$$

If we choose an estimator, ω^* of the ω which maximises the likelihood, and therefore the log-likelihood, subject to the constraint that $A\omega^* = s$, then, with Γ known, the problem is simply

$$\text{Min } -(w-\omega)'\Gamma^{-1}(w-\omega) \quad (7.27)$$

³ See, Weale (1985, 1992) for the detailed analysis of the Maximum Likelihood Method.

given $A\omega^* = s$, and this is exactly the same as the problem to be solved in calculating the least squares solution. The two estimators are identical.

4.3. Unknown variance and a data estimator

When the data variances are not known, Satchell, Smith and Weale (1992) and Weale (1992) calculate the estimator from the time-series variances and covariances of the inconsistent observations. The estimator converges in probability to the Stone, Champernowne and Meade (1942) estimator which can be calculated in the case where reliabilities are known. He uses the time-series variance since the accounting constraint is used to purge the genuine volatility, leaving only the noise.

We first make an assumption about the nature of the measurement error in order to consider possible data estimators.

Assumption 1: *If, in a sequence of T observations, ω_t is the true value taken by a vector of data and w_t is its measured value, then the standard assumption is $w_t = \omega_t + u_t$ and u_t are vectors of dimension p ,*

$$w_t = \omega_t + u_t \quad (7.28)$$

and

$$E(\omega_t u_t') = 0 \quad (7.29)$$

The random component of the data, u_t , is orthogonal to the true data, ω_t .

As data errors are likely to be larger (absolutely) the bigger the data, Assumption 1 suggests using logs, although this is difficult with linear identities.

In order to find an asymptotic maximum-likelihood estimator of data, it is necessary to make further assumptions about the structure of the errors:

Assumption 2: Γ is a matrix of dimension $p \times p$. u_t is independently identically normally distributed with 0 mean and variance Γ .

$$u_t \sim N(0, \Gamma) \quad (7.30)$$

The assumption of normality is common to almost all derivations of maximum-likelihood estimators. Serial independence is assumed in the derivation of the estimator, although the estimator is also valid when all components of the error term, u_t , have the same pattern of serial correlation.

The nature of the linear restrictions can be specified as follow:

Assumption 3: A is a $k \times p$ matrix. The true data ω_t satisfy the k accounting constraints, $A\omega_t = 0$.

Any estimator should also satisfy these constraints. As it was established before, with the log-likelihood function

$$C - T \log |\Gamma| - \frac{1}{2} \sum_{t=1}^T (w_t - \omega_t)' \Gamma^{-1} (w_t - \omega_t) \quad (7.31)$$

minimisation subject to the constraint $A\omega_t = 0$ will yield an estimate of ω_t ,

$$\omega_t^* = (I - \Gamma A' [A \Gamma A']^{-1} A) w_t \quad (7.32)$$

Here the problem is to find an estimator of ω_t^* in the case where Γ is unknown.

The basic result is that the data-covariance matrix, Ψ is used in place of Γ to give an estimator of $\Psi A'$ which converges to asymptotically to $\Gamma A'$.

Proposition 4: If Ψ is the maximum-likelihood estimate of the covariance matrix of

the data $\Psi = \sum_{t=1}^T (w_t - \bar{w})(w_t - \bar{w})' / T$ and $\bar{w} = \sum_{t=1}^T w_t / T$ then it follows that :

$$\text{plim} \Psi A (A \Psi A')^{-1} = \Gamma A (A \Gamma A')^{-1} \quad (7.33)$$

Furthermore, the variance of Ψ is of order $1/T$ and taking the limit in probability, it therefore follows that:

$$\text{plim}\Psi A' = \Gamma A' \quad (7.34)$$

The covariance matrix of the residuals allows us to derive an estimator of $\Psi A'$, which converges in probability to $\Gamma A'$. This implies that the covariance matrix of data Ψ , may be used in place of Γ for the calculation of asymptotic maximum-likelihood estimates of the true data, ω_t , because the data variance reflects both the true data and the measurement error. However, the true data satisfy the accounting constraint and are filtered out on post-multiplying by A' . Only the noise remains and so the above result is found. This result leads to the following conclusion:

$$\omega_t^* = \text{plim}[I - \Psi A'(A\Psi A')^{-1}A]w_t \quad (7.35)$$

This converges asymptotically to the estimator calculated with known error variance, but it can be calculated without knowledge of the variance of the measurement error.

By applying the method to the US national accounts, Weale (1992) shows that 64% of the discrepancy between expenditure and income/output estimates of GNP is deducted from the expenditure account, with the remaining 36% added to the estimate derived from the income/output side. Thus, the income/output estimate of constant price GNP is considerably more reliable than the expenditure estimate.

5. BALANCING THE TURKISH NATIONAL ACCOUNTS

The failure of the accounting identities to be satisfied means that there are a number of residuals typically observed in the accounts. In the Turkish national accounts these residuals are visible as the error between expenditure and output measures of GDP. More careful measurement is necessary to improve the reliability of the statistics and so to reduce the discrepancies. The statistical techniques mentioned above have the

effect of allocating the residual errors, and in doing so, enhance the accuracy of the data.

5.1. Linear Regression Approach With PcGive

Linear Regression Approach will be applied to Turkish data for the period 1962-1989 in constant price old data and for the period 1987-1994 in constant price new data (see, Appendix 7 for the data set). As explained in Section 4, in practice three measures of GDP - expenditure, output and income - are reduced to two for each of constant and current prices. Factor incomes are not measured independently of the industries in which those incomes are earned. In constant prices, output and expenditure are measured separately, but the income measure is calculated by applying the expenditure deflator to current price income, and it does not offer a third dependent measure of output. Thus, there are discrepancies between income and expenditure measured at current prices, and output and expenditure measured at constant prices. However, the Turkish data differs from UK data because Turkey does not produce an income measure of GDP. In order to avoid the problem of heteroscedasticity and nonstationarity we will work in terms of logarithmic first differences and use ordinary least squares regression to estimate the allocation of the residual errors (see Equations 5.1.a, b, and c.).

5. 1. a. *The Allocation of Turkish Accounting Residuals, (1962-1989)-Old*

Data Set (SPO) in constant prices:

If we define *DRES88* as

$$DRES88 = \Delta \ln OUT88 - \Delta \ln EXP88$$

where $\Delta \ln OUT88$ is the change of the log of the output measure of GDP in 1988 prices and $\Delta \ln EXP88$ is the change of the log of the expenditure measure of GDP in 1988 prices for the old data set.

Equation 5.1.a. $\Delta \ln OUT88 = 0.052 + 0.18434 DRES88$
 se: (0.00596)(0.263)
 t-ratio : (8.724) (0.703)

$R^2 = 0.019$ $F(1, 25) = 0.493$ (0.489) $\sigma = 0.031$ $DW=1.33$
 Passes all the diagnostic tests.

The results of the regression (5.1.a.) indicate that the balanced growth in *GDP* in constant prices should be estimated by

$$\Delta \ln GDP88 = \Delta \ln OUT88 - 0.18434 DRES88$$

where $\Delta \ln GDP88$ is the annual growth in the constant latent *GDP* variable, which yields

$$\Delta \ln GDP88 = 0.81566 \Delta \ln OUT88 + 0.18434 \Delta \ln EXP88 \quad (7.36)$$

indicating that the bulk of weight should be placed on the output estimate.

Table 5. 1. Summary Statistics for Estimates of GDP Growth [SPO Old Data-(1962-1989)] in Constant Prices

Means				
	OUTPUT	EXPENDITURE	AVERAGE	BALANCED
	0.051626	0.053489	0.052558	0.051970
Standard Deviations				
	OUTPUT	EXPENDITURE	AVERAGE	BALANCED
	0.030547	0.035620	0.031114	0.030250
Correlation matrix				
	OUTPUT	EXPENDITURE	AVERAGE	BALANCED
OUTPUT	1.0000			
EXPENDITURE	0.76750	1.0000		
AVERAGE	0.93024	0.94919	1.0000	
BALANCED	0.99027	0.84924	0.97225	1.0000

The above analysis again yields four possible estimates of annual growth in *GDP* in constant prices; the two original measures (*Output and Expenditure*), the average of these (*Average*) and the current information (*Balanced*) estimates. Table 1 displays the sample means and standard deviations of all four estimates together with their

sample contemporaneous correlation matrix. However, although the results of Equation (5.1.a.) indicate that the output measure is more reliable than the expenditure measure, the expenditure measure has the largest mean growth rate. In addition, its standard deviation is also the largest indicating relative information in the data. Thus, since the income and expenditure measures are believed to provide better indicators of long-run trends, this result is not surprising. Furthermore, given the very small residuals between output and expenditure measures and the strong correlation between the average and balanced estimates (see Figures 7.1), the quality of the expenditure measure of *GDP* should be treated cautiously. This result is also consistent with our findings in Chapter 8 that consumption (an expenditure component of *GDP* and income (an output component of *GDP*)⁴ data are corrected by the SPO in a related way to avoid divergence, which suggests an I(0) measurement errors for the ratio of them.

5. 1. b. The Allocation of Turkish Accounting Residuals, (1987-1994)-New

Data Set (SPO) in constant prices:

If we define *DRES87* as

$$DRES87 = \Delta \ln OUT87 - \Delta \ln EXP87$$

where $\Delta \ln OUT87$ is the change of the log of the output measure of GDP in 1987 prices and $\Delta \ln EXP87$ is the change of the log of the expenditure measure of GDP in 1987 prices for the new (SPO) data set.

Equation 5.1.b. $\Delta \ln OUT87 = 0.027815 + 0.31059 DRES87$
 se: (0.01953) (0.72384)
 t-ratio : (1.424) (0.429)

$R^2 = 0.032$ $F(1,5)=0.1644$ (0.7019) $\sigma = 0.0043$ $DW=2.45$

⁴ Private Sector Disposable Income is provided as a residual from GNP and Public Disposable Sector Income, since the income measure of GDP has been available only since 1987. In the income measure of GDP, Operating Surplus is calculated as a residual from the output measure of GDP and Income from Employment.

Passes all the diagnostic tests.

The results of the regression (5.1.b.) indicate that the balanced growth in *GDP* in constant prices should be estimated by

$$\Delta \ln GDP87 = \Delta \ln OUT87 - 0.31059 DRES87$$

where $\Delta \ln GDP87$ is the annual growth in the constant latent *GDP* variable, which yields

$$\Delta \ln GDP87 = 0.68941 \Delta \ln OUT87 + 0.31059 \Delta \ln EXP87 \quad (7.37)$$

indicating that the bulk of weight should be placed on the output estimate.

Table 5. 2. Summary Statistics for Estimates of GDP Growth (SIS New Data- (1987-1994)) in Constant Prices

Means

OUTPUT	EXPENDITURE	AVERAGE	BALANCED
0.028777	0.025681	0.027229	0.027815

Standard Deviations

OUTPUT	EXPENDITURE	AVERAGE	BALANCED
0.047712	0.050931	0.047177	0.046857

Correlation matrix

	OUTPUT	EXPENDITURE	AVERAGE	BALANCED
OUTPUT	1.0000			
EXPENDITURE	0.82968	1.0000		
AVERAGE	0.95352	0.95933	1.0000	
BALANCED	0.98208	0.92002	0.99322	1.0000

The above analysis again yields four possible estimates of annual growth in *GDP* in constant prices; the two original measures (*Output and Expenditure*), the average of these (*Average*) and the current information (*Balanced*) estimates for the new SPO data. Table 2 displays the sample means and standard deviations of all four estimates together with their sample contemporaneous correlation matrix. The results of Equation (5.1.b.) indicate that the output measure is more reliable than the expenditure measure. However, standard deviation of the expenditure measure is the largest indicating relative information in the data. The results are similar to the previous section, and given the previous explanations with the stronger correlation

between the expenditure and balanced measures and the Figures 7.2, the quality of the expenditure measure of *GDP* in constant prices again should be treated cautiously.

5. 1. c. The Allocation of Turkish Accounting Residuals, (1987-1994)-New Data Set (SIS) in constant prices:

If we define *DRES87* as

$$DRES87 = \Delta \ln OUT87 - \Delta \ln EXP87$$

where $\Delta \ln OUT87$ is the change of the log of the output measure of *GDP* in 1987 prices and $\Delta \ln EXP87$ is the change of the log of the expenditure measure of *GDP* in 1987 prices for the new (SIS) data set.

Equation 5.1.c. $\Delta \ln OUT87 = 0.026 + 4.3956 DRES87$
se: (0.0188)(5.1739)
t-ratio : (1.358) (0.850)

$R^2 = 0.13$ $F(1, 5) = 0.7277$ [0.43] $\sigma = 0.049$ $DW = 2.71$
Passes all the diagnostic tests.

The results of Equation 5.1.c. are not satisfactory as the coefficient estimate exceeds unity.

The regression for the old (SPO) data indicates that 18% of the adjustment should be put on the expenditure data and 82% on the output data. The new (SPO) data suggests that 31% of the adjustment should be put on the expenditure data and 69% on the output data. These results suggest that more weight should be placed on the output expenditure. Although, none of the weights are significant, the aim was to derive appropriate weights for the output and expenditure measures. It is an issue in accounting not statistics.

The results are similar to Sefton and Weale (1995)'s UK results: As their results give more weight to output than expenditure data - with insignificant coefficients. They argue that this method may not be helpful for looking at annual

data because a large number of observations are needed in order to produce results which have any useful degree of precision. Therefore, another approach which is based on available information and inference about the structure of measurement errors would be better.

6. CONCLUSIONS

The main aim of this chapter is to reveal the problems of Turkish data by analysing the history of the Turkish National Accounts and to construct a data-base for estimating consumption function for Turkey. GDP by expenditure component is constructed from the five different resources.

As explained in Section 4, the necessary adjustments should be made to the income and expenditure series which are believed to be less reliable than the output series. This is particularly important in this study, since I am interested in explaining the large drop in the consumption-to-income ratio that occurred in the late 1980s in Turkey. The Linear Regression Approach is used for consistent estimation of the weights applied to the Turkish accounting discrepancies in forming the estimator for the latent data. The results show that GDP by output measure is more reliable than the GDP by expenditure measure for Turkey. However, the expenditure measure has the largest mean growth rate. In addition, its standard deviation is also the largest indicating relative information in the data (see, Chapter 4 for a more detailed analysis). Thus, if the income and expenditure measures are believed to provide better indicators of long-run trends, this result is not surprising. Furthermore, given the very small residuals between output and expenditure measures and the strong correlation between the average and balanced estimates, the quality of the expenditure measure of *GDP* should be treated cautiously. Hence, the large drop in the

consumption-to-income ratio in the late 1980s is a genuine drop rather than mis-measurement.

This results are also consistent with our findings in Chapter 8 that consumption (an expenditure component of *GDP*) and income (an output component of *GDP*) data are corrected by the SPO in a related way to avoid divergence, which suggests an $I(0)$ measurement errors for the ratio of them.



Figure 7.1 - The Real Gross Domestic Product (GDP) and Real Consumption (C) from 1970 to 1990. Average (1970-1990) = 0.75 (C) and 1.00 (GDP) (Equation 7.1.1)

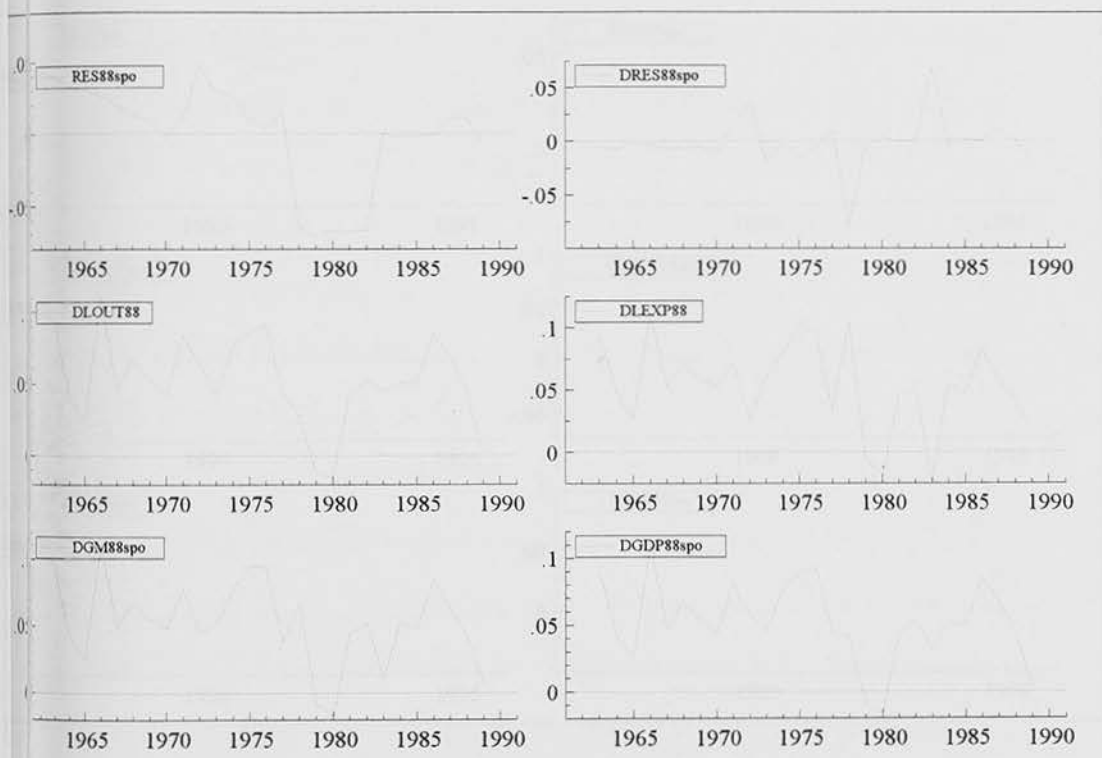


Figure 7.1 : The Residuals in Levels (RES88spo) and in Changes (DRES88spo); and GDP Growth Rates [Output (DLOUT88), Expenditure (DLEXP88), Average (DGM88spo) and Balanced (DGDGP88spo)] (Equation 5.1.a)

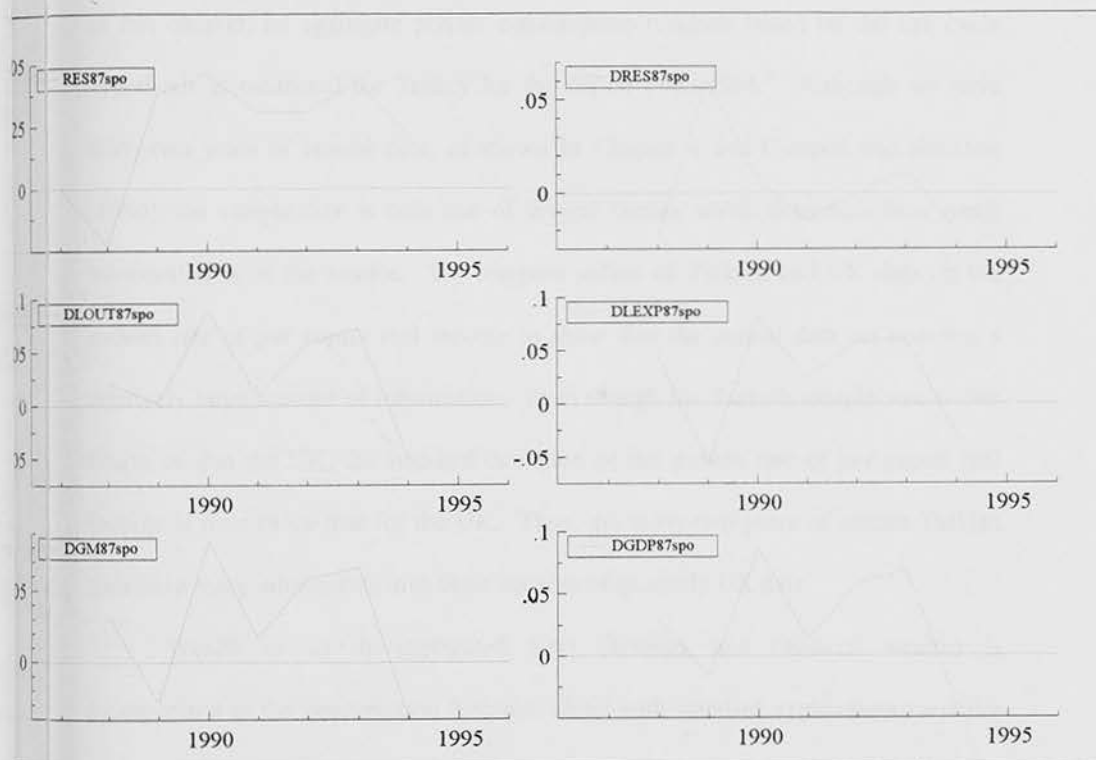


Figure 7. 2 : The Residuals in Levels (RES87spo) and in Changes (DRES87spo); and GDP Growth Rates [Output (DLOUT87spo), Expenditure (DLEXP87spo), Average (DGM87spo) and Balanced (DGDP87spo)] (Equation 5.1.b)

Chapter 8:

ESTIMATING THE TURKISH CONSUMPTION FUNCTION

1. INTRODUCTION

In this chapter, an aggregate private consumption function based on the life cycle hypothesis is estimated for Turkey for the period 1962-1994.¹ Although we have thirty-two years of annual data, as shown in Chapter 4 and Campos and Ericsson (1990), the sample size is only one of several factors which determine how much information is in the sample. We compare values of Turkish and UK data on the growth rate of *per capita* real income to show that the annual data set contains a relatively large amount of information. Even though the Turkish sample size is one fourth of that the UK, the standard deviation of the growth rate of *per capita* real income is over twice that for the UK. Thus, the thirty-two years of annual Turkish data have more information than three decades of quarterly UK data.

Wealth in its dis-aggregated form (housing and financial wealth) is incorporated in the consumption function, along with standard explanatory variables including the government deficit. Using the general to specific modelling strategy, one final model is deduced by applying a sequential testing procedure.

Section 2 gives the results of earlier work on the Turkish consumption function. Section 3 discusses the explanatory variables. Section 4 estimates a consumption function for Turkey. Section 5 evaluates the forecasting performance of

¹ The independent variable is the average propensity to consume, since *per capita* real private consumption has a unit coefficient on *per capita* real private disposable income.

the econometric model. Section 6 encompasses the final model with the previous models, Rittenberg (1988) and Uygur (1993). Section 7 concludes and Section 8 considers comments, discussion and future research.

2. THE RESULTS OF EARLIER WORK ON TURKISH CONSUMPTION FUNCTION

In this subsection, I will summarise the previous findings on consumption function for Turkey. Previous explanations were formulated using conventional econometric techniques with single equation estimation within the theory of the permanent income hypothesis (PIH). Figure 8.1 shows the time-series of consumption and income.

Gazioglu (1984) examines the dynamic structure of the consumption theories such as permanent income, life cycle, stock-adjustment and Stone models for annual Turkish data for the period 1952-1981.² The dependent variable is private consumption in all equations. *The permanent income hypothesis* fits the data poorly and the implied parameter restrictions are not consistent with the data.

She estimates the following consumption function (see pg. 222)

$$\text{Pr } C_t = \lambda \text{Pr } C_{t-1} + \varphi(1 - \lambda)Y_t + u_t - \lambda u_{t-1}$$

$$\begin{array}{cc} -0.626 & 1.559 \\ & (0.002) \end{array} \quad (8.1)$$

$$\hat{\rho} = 0.630 \quad \hat{\lambda} = -0.630 \quad \bar{R}^2 = 0.873 \quad \text{SEE} = 0.0340 \quad \text{DW} = 2.021$$

(0.16)

The equation (8.1) assumes that the disturbances follow a first order moving average (MA (1)) process, with the parameter, λ , of the process being exactly equal

² Private consumption is the endogenous variable.

to the weight used in constructing permanent income. She estimates the disturbance as a first order autoregressive process using the Cochrane-Orcutt iterative technique. This is expressed as an infinitely long moving average process using

$$\frac{1}{1-\rho L} \sum_{t=0}^{\infty} \rho^t L^t$$

For reasonably small values of ρ , this expression is truncated to $\frac{1}{1-\rho L} \cong 1 + \rho L$.

This gives an approximate estimate of $\lambda (= -\hat{\rho})$ as in the above equation. She argues that the negative value of λ makes nonsense of the definition of permanent income, for it implies that an increase in income lowers permanent income.³ As a consequence of the negative value of λ consumption responds in an oscillatory manner to income, initially overshooting its long run response, then undershooting, then overshooting and so on (see Gazioglu, 1982).

The life cycle theory yields persistently wrong coefficients. For wealth, it generates a dynamically unstable model. She estimates the following equation in the logarithmic form:⁴

³ Friedman (1957) assumed that permanent income is given by

$$Y_t^p = (1-\lambda) \sum_{t=0}^{\infty} \lambda^t Y_{t-t} + u_t$$

⁴ The theoretical derivation of the model is as follows [Modigliani (1975)]:

$$C_t = \alpha_1 Y_t + \alpha_2 W_t + u_t \quad (1)$$

where W_t is the real wealth holdings of consumers at the beginning of the period. If income is measured to include capital gains and interest, then the identity

$$\Delta W_t = Y_{t-1} - C_{t-1} \quad (2)$$

holds. Taking first differences of (1) and using (2), we have

$$\Delta C_t = -\alpha_2 (C_{t-1} - Y_{t-1}) + \alpha_1 \Delta Y_t + \Delta u_t \quad (3)$$

If changes in the real value of assets are allowed for in measuring income, then

$$\Delta W_t = Y_{t-1} - C_{t-1} - \bar{L} \Delta P_t \quad (4)$$

where \bar{L} is a parameter reflecting real holdings of nominally denominated assets in the economy.

$$\Delta C_t = -\alpha_2 (C_{t-1} - Y_{t-1}) + \alpha_1 \Delta Y_t - \alpha_2 \bar{L} \Delta P_t + \Delta u_t \quad (5)$$

u_t is assumed to be white noise, then

$$P_t C_t = 0.729 + 0.867 Y_t - 0.0006 W_t + 0.0364 P_t \quad (8.2)$$

$$(3.67) \quad (0.256) \quad (0.049) \quad (0.030)$$

$$\bar{R}^2 = 0.995 \quad DW = 1.306 \quad SEE = 0.0273$$

The model shows signs of positive auto-correlation of the disturbance terms; this auto-correlation is corrected by means of the Cochrane-Orcutt iterative technique. The coefficient on income is still significant, but the coefficient on wealth⁵ stays negative and perverse, though still insignificant. The price variable⁶ is insignificant with a positive sign, which is not consistent with the motivation to include it to deal with mis-measurement of income. Thus, she claims the life cycle theory does not perform satisfactorily on Turkish data. In particular, the insignificance and often perverse sign of the wealth variable means that the long-run properties of the estimated equations are unsatisfactory.

The Stone model yields implied estimates of the structural parameter values that are not interpretable. The results of the Stone model⁷ are as follows:

$$W_t = \sum_{i=0}^{\infty} (Y_{t-i} - C_{t-i}) - \bar{L}P_t \quad (6)$$

and

$$C_t = \alpha_1 Y_t + \alpha_2 \left(\sum_{i=0}^{\infty} (Y_{t-i} - C_{t-i}) \right) - \alpha_2 \bar{L}P_t + u_t \quad (7)$$

In logs:

$$c_t = \alpha_1 y_t + \alpha_2 k^{-1} \left(\sum_{i=0}^{\infty} (y_{t-i} - c_{t-i}) \right) - \alpha_2 l \left(\sum_{i=0}^{\infty} \pi_{t-i} \right) + u_t \quad (8)$$

⁵ The wealth is defined as the accumulated savings: $W_t = \sum_{i=1}^{\infty} (Y_{t-i} - C_{t-i})$

where $\Delta w \approx k^{-1}(y_{t-1} - c_{t-1}) - l\pi_{t-1}$

⁶ The price level.

⁷ The theoretical model is (see Gazioglu (1984, pg. 216) for the derivation of the model):

$$\Delta c_t = \delta_1 \left(\sum_{i=0}^{\infty} y_{t-i} - c_{t-i} \right) - \delta_2 \left(\sum_{i=0}^{\infty} \pi_{t-i} \right) + \delta_3 y_t + \delta_4 \Delta y_t - \delta_5 c_{t-1} - \delta_6 \pi_{t-1} + u_t - \lambda u_{t-1}$$

$$\begin{aligned}
PrC = & 1.201 + 0.409 Y + 0.966 \Delta Y + 0.134 W + 0.372 PrC_{-1} + 0.209 \pi_{-1} + 0.039 P_{-1} \\
& (0.352) (0.131) (0.208) (0.036) (0.160) (0.068) (0.029) \\
\hat{\rho} = & -0.245 \quad R^2 = 0.998 \quad DW = 2.129 \quad SEE = 0.0185 \quad (8.3) \\
& (0.198)
\end{aligned}$$

The wealth term becomes significant, particularly once correction has been made for auto-correlation by the Cochrane-Orcutt procedure. Income and the change in income continue to be significant; and the lagged dependent variable is significant. The estimates are broadly consistent only when $\hat{\lambda} = -\hat{\rho}$, however the results imply a negative propensity to consume out of transitory wealth and a propensity to consume out of transitory income which is of the order 2.5-3.5. She finds that the Stone model does not perform satisfactorily on Turkish data.

She concludes that *a stock adjustment model* with satisfactory long-run properties performs best for the Turkish data. The following generalised stock adjustment model is estimated.⁸

$$\begin{aligned}
PrC = & 1.720 + 0.681 Y + 0.643 \Delta Y + 0.176 W + 0.188 \pi_{-1} + 0.071 P_{-1} \\
& (0.400) (0.067) (0.197) (0.054) (0.086) (0.031) \\
\hat{\rho} = & 0.818 \quad R^2 = 0.997 \quad DW = 1.700 \quad SEE = 0.02 \quad (8.4) \\
& (0.204)
\end{aligned}$$

The first estimation of equation (8.4) without the price or inflation terms shows significant positive auto-correlation of the disturbance term and it is corrected by the Cochrane-Orcutt iterative technique. Again, in the new estimation the level of income continues to be highly significant, and the change in income loses some of its significance, while the wealth term ($= y_{-1} - c_{-1}$) increases its contribution.⁹ The

⁸ The theoretical models is (see Gazioglu, 1984, pg. 213) for the derivation of the model):

$$c_t = \alpha_0 + \alpha_1 y_t + \alpha_2 \pi_t + \alpha_3 \Delta y_t + \alpha_4 \left(\sum (y_{t-i} - c_{t-i}) \right) + \alpha_5 \left(\sum \pi_{-i} \right) + u_t$$

⁹ In this equation, the parameter reflecting autocorrelation in the disturbance process ρ is significant.

parameter estimates suggest a fairly lengthy wealth adjustment process, whereby something over a half of any discrepancy between the actual and desired wealth income ratio is eliminated within four years. However, the mean lag of consumption to income changes is shorter, being of the order of one or two years only. The impact of inflation is harder to determine, as it is rather collinear with a simple trend term, so it is not possible to identify reliably the impact of inflation on the relationship between consumption and income. However, the estimates suggest that the wealth/income ratio is a negative function of the rate of growth, a 1% higher path of growth lowering the long run wealth income ratio by nearly 6%, but nonetheless raising the overall savings ratio.

Gazioglu (1986) examines whether government deficits influence private consumption in Turkey by comparing the efficacy of three alternative definitions of wealth in explaining consumption. She finds that consumption is best explained in terms of a model in which government deficits influence consumers expenditure.¹⁰ She defines wealth as cumulated investment, government spending and current account surplus. A more appropriate definition would allow for taxes.¹¹ There is the possibility that the private sector may regard the budget deficit as having a rather different effect on wealth than investment and current surpluses, as it tends to discount budget deficits in the assessment of wealth. As it is argued in Barro (1974), the private sector discounts the future tax revenues required to finance the interest

$$^{10} W_t = \sum_{i=1}^{\infty} (I_{t-i} + G_{t-i} + X_{t-i} - M_{t-i})$$

$$^{11} \bar{W}_t = \sum_{i=1}^{\infty} (I_{t-i} + G_{t-i} - T_{t-i} + X_{t-i} - M_{t-i}) = W_t - \sum_{i=1}^{\infty} T_{t-i}$$

payments on additional government debt. Since, however, in countries like Turkey, the private sector may discount the effect of government deficits on wealth because of their inflationary consequences, in contrast to investment and the balance of payment surpluses. Hence, she also considers an alternative definition of wealth.¹² By comparing the relative influences of W_t and \bar{W}_t , she assesses whether or not consumer behaviour is affected by the budget deficit position. Rather than include the W_t and \bar{W}_t variables themselves, a greater degree of generality is allowed by including W_t and the two correction factors $LCUGR = \sum_{i=1}^{\infty} T_{t-i}$ and $LCUGD = \sum_{i=1}^{\infty} (G_{t-i} - T_{t-i})$ in the regressions. The negative and significant coefficient on the budget deficit indicate that current consumption is depressed by current government deficits. However, she is sceptical about the significance of this result because of the obvious two-way causality between consumption and the budget deficit. Thus higher consumption is likely to lead to higher GDP and higher tax revenues, so that the government deficit falls. These results suggest that the most appropriate definition of wealth is the conventional one of cumulated savings, as given by \bar{W}_t , though the fact that the coefficient on taxes is typically less than on W provides some evidence of a degree of discounting of tax changes.

In an analysis of the 1961-1985 period, Rittenberg (1988) examines Turkey's savings function to determine whether its structure changed between the pre-1980 and post-1980 periods in ways predicted by the literature on financial liberalisation. She finds that the changes in real interest rates had a positive effect on savings with a

¹² $W_t^* = \sum_{i=1}^{\infty} (I_{t-i} + X_{t-i} - M_{t-i}) = W_t - \sum_{i=1}^{\infty} G_{t-i} = \bar{W}_t - \sum_{i=1}^{\infty} (G_{t-i} - T_{t-i}) = W$

coefficient of 0.29 and the savings rate increased at a decreasing rate as the real interest rate rose.¹³ Thus, while negative interest rates discouraged savings in the 1970s, positive real interest rates in the 1980s had a much milder effect in terms of encouraging savings. She notes that there was a substantial autonomous drop¹⁴ in the savings rate from 1982 onward which may have been the result of a shaken public confidence following the bankruptcy of the major brokerage houses. She finds that positive interest rates are a necessary, but not a sufficient condition for a higher saving rate, and that financial liberalisation must be accompanied by the creation of orderly financial markets. Following Fry (1979, 1980) and Giovannini (1983), the ratio of national savings to GDP was regressed on the rate of growth of real GDP, the level of *per capita* GDP, the real deposit rate of interest¹⁵, and the savings rate lagged by one year. The coefficients of real income growth and *per capita* real income are expected to be positive. The inclusion of the foreign savings rate seeks to determine whether or not foreign savings may substitute for national savings. The coefficient of foreign savings becomes negative and significant. The real deposit rate is never significant after 1979 while the lagged savings rate is only significant after 1980. In order to account for shifts in the savings function in the post-1980 period, dummy variables are added to the equation; with the inclusion of the dummy variables, the coefficient

¹³ She also allowed for a non-linear relationship between the interest rate and the domestic savings rate as well as the private savings rate. The coefficient of the linear term is estimated to be positive and significant, while that of the quadratic term is estimated to be negative and significant. Thus, increases in the interest rate appear to lead to increased savings but at a decreasing rate. A similar regression was estimated using the private savings rate as the dependent variable. While the quadratic term was insignificant, the coefficient of the real deposit rate was much smaller initially.

¹⁴ This may represent what Diaz-Alejandro (1985) referred to as an "unintended consequence of financial liberalisation". He describes this as a cycle of financial repression-financial liberalisation-financial crash.

¹⁵ She uses the realised real deposit rates instead of expected rates and argues that in economies with histories of rapid inflation expectations are less sticky because the cost of ignoring the future effects of current policy actions can be quite high. Under this rational expectations hypothesis, the expected rate of inflation will equal the actual rate of inflation Mathieson (1979).

of the real interest rate is estimated to be positive and statistically significant. Also, its magnitude (0.29) is virtually identical to that estimated for the-1980 period, indicating that savings do respond favourably to higher interest rates, as predicted by the literature on financial repression and liberalisation.

Rittenberg (1988) also estimates the private saving equation as a function of real private disposable income, the ratio of foreign savings to private disposable income, the ratio of public savings to private disposable income which is included to allow for the consideration of the extent to which public and private savings are substitutes. The real private disposable income growth has a wrong sign and is statistically insignificant; the public savings rate is also insignificant. However, real interest rates have a positive influence on private savings, with a smaller coefficient (0.09) than domestic savings. This function was also estimated to have shifted downward in the 1982-85 period.

Akyuz (1990) and Uygur (1989) find a negative significant effect of the real deposit rates on consumption, while real time deposits lagged three and four quarters had considerable positive effects on the same variable in repeated estimations.

Wijnbergen *et al.* (1992) estimate a consumption function in which real private consumption depends on the real after tax deposit rate, inflation, temporary income (the excess of actual income over trend) and permanent income (the trend growth in private disposable income). They find the effect of the real after-tax deposit rate on private consumption to be negative and significant (0.82). In addition, private consumption depends negatively on inflation. The effect of permanent income on consumption is strongly positive with a coefficient not significantly different from 1. The coefficient of temporary income is low, insignificant and negative (-0.19).

Erol (1992) examines short-run macroeconomic adjustment mechanisms in the Turkish economy. The IS-LM model adopted is originally developed by Leff and Sato (1980) for a closed economy. This is modified in two respects. First, it is opened by adding a trade balance equation. Second, in order to reflect the changes in economic policy after 1980, a somewhat different adjustment mechanism is taken into account by replacing the supply of credits with the interest rate as the adjustment variable. The first version covers the 1960-80 period and uses annual data, and the second version covers the 1980(III)-1986(IV) period and uses quarterly data. As the estimation technique, the instrumental variables method is used. In the first version, the saving equation includes the change in income, inflation and its one period lag. In the second version, the real interest rates variable is added to the same equation. A permanent negative relation is found between the total savings and inflation in the first period. In contrast, a significant positive correlation is observed in the second period. In the second version, the real interest rates have a positive and significant effect on total savings with a coefficient of 1.06 and t-ratio of 4.

Celasun and Tansel (1993) find the estimated coefficient of temporary income¹⁶ (the difference between the trend value of private disposable income and actual income), the real (compound) interest rate on time deposits and inflation to have a positive and significant effect, and the trend value of private disposable income to have a negative and significant effect on the private saving rate over the 1972-1988 period. The estimation results capture the significant impact of functional income distribution¹⁷ on private as well as on total domestic saving.¹⁸ The Turkish economy

¹⁶ They argue that the relatively large size of the estimated coefficient for temporary income implies that swings in private saving are explained by fluctuations in real private income.

¹⁷ They employ time series data on functional income distribution; the distributional indicator is the ratio of non-wage income (YK) to wage income (YL) within the non-agricultural sector. Because of the lack of data, they do not incorporate agricultural factor shares into the treatment of functional

experienced notable changes in functional income distribution under the different policies in the post 1973 (oil crisis) period. Financial liberalisation, involving a switch to a higher interest rate appears to have produced a positive effect on this private saving equation. The impact of inflation on private saving is separated into the effects of expected inflation (PE) and unexpected inflation (PU). Expected inflation is used with the suggestion that households adjust their perceived disposable income downward as expected capital losses on their assets increase. On the other hand, expected inflation may lead to higher spending on consumer durables in developing countries in the absence of adequately indexed financial instruments. They assume that the impact of unexpected inflation on private saving would be positive according to the involuntary saving hypothesis of Deaton (1977).¹⁹ Therefore, they replace the inflation term, ΔP by PE (expected inflation - a three-year moving average of the actual inflation rate) and PU (unexpected inflation = $\Delta P - PE$) in the alternative models. The estimated coefficients on inflation alone as well as expected and unexpected inflation are all significant at 1% level and have a positive effect on all the equations.

Uygun (1993) finds positive and significant effects of *per capita* real private disposable income, growth of real private disposable income, share of housing investment in total private investment; and a negative and significant effect of the ratio of total time deposits to the GNP on private saving rate. He finds a positive but

distribution of income. Dervis and Robinson (1980) indicate that a decline (rise) in the (YK/YL) ratio tends to yield a decrease (increase) in overall income inequality, because within-group income inequality for the working class is lower and its group population share is higher than those of non-labour classes in the non-agricultural sector.

¹⁸ As the recent reviews of saving and development studies indicate, the cross-country evidence on the saving-investment impact of financial liberalisation and income distribution is a mixed one (see Gersowitz (1988), Deaton (1989) and Balassa (1989)).

¹⁹ Thus, the signs of the coefficients of inflation and expected inflation are indeterminate, whereas the unexpected inflation is positive in private saving models.

insignificant real after tax deposit interest rate, noting that an increased savings rate was not associated with financial liberalisation.

Akcin and Alper (1996) examine the validity of the Hall's permanent income hypothesis (PIH) for the quarterly Turkish aggregate consumption data²⁰ (1987-1994). They find evidence against the PIH for Turkey. Approximately 40% of income goes to individuals who consume their current income.

They estimated the following equation with the instrumental variables (IV) technique in order to derive consistent estimates of λ .

$$\Delta C_t = \Delta C_{1t} + \Delta C_{2t} = \mu + \lambda \Delta Y_t + (1 - \lambda) \varepsilon_t \quad (8.5)$$

The model is similar to Campbell and Mankiw (1990) where aggregate consumption is best viewed as generated by two types of consumers. Consumers in the first group, called the "rule-of-thumb", consume their current income. Consumers in the second group are forward-looking and behave according to the PIH. The first group receives a fixed share λ of total disposable income, so $Y_{1t} = \lambda Y_t$ and the second group receives the rest of the total disposable income $Y_{2t} = (1 - \lambda) Y_t$.

Agents in the first group consume their current income, so $C_{1t} = Y_{1t}$. Taking first differences, one can obtain $\Delta C_{1t} = \Delta Y_{1t} = \lambda \Delta Y_t$. Agents in the second group consume their permanent disposable income, thus $C_{2t} = Y_{2t}^p = (1 - \lambda) Y_t^p$. By using the Hall random walk hypothesis, the change in consumption of second-type agents is $\Delta C_{2t} = \mu + (1 - \lambda) \varepsilon_t$, where μ is a constant and ε_t , a rational forecast error, is the

²⁰ They use real *per-capita* personal disposable income as an income variable, since annual private disposable income data are computed by State Planning Organisation (SPO). However, it is not possible to convert the data from annually to quarterly data by using the method of SPO, because SPO collects the public sector income on an annual basis in order to obtain public disposable income in this method. They calculated Turkish quarterly personal disposable income data using available statistics and data.

innovation between time $t-1$ and t in agents' assessment of total permanent income Y_t^p . The change in aggregate consumption is written as in equation (8.5).

Equation (8.5), estimated by the IV procedure, is equivalent to a restricted version of the following two-equation system in which ΔC_t and ΔY_t are regressed directly on the instruments

$$\begin{aligned} \Delta C_t &= \alpha_0 + \alpha Z_{t-j} + u_{1t} \\ \Delta Y_t &= \beta_0 + \beta Z_{t-j} + u_{2t} \end{aligned} \quad \text{for } j \geq 2 \quad (8.6)$$

where Z_{t-j} is a q -vector of instruments, the most recent of them is measured during period $t-2$. The PIH implies that the vector $\alpha = 0$ in equation (8.6), which is equivalent to testing the null hypothesis of $\lambda = 0$ in equation (8.5). Using $\Delta y_{t-2}, \Delta y_{t-3}, \Delta y_{t-4}, \Delta c_{t-2}, \Delta c_{t-3}, \Delta c_{t-4}, \Delta c_{t-5}, \Delta c_{t-6}$ and $c_{t-2} - y_{t-2}$ as instruments they find λ to be approximately 0.4²¹ and significantly different from zero suggesting evidence against the PIH since the PIH would have implied an insignificant λ .²² They also examine whether the empirical failures of the random walk hypothesis can be attributed to the failure of the auxiliary assumptions used to derive the hypothesis - constant real interest rates and nonseparability in utility function. They find the real interest rate to be insignificant and find no evidence of nonseparability in the utility function between consumption and other goods - stock of durable goods and government purchases.

²¹ However, their Monte Carlo results suggest that their estimates of the fraction may have a downward bias. When the true value of λ is 0.5 (0), the bias is downward (upward) the estimates of λ are about 0.12 (0.4) and insignificant (insignificant).

²² When they consider food and beverages consumption this result is even stronger since the fraction turns out to be around 60%. However, consumption of semi and non-durables including services, transportation, energy, communication, etc. gives support to the PIH since the fraction is a significant amount.

Elhan (1996) estimates a similar saving function to Uygur (1993) for the period of 1971-1992 where the private saving rate is a function of real deposit rates of interest (short-term interest rates on time deposits with up to 6-month maturity, $rder$), real *per capita* disposable income (Y_{RPC}), the ratio of time deposits to GNP (D/GNP), the ratio of net current transfers from the rest of the world to GNP (T/GNP), the lagged of the ratio of foreign savings to GNP (FS/GNP), and the ratio of housing investment to total investment (HI/II).²³

The 'net current transfers from the rest of the world' is comprised mainly of workers' remittances and other interest and investment income from abroad. Particularly in the 1970s, workers' remittances have been crucial in relieving the foreign exchange bottlenecks in Turkey. Foreign inflows are a net substitute for domestic savings, as they mitigate the liquidity constraints arising from low domestic savings. Similarly, 'the ratio of foreign savings to GNP' is inversely related to the savings rate, since foreign savings are net substitutes for domestic saving. Elhan (1996) also finds low price elasticity of savings for Turkey.

Asirim (1996) tests²⁴ whether Turkish consumers behave as the Life Cycle consumption theory predicts; and compares continuous time²⁵ and error correction

²³ She obtains the following results:

$$s = \alpha_0 + \alpha_1 rder + \alpha_2 Y_{RPC} + \alpha_3 T/GNP + \alpha_4 D/GNP + \alpha_5 (FS/GNP)_{-1} + \alpha_6 HI/II$$

-5.9	0.06	0.002	-0.25	-1.08	-0.59	0.32
(-2.5)	(2.59)	(7.16)	(-0.32)	(-2.76)	(-2.37)	(2.74)

$\bar{R}^2 = 0.91$ $DW = 2.1$ SEE is not provided.

²⁴ He uses seasonally adjusted total real consumption, seasonally adjusted real GNP, and the rate of inflation. All series are at constant prices, 1987=100, and obtained from the State Institute of Statistics (SIS). The SIS produces quarterly GNP and consumption series beginning from 1987.

²⁵ Chambers (1991) formulates consumption function in continuous time based on Bergstrom (1983, 1984, 1985, 1986) who developed the Gaussian estimation of structural parameters in continuous time dynamic models. It is argued that since aggregate consumption represents the spending decision of millions of individuals which are taken at different stages through the observation period, a realistic model which takes account of the microeconomic decisions process must be formulated in continuous time. One motivation for a continuous time model is that it allows us to make a distinction between variables, e.g. stock versus flow variables. Another advantage of a continuous time model is that the

models of consumption and selects the most representative consumption model for the Turkish economy on the criteria that a superior model produces a superior forecast. However, Hendry (1997) and Clements and Hendry (1998) warn of the potential dangers of selecting policy models by forecast-accuracy criteria. The empirical results of the random walk model reveal some evidence for the model since lags on measures of consumption earlier than $t-1$ lags on income, and the rate of inflation at $t-1$ or earlier than $t-1$ enter the regression insignificantly and thus have no predictive power for changes in consumption.²⁶

The estimated ECM for the period of 1987Q1-1992Q4, the remaining 8 observations were saved for forecasting, is

$$\Delta \ln c_t = -0.008 + 1.08 \Delta \ln y_t - 0.658 (\ln c_t - \ln y_t - cons)_{t-1}$$

(-0.18) (7.44) (-3.5)

$$R^2 = 0.76$$

$$\text{Mean Prediction Error (MPE)} = 0.0009$$

$$\text{Root Mean Square Prediction Error (RMSFE)} = 0.102$$

SEE is not provided, but we calculate it from $R^2 = 0.76$ and the SEE in the below equation and find to be 0.028.

variables which are observed by the econometrician are the outcome of a larger number of decisions taken at different points in time, but many individual economic decisions are made at regular intervals and the intervals at which most economic variables are observed are larger than the intervals between the decisions being made. These facts suggest that the variables that enter into a typical econometric model should be formulated as a system of differential equations. A further advantage of specifying a model in continuous time is that it does not depend on the unit of time being used or on the frequency with which the data are observed. Moreover, continuous time models are formulated as differential equations, so that behaviour is allowed to adjust continuously, rather than as discrete jumps coinciding with the observed period. In addition, it is possible to formulate these models so that there exists an appropriate long-run steady-state solution. The continuous time model places certain complicated parametric restrictions on both the coefficients and the autocovariances of its discrete representations.

$${}^{26} \Delta c_t = \alpha_0 + \alpha_1 \Delta c_{t-1} + u_t$$

Three alternative specifications are tested on the above restricted random walk model; in the first case, Δc_{t-2} , in the second and the last case, Δy_{t-1} , Δy_{t-2} and Δy_{t-1} , Δp_{t-1} are included respectively in the restricted model to test, as if Turkish consumers behave as the Life-Cycle Permanent-Income (LCPI) theory predicts. It is found that only consumption lagged one period has a non-zero coefficient in all cases.

Estimation of the continuous time model requires special programming.²⁷

However, since the model is a single equation, the OLS method is used to estimate the discrete version of the continuous time model, with a simplifying assumption that the residuals are white noise. The estimated model for the period of 1987Q1-1992Q4 is

$$\begin{aligned} \Delta \ln c_t = & 0.067 - 0.095 \Delta \ln c_{t-1} - 0.414 \Delta \ln c_{t-2} + 1.030 \Delta \ln y_t + 0.079 \Delta \ln y_{t-1} \\ & (0.93)(-0.03) \quad (-1.86) \quad (5.16) \quad (0.21) \\ & + 0.602 \Delta \ln y_{t-2} - 0.02 \ln p_t + 0.008 \ln p_{t-1} + 0.08 \ln p_{t-2} \\ & (2.04) \quad (-1.40) \quad (0.05) \quad (0.63) \end{aligned}$$

$$R^2 = 0.82 \quad \text{SEE} = 0.021$$

$$\text{Mean Prediction Error (MPE)} = 0.0168$$

$$\text{Root Mean Square Prediction Error (RMSFE)} = 0.147$$

Asirim (1996) concludes that the error correction model is the most representative model for the Turkish economy on the criteria that the error correction model produces MPE and RMSPE lower than those of the continuous time model so that Turkish consumers behave as the life cycle hypothesis predicts.

Selcuk (1996) examines the Turkish balance of payments over the period 1987-1995²⁸ by adopting an *intertemporal consumption-smoothing approach*. The current account of a country will be in deficit whenever there is an expected rise in the national cash flow defined as gross national product less investment less government spending. Similarly, the current account should give a surplus if there is an expected fall in the national cash flow. He derives the *consumption smoothing* component of

²⁷ Chambers (1991) uses the PC programming language GAUSS to estimate the model by Davidson-Fletcher-Powell algorithm.

²⁸ Data used to estimate the parameters of the model are quarterly national accounts of the Turkish economy for the period 1987-1995, expressed in billions of Turkish Lira (1987 prices). The data is obtained from the State Institute of Statistics (SIS).

the current account.²⁹ This has important implications regarding the permanent and temporary shocks to national cash flow.

A permanent increase in the gross domestic product causes an equal increase in consumption and leaves the current account unchanged, since the expected change in permanent shock is zero, they would not have any effect on the current account. However, permanent positive shocks to investment, if they increase the future output, may lead to a permanently worsening current account situation. A temporary decrease in national cash flow either from a temporary increase in investment or from government expenditures will push the current account into a larger deficit and the economy will accumulate foreign liabilities. Also, temporary positive shocks to national cash flow such as a temporary increase in the gross domestic product or a temporary decrease in government spending will improve the current account position of the economy and foreign assets will increase. In other words, the current account plays a role of buffer to smooth the consumption presence of temporary shocks under perfect capital mobility and perfect financial market. The findings of the paper indicate that Turkey could not smooth (private) consumption during the sample period, since the realised current account diverges from the optimum current account balance. This is especially the case when the economy experienced foreign borrowing difficulties most heavily in 1990-1991 and 1994 and could not exercise optimal borrowing from the rest of the world. The result also implies capital market imperfections in the economy. As a result, realised consumption in Turkey was more

²⁹ $CA_t^* = -E \left(\sum_{j=1}^{\infty} (1+r)^{-j} \Delta n f_{t+j} \right)$ where the right-hand side of the equation is (minus) the present discounted value of the expected changes in national cash flow.

volatile than the estimated optimum consumption. Figure 8.2 shows the consumption to income ratio.

In the following section I discuss the variables that may be significant in explaining the Turkish consumption. This includes the variables that have been used in the previous studies as well as the variables that have not been thought of before such as housing wealth, demographic factors, inflation and income uncertainty *etc.*

3. EXPLANATORY VARIABLES IN THE CONSUMPTION FUNCTION

3. 1. Housing Wealth: Housing wealth is claimed to be a major determinant of private savings in Turkey. However, lack of proper data on this variable makes analysis quite difficult. I used the private housing investment to private disposable income ratio and the private housing investment to total private investment ratio as approximations and found that neither of them was significant.³⁰ This forces us to construct housing wealth for Turkey, see Chapter 6. The data are shown in Figure 8.6.

The SIS constructs the Metre Square unit cost for housing. This however, only includes materials and labour cost. The lack of data on land prices is another reason for not having accurate data on house prices in Turkey.

The positive correlation between private saving and private investment in housing in Turkey indicates that the high level of investment did not reduce continued high *growth* in Turkey's economy, but the composition of investment is a reason for concern. The share of manufacturing in private investment fell in response to strong public sector support of investment in housing through the Mass Housing Fund.

³⁰ The results are available from the author.

Investment by the private sector shifted away from the main export sectors, agriculture and manufacturing. The share of agriculture and manufacturing investment in total private investment fell from 11.83% and 33.81% in 1984, to 3.28% and 13.67% in 1994 respectively; whereas the share of housing investment in total private investment increased from 28.91% in 1984 to 47.74% in 1994. New incentives, such as preferential credit extended by the Mass Housing Fund, played a role in this shift. However, the substantial decline of the share of total investment in the main export sectors could affect the link among export growth, the real exchange rate and the cost of external debt. With less capital in the sectors producing tradable goods, the real exchange rate must shift even more to achieve a given export target. This in turn increases the capital losses. Wijnbergen *et.al* (1992) suggest that reorienting investment incentives toward the main export sectors will reverse this unfavourable shift in the trade-off between export growth and the cost of external debt. Also lowering the real interest rates and reallocating incentives to the traded goods sectors would allow the export drive to continue with a slower increase in the debt-output ratio.

The Turkish government can take an active role in achieving sustainable growth in Turkey. The government with the effective policies can prevent speculative demand for housing due to the continuous increase of house prices in certain areas (i.e., in the big cities and holiday resorts); and deviate low income and middle income households' savings from time deposits to the housing sector by easing ownership of a house for these groups; and keep constant or reduce the share of housing investment in total private investment and give priorities to the construction of social houses for low and middle income families rather than building luxurious houses for upper-middle income and upper-income families.

3. 2. Short term interest rates on deposits or broad money: Pre-1980, while real interest rates on time deposits were negative; -14.3% in 1978, -16.2% in 1979 and -30% in 1980, the increase in the dwelling income index was positive 52.2% in 1978, 61.2% in 1979 and 113.6% in 1980. Thus, in the pre-1980 period most of the private sectors' savings were channelled to the housing sector. The initiation of the free interest-rate policy in 1980, did not encourage savings. Interest income was the means to sustain the level and pattern of consumption and hence, interest payments were rarely invested. One important factor was housing investments encouraged by low cost housing credits extended by public agencies in the second half of the 1980s. Another important factor in the second half of the 1980s was the rising public sector deficits financed by domestic borrowing at larger proportions. This was achieved by higher interest rates on public securities as compared to bank deposit rates and brought about a further portfolio shift, this time towards public bonds and treasury bills from time deposits. The increase in the domestic debt stock ratio from 13.6 percent in 1980 to 22.95 per cent in 1987 indicates heavy public sector borrowing from the financial markets.

We used short term real interest rates (three month interest rates on time deposits) which represent credit rationing in the economic theory, as they seem more appropriate than the long term interest rates for a country with high credit constraints: see Figures 8.7 and 8.8.

The effect of an increase in the interest rate can be divided into substitution and income effects. The substitution effect is always negative because today's consumption becomes more costly and there is a substitution towards tomorrow's

consumption. The income effect works in the following manner: a higher interest rate implies a positive effect for savers but a negative one for borrowers. For the economy as a whole the total effect can either be positive or negative, depending on which effect dominates, which we will be finding with the empirical model.

3. 3. Inflation : Although inflation is not an argument of the theoretical consumption function, it is statistically significant when added to the empirical function. Bachelor and Dua (1992) offer three explanation for this phenomenon:

- 1) That it reflects the confusion between relative and general price movements,
- 2) It is proxying for the effect of inflation uncertainty, see Blinder and Deaton (1985),
- 3) That it is proxying for inflation-induced losses on assets which are not approximately incorporated in national income measures, see Hendry and Ungern-Sternberg (1981). Figure 8.4 shows the time series of inflation.

3. 4. Demographic Changes: A number of potentially significant life-cycle groups altered in proportion in the population aged under 44. The population aged under 14 fell in proportion from 0.41 in 1962 to 0.32 in 1994, whereas the population aged between 15 and 44 increased in proportion from 0.41 in 1962 to 0.49 in 1994. The pre-retirees aged 45-64, the likely prime savers and those aged 65 and over remained constant in proportion. If we believe that the demographics reflect life-cycle saving phenomena, then we expect young people with currently low incomes but high income expectations and life-cycle needs to consume a high proportion of income; middle-aged cohorts to save in anticipation of a lower income in retirement; and old-people to use their stock accumulated savings – generating a hump-shaped life-cycle

savings profile. However, the significance of age distribution in the consumption function factors can clearly reflect all sorts of life-cycle phenomena other than those associated with life-cycle smoothing. See Figure 8.9.

3. 5. Additional Variables

3. 5. a. Demographic factors: I tried the following demographic variables to take into account demographic effects:

UNEMP: Unemployment rate

DUNEMP: Change in Unemployment rate

DIVOR: Divorce Rate

TOTPART: Total Labour Participation rate

MALPART: Male Participation rate

FEMPART: Female Participation rate

D.RATE: Death rate

LIFEEXP: Percentage of Death 65+ in Total Death

LIT.RATE: Literacy rate

0-14ADR: Age Dependency Ratio of 0-14 years old

65+ADR: Age Dependency Ratio of 65 years of age and above

TAGEDR: Total Age Dependency Ratio

POP0-19: The % of the population which is aged between 0 and 19.

POP15-19: The % of the population which is aged between 15 and 19.

POP20-24: The % of the population which is aged between 20 and 24.

POP20-34: The % of the population which is aged between 20 and 34.

POP25-34: The % of the population which is aged between 25 and 34.

POP20-64: The % of the population which is aged between 20 and 64.

POP20-44: The % of the population which is aged between 20 and 44.

POP25-34: The % of the population which is aged between 25 and 34.

POP35-44: The % of the population which is aged between 35 and 44.

POP45-64: The % of the population which is aged between 45 and 65.

POP64+: The % of the population which is aged 64+.

Clearly, combinations of these variables are perfectly collinear, so relevant subsets were tried in various regressions (available from the author).

3. 5. b. Current account deficit (CAD/Y): The current account deficit is defined as the total export of goods and services minus total import of goods and services. The current account deficit to GNP (both in current prices) ratio was used as an additional variable.

3. 5. c. Foreign deficit (FDEF/Y): Foreign deficit is defined as the sum of deficit in the trade of goods and services plus net factor income from abroad. The ratio of foreign deficit to GNP, both in current prices was used as an additional variable and it was found to be insignificant in all cases. However, Uygur (1993) found FDEF/Y-1 to be negative and significant.

3. 5. d. Monetary Depth (M2/GNP and/or PrCREDIT/GNP): Broad Money (M2) to GNP (M2/GNP) ratio is used as a financial wealth variable, since the variable substantially increased after 1983 when the residents (and non-residents) were allowed to open foreign exchange deposits with the commercial banks. They contain an element of the negative income effect and a negative redistribution effect which are

observed when real deposit rates rise. Furthermore, they constitute a substantial part of the financial wealth in developing countries.

I also included total credits to the private sector as a percentage of GNP (**PrCREDIT/GNP**) for an easing of credit market conditions facing households.

The use of Credit Cards (**CrCARDS**) in order to take into account consumer credit delinquencies is left out in this model, since with the 100% inflation environment Turkish consumers do not use Credit Cards as much as they are used in the Western Countries and the US.

3. 5. e. Income Uncertainty (Yunc): *Yunc* which is a 3-year moving standard deviation of the change in Real Private Disposable Income is used as a measure of income uncertainty. The mean of this variable is MA4DY where MA4 denotes a 4 year moving average from t-3 to t.

3. 5. f. Government deficit (GDEF/Y): I tried to incorporate the effect of heavy public sector borrowing from the financial markets by using the government deficit (Government Revenues - Government Expenditure) to GNP ratio (in current prices) as an additional variable.

3. 5. g. The Distributional Indicator: The ratio of non-wage income (YK) to wage-income (YL) within the non-agricultural sector is used to take into account the income inequality.

However, none of the additional variables in this section had a significant effect on explaining the average propensity to consume in Turkey in the equations to which they were added.³¹

4. THE GENERAL TO SPECIFIC APPROACH AND ECONOMETRICS RESULTS

In our general model we used the average propensity to consume (Log of the per capita real private consumption [LPCRCna] minus log of the per capita real private disposable income [LPCRYna]) as the dependent variable. When we do the following estimation we find consumption and income not to be cointegrated but the coefficient on per capita real disposable income to be close to unity (see, Figure 8.3 for the time series). LPCRYna is a regressor and no restrictions are imposed.

Modelling LPCRCna by OLS
The present sample is: 1963 to 1994

Variable	Coefficient	Std.Error	t-value	t-prob	PartR 2	Instab
Constant	0.15317	0.14548	1.053	0.3014	0.0381	0.15
LPCRCna_1	0.89134	0.10923	8.160	0.0000	0.7040	0.15
LPCRYna	0.97055	0.078994	12.286	0.0000	0.8435	0.15
LPCRYna_1	-0.88906	0.12458	-7.137	0.0000	0.6453	0.15

R2 = 0.987559 F(3,28) = 740.85 [0.0000] SEE= 0.0280314 DW = 1.83
 RSS = 0.02200121552 for 4 variables and 32 observations

Solved Static Long Run equation

$$\begin{aligned} \text{LPCRCna} &= +1.41 && +0.75 \text{ LPCRYna} \\ (\text{SE}) & (1.285) && (0.2017) \\ \text{ECM} &= \text{LPCRCna} - 1.40964 - 0.749983 * \text{LPCRYna}; \end{aligned}$$

Tests on the significance of each variable

Variable	F-test	Value	Probability	Unit-root t-test
LPCRCna	F(1, 28) =	66.593	[0.0000] **	-0.99481
Constant	F(1, 28) =	1.1084	[0.3014]	
LPCRYna	F(2, 28) =	75.928	[0.0000] **	0.85156

In fact, the final model contains several additional non-stationary variables and Figure 8.2 shows a trend in C/Y, so this result is expected. We test for cointegration in the final congruent model.

³¹ The results are available from the author.

We start with a general model which is probably over-parameterised with two lags for both average propensity to consume (LAPCna) and income (LPCRYna) and a broad set of explanatory variables (population aged 15-44 (POP15-44), housing wealth to income ratio (HtoYt), the inflation rate (INF), the real short-term interest rates (RSir) and a dummy variable (D)).

Inflation rate (\dot{P}_t) is defined as $\frac{P_t - P_{t-1}}{P_{t-1}}$ where P_t is CPI (1987=1) and the

real short term interest rates is defined as $LRSir = \left[\log \left(\frac{1+R_t}{1+\dot{P}_t} \right) \right]$ where R_t is the

nominal interest rates on three months time deposits. The dummy variable is used for the outliers in 1976=1 and 1978=-1 which are the same magnitude but are in opposite directions.³²

EQ(1) Modelling LAPCna by OLS
The present sample is: 1964 to 1994

Variable	Coefficient	Std. Error	t-value	t-prob	PartR 2	Instab
Constant	2.3876	0.34220	6.977	0.0000	0.7644	0.05
LAPCna_1	0.25372	0.11550	2.197	0.0442	0.2434	0.05
LAPCna_2	-0.24506	0.11294	-2.170	0.0465	0.2389	0.05
LPCRYna	0.025289	0.038527	0.656	0.5215	0.0279	0.05
LPCRYna_1	0.12128	0.073418	1.652	0.1193	0.1539	0.05
LPCRYna_2	-0.043923	0.062124	-0.707	0.4904	0.0323	0.05
LRSir	0.31277	0.13899	2.250	0.0399	0.2524	0.12
LRSir_1	0.55083	0.15736	3.500	0.0032	0.4496	0.13
INF	0.14191	0.044659	3.178	0.0062	0.4023	0.04
INF_1	0.16130	0.057702	2.795	0.0136	0.3425	0.05
POP15-44	-2.4942	1.6742	-1.490	0.1570	0.1289	0.05
POP15-44_1	-0.37758	2.4852	-0.152	0.8813	0.0015	0.05
POP15-44_2	-4.8538	2.0647	-2.351	0.0328	0.2692	0.05
HtoYt_1	0.095989	0.031282	3.069	0.0078	0.3856	0.05
HtoYt_2	-0.053067	0.031395	-1.690	0.1116	0.1600	0.06
D	-0.046724	0.0085559	-5.461	0.0001	0.6653	0.03

R2 = 0.985228 F(15,15) = 66.694 [0.0000] SEE = 0.0108689 DW = 2.08
 RSS = 0.001771980644 for 16 variables and 31 observations

Instability tests, variance: 0.13594 joint: 2.33521
 Information Criteria: SC = -7.99726; HQ = -8.49613; FPE = 0.000179103

AR 1- 2 F(2, 13) = 0.070741 [0.9321]
 ARCH 1 F(1, 13) = 0.30162 [0.5922]
 Normality Chi 2(2) = 4.7711 [0.0920]
 RESET F(1, 14) = 1.1665 [0.2984]

³² Although there is a big structural change in 1980, the dummy for 1980 was found to be insignificant.

The slightly weird effect in the standard errors of the lagged income variable suggests a model in levels and differences of income. However, the income elasticity of consumption is not equal to 1 so we use the inverse of PCRYna (=1000/PCRYna), denoted OTOYna, which converges asymptotically to a unit elasticity (see, Figure 8.10). OTOYna attributes the fall in C/Y to the rise in Y such that the income elasticity of expenditure is unity only in an equilibrium with very high income levels, otherwise is less than unity.

EQ(2) Modelling LAPCna by OLS
The present sample is: 1964 to 1994

Variable	Coefficient	Std.Error	t-value	t-prob	PartR 2	Instab
Constant	3.1230	0.34595	9.027	0.0000	0.8274	0.05
LAPCna_1	0.24977	0.10862	2.300	0.0344	0.2373	0.05
LAPCna_2	-0.27116	0.10211	-2.656	0.0166	0.2932	0.05
LRSir	0.31835	0.13371	2.381	0.0292	0.2501	0.11
LRSir_1	0.56614	0.14461	3.915	0.0011	0.4741	0.10
INF	0.14451	0.042663	3.387	0.0035	0.4029	0.04
INF_1	0.16030	0.055056	2.912	0.0097	0.3327	0.04
POP15-44	-1.7126	1.5643	-1.095	0.2889	0.0659	0.05
POP15-44_1	-1.0488	2.3508	-0.446	0.6611	0.0116	0.05
POP15-44_2	-4.9448	1.8803	-2.630	0.0176	0.2892	0.05
HtoYt_1	0.089782	0.026787	3.352	0.0038	0.3979	0.05
HtoYt_2	-0.038860	0.020359	-1.909	0.0733	0.1765	0.06
D	-0.045087	0.0078875	-5.716	0.0000	0.6578	0.03
OTOYna_1	-0.060376	0.013380	-4.513	0.0003	0.5450	0.06

R2 = 0.984573 F(13,17) = 83.457 [0.0000] SEE = 0.0104334 DW = 1.97
 RSS = 0.001850531995 for 14 variables and 31 observations

Instability tests, variance: 0.142125 joint: 2.15739
 Information Criteria: SC = -8.17544; HQ = -8.61194; FPE = 0.000158015

AR 1- 2 F(2, 15) = 0.0022138 [0.9978]
 ARCH 1 F(1, 15) = 0.41648 [0.5284]
 Normality Chi 2(2) = 2.3965 [0.3017]
 RESET F(1, 16) = 1.2073 [0.2881]

Solved Static Long Run equation

LAPCna = +3.058	+0.866 LRSir	+0.2984 INF
(SE)	(0.1655)	(0.07624)
	(0.3872)	(0.009979)
	(0.01902)	
-7.545 POP15-44	+0.04986 HtoYt	-0.04414 D
-0.05911 OTOYna		
(0.01195)		

ECM = LAPCna - 3.05761 - 0.865968*LRSir - 0.298423*INF
 + 7.54478*POP15-44 - 0.0498561*HtoYt + 0.0441425*D
 + 0.0591119*OTOYna;

WALD test Chi2(6) = 513.44 [0.0000] **

Tests on the significance of each variable				
Variable	F-test	Value	Probability	Unit-root t-test
LAPCna	F(2, 17) =	4.4046	[0.0288]	*
Constant	F(1, 17) =	81.495	[0.0000]	**
LRSir	F(2, 17) =	28.509	[0.0000]	**
INF	F(2, 17) =	25.253	[0.0000]	**
POP15-44	F(3, 17) =	35.283	[0.0000]	**
HtoYt	F(2, 17) =	5.6363	[0.0132]	*
D	F(1, 17) =	32.675	[0.0000]	**
OTOYna	F(1, 17) =	20.363	[0.0003]	**

Tests on the significance of each lag			
Lag	F-test	Value	Probability
1	F(6, 17) =	20.568	[0.0000]
2	F(3, 17) =	5.5992	[0.0074]

Tests on the significance of all lags up to 2			
Lag	F-test	Value	Probability
1- 2	F(9, 17) =	17.834	[0.0000]
2- 2	F(3, 17) =	5.5992	[0.0074]

It is immediately clear that this set cointegrates.³³

There are a few steps in the reduction of the final model from the above general specification:

EQ(3) Modelling LAPCna by OLS
The present sample is: 1966 to 1994

Variable	Coefficient	Std.Error	t-value	HCSE	PartR 2	Instab
Constant	2.2915	0.21267	10.775	0.30544	0.8530	0.03
DLAPCna_1	0.22023	0.081233	2.711	0.067396	0.2687	0.05
DHtoYt_1	0.045350	0.015874	2.857	0.015662	0.2898	0.20
MAPOP15-44	-5.6267	0.48496	-11.602	0.68959	0.8706	0.03
MARSir	0.49209	0.11499	4.280	0.16007	0.4780	0.03
MAINF	0.16999	0.038283	4.440	0.051479	0.4964	0.02
D	-0.047190	0.0072881	-6.475	0.0018469	0.6770	0.03
OTOYna_1	-0.036093	0.010019	-3.603	0.011957	0.3935	0.04
INFunc_2	0.12370	0.033622	3.679	0.042352	0.4036	0.02

R2 = 0.982134 F(8,20) = 137.43 [0.0000] SEE = 0.0100422 DW = 2.50
 RSS = 0.002016934711 for 9 variables and 29 observations

Instability tests, variance: 0.0588519 joint: 0.934563
 Information Criteria: SC = -8.52845; HQ = -8.81989; FPE = 0.000132144

AR 1- 2	F(2, 18) =	2.0916	[0.1525]
ARCH 1	F(1, 18) =	0.19904	[0.6608]
Normality	Chi 2(2) =	3.917	[0.1411]
Xi 2	F(16, 3) =	0.31601	[0.9467]
RESET	F(1, 19) =	1.1618	[0.2946]

The 3-year moving average of the population aged 15-44 (MAPOP15-44), the 2-period moving average of the real interest rates (MARSir) and the 2-period moving average of inflation (MAINF) are used to simplify the general model to a more

³³ PcGive unit-root test is used.

parsimonious representation. INFunc-2 is a 3-period moving standard deviation of inflation lagged 2 periods, which represents the inflation uncertainty [see, Muellbauer and Murphy (1993a, 1993b), Hendry *et al.* (1990), Hendry (1994) and Lattimore (1994)]. The mean of this variable is MA4INF, where MA4 denotes 4 year moving average from t-3 to t (see Figure 8.5).

Formulating in terms of deviations from means (denoted by m), the final model is:

EQ(4) Modelling LAPCna by OLS
The present sample is: 1966 to 1994

Variable	Coefficient	Std.Error	t-value	HCSE	PartR 2	Instab
Constant	-0.16301	0.0019222	-84.807	0.0021374	0.9972	0.03
DLAPCnam_1	0.22023	0.081233	2.711	0.067396	0.2687	0.06
DHtoYtm_1	0.045350	0.015874	2.857	0.015662	0.2898	0.20
MAPOP15-44m	-5.6267	0.48496	-11.602	0.68959	0.8706	0.05
MARSirm	0.49209	0.11499	4.280	0.16007	0.4780	0.05
MAINFm	0.16999	0.038283	4.440	0.051479	0.4964	0.04
D	-0.047190	0.0072881	-6.475	0.0018469	0.6770	0.03
OTOYnam_1	-0.036093	0.010019	-3.603	0.011957	0.3935	0.05
INFuncm_2	0.12370	0.033622	3.679	0.042352	0.4036	0.06

R2 = 0.982134 F(8,20) = 137.43 [0.0000] SEE = 0.0100422 DW = 2.50
 RSS = 0.002016934711 for 9 variables and 29 observations

Instability tests, variance: 0.0588519 joint: 0.934563
 Information Criteria: SC = -8.52845; HQ = -8.81989; FPE = 0.000132144

AR 1- 2 F(2, 18) = 2.0916 [0.1525]
 ARCH 1 F(1, 18) = 0.19904 [0.6608]
 Normality Chi 2(2) = 3.917 [0.1411]
 Xi 2 F(16, 3) = 0.31601 [0.9467]
 RESET F(1, 19) = 1.1618 [0.2946]

LAPCna
 Sample size 33: 1962 to 1994
 Mean -0.163378

The model has no lagged dependent variable, but white-noise errors so LAPC, OTOYnam, MAPOPm MARSir100m, MAINFm and INFuncm must cointegrate. Figure 8.11 shows the actual and fitted values of the final model. Figure 8.12 records the recursively estimated coefficients.

It is apparent that this final model "over-fits" with the SEE of only 1%, then the question arises if consumption and income are measured badly, why do we still get such good results?

We find that measurement errors to be co-integrated: Thus, $I(1)$ measurement errors on the levels must cointegrate to $I(0)$ if the observed series are to cointegrate in the same way as the latent variables when the measurement errors are $I(0)$ on growth rates. Nowak (1990) calls a failure to observe the observed series to cointegrate when the cointegrated latent series is $I(0)$ a problem of hidden cointegration. We believe that consumption and income are likely to have connected measurement errors and that the SIS and SPO correct the data (the national accounts) on such series, in a related way to avoid divergence, which suggests an $I(0)$ measurement error for the ratio of them. When we generated housing wealth, we saw the same result in a constructed example.

The specific model (Equation 4) is a valid reduction, in the sense that it does not contradict the general model. Thus, the model is both congruent and parsimoniously encompasses the general model as well as the previous work on Turkish consumption, (see, section 6 in this Chapter). $OTOY_{nam}$, $MAPOP15-44m$, $MARS_{irm}$, $MAINF_m$ and INF_{uncm} are the mean removed values of $OTOY_{na}$, $MAPOP15-44$, $MARS_{ir}$, $MAINF$ and INF_{unc} . Hence, we find the constant to be quite close to the mean value of the LAPC, which represents the long-run solution in this equation.

In this subsection, I attempted to derive a more rigorous and wide-ranging foundation for the solved out aggregate consumption function, in the spirit of Ando and Modigliani (1963) and of Stone (1964, 1966). Apart from the changes in wealth

effects, the other explanations for the increase in saving rate are demography, changes in uncertainty, habit formation, and the direct effects of financial liberalisation.

I adopted a conventional treatment of demography by entering a linear term in the percentage of population aged between 15 and 44. The advantage of the age distribution data used in this model is that there is a considerable variation in the age-distribution data over the sample period. Thus, there was a good chance of picking up the effects of the changing age distribution on coefficient in the equation. Currie *et al.* (1989), Fair and Dominguez (1991) and Lattimore (1994) find that the demographics reflect life cycle phenomena.³⁴ That is, young people with currently low incomes but high income expectations and life-cycle needs, consume a high proportion of income, middle-aged cohorts save in anticipation of a lower income in retirement, and old people dissipate their stocks of accumulated savings – generating a hump-shaped life-cycle savings profile. The demographic effects estimated for Turkey are implausibly large in magnitude. As in other developing countries, Turkey faces the prospects of an increasing population of the young (aged 15-44) and a decreasing relative population of children. The effect of the young will dominate over the next years so that demographics will decrease the consumption to income ratio in Turkey. However, the coefficient here may reflect unmodelled factors. Moreover, while both the dependent variable and the demographic variable are trending, the relationship is not spurious. This could be explained by two arguments: one is Phillips (1986) type of nonsense regression: but the equation has white noise errors. The other one is recursive estimation: although the recursive estimation of Equation 4 is constant, the recursive estimation of the age distribution variable on the dependent variable is not

³⁴ See also, Heien (1972), Blinder (1975), Denton and Spencer (1976), Lieberman and Watchel (1980) and Auerbach and Kotlikoff (1989).

constant [see, Engle and Hendry, 1993]. Thus, the effect of the age-distribution on consumption is genuine rather than a coincidence.

The real interest rate, which was low in the 1970s and rose in the 1980s is a proxy for financial liberalisation in Turkey. This could induce a positive association with consumption: Muellbauer (1994); and Murata (1994). Empirically, there is some tendency to find small negative influences of real interest rates on consumption, but they are not stable when re-estimated over different samples (see, Chapter 2 for the theoretical relationship). Muellbauer and Murphy (1993a, 1993b) find a negative real interest rate effect for the US, negative but somewhat smaller importance in the UK. Lattimore (1994) omits the interest rate, because of its insignificance in Australia. These studies use consumers' expenditure on non-durables and services as a consumption variable and personal disposable income as an income variable, whereas we used total private consumption as a consumption variable and private disposable income as an income variable in the above model.

The inflation rate has a positive and significant effect on the average propensity to consume in Turkey. The impact of inflation on private saving is separated into the effects of expected inflation and unexpected inflation. Expected inflation is used with the suggestion that households adjust their perceived disposable income downward as expected capital losses on their assets increase. On the other hand, expected inflation may lead to higher spending on consumer durables in developing countries in the absence of adequately indexed financial instruments. They assume that the impact of unexpected inflation on private saving would be positive according to the involuntary saving hypothesis of Deaton (1977).³⁵ The

³⁵ Thus, the signs of the coefficients of inflation and expected inflation are indeterminate, whereas the unexpected inflation is positive in private saving models.

previous studies generally have found a significant negative effect of inflation on consumption [see, DHSY (1978), HUS(1981), Hendry (1983b), Hendry *et al.* (1990) and Hendry (1994)]. However, again they use consumers' expenditure on non-durables and services as a consumption variable and personal disposable income as an income variable, whereas we used total private consumption as a consumption variable and private disposable income as an income variable in the above model.

If marginal utility is convex, an increase in risk will increase marginal utility so that current consumption will have to decrease in order to bring the current marginal utility back into equality. Therefore, saving responds positively to uncertainty and consumption can be made to track income over the life-cycle. Fiscal policies that do not change expected life time resources can have large effects on consumption and consumers will typically behave as if they discount the future. Precautionary motives can account for large wealth holdings and they can explain why people hold a mixed portfolio of assets even where some assets dominate others in both mean and variance. However, the coefficient on 'the inflation uncertainty' has a positive and significant effect on Turkish consumption. This could be explained by 'impatience', the nature of Turkish inflation and consumption of durable goods in Turkey. If impatience is stronger, then consumers would typically want to consume today. Impatience keeps the buffer stocks small thereby providing a possible explanation of why many households save little throughout their life. Additionally, inflation in Turkey is chronic. Turkey has had high inflation periods over the years, but once inflation reaches 100%, necessary measures are taken to stabilise inflation, especially with the assistance of the international organisations. Turkish consumers believe that inflation will never be higher than today, but will be lower. Therefore, it is not surprising to see that the Turkish consumers spend on durable goods when

inflation is high and when there is availability of spreading the payment over a long term with interest-free credit. We can also interpret this result as when inflation is high, preferences over durable goods dominate risk aversion. If we exclude the inflation uncertainty from the model, the coefficient on the core inflation increases by the same amount as the coefficient as the inflation uncertainty variable.

I find a significant change in wealth effect. However, relatively illiquid assets such as housing have a marginal effect on expenditure compared to liquid assets such as broad money (M2/Y). We find a positive wealth effect of illiquid assets. This confirms the role of asset values in contributing to the determination of consumer expenditure. The demand for non-housing consumption will be affected by the price of housing. A permanent change in the price of housing, after which the relative prices of non-housing and housing consumptions are expected to remain fixed, has two effects: One is a positive wealth effect for those with housing wealth and the other is a negative combined income and substitution effect from facing a higher house price. For those without housing wealth, there is no wealth effect so that the negative effect remains. The smaller the proportion of people who are not owner-occupiers but have aspirations in that direction, the more the wealth effect dominates at the aggregate level. In Turkey, 70.5% of households own a house in 1994. Furthermore, ownership of housing is positively correlated with income levels. While only 52% of low income families own a house, 77% of upper income families can afford a house. One might expect non-owner-occupiers to save more when real house prices rise. Furthermore, increases in real house prices tend to redistribute wealth between young households and older households, since the young have typically accumulated less housing wealth. Younger households may have smaller MPCs to spend out of housing wealth, this redistribution adds to the aggregate saving decision.

It is also important to note the difference between housing wealth increases and house price increases. The accumulation of owner-occupied housing capital through investment and the transfer of publicly-owned housing into private hands are household wealth increases that do not rest on increases in real prices. Such increases have clearly positive expenditure implications. Although, there is little empirical evidence on the scale of the effect of housing wealth on consumption, and what evidence does exist is open to several different interpretations, Muellbauer and Murphy (1990) find a strong link between rising UK house values and consumers' expenditure. However, King (1990) and Pagano (1990) are sceptical that the relation reflects a causal link from changes in house values to consumption. Carruth and Henley (1990) argue that the under-prediction of the boom in consumer spending over the critical three year period up to end of 1987 by the DHSY model [Davidson *et al.* (1978)] can be eliminated once the omission of housing wealth effects from the model is corrected. Miles (1994) finds evidence that house-price effects on spending had become more significant in the 1980s and argued that this was consistent with a collateral enhancement interpretation of how price increases work, but was harder to see as a pure wealth effect. Lattimore (1994) and Murata (1994) show that there is strong evidence for the negative real house-price effect which partly offsets the positive wealth effect of illiquid assets including housing. They both report that it is otherwise hard to get sensible wealth effects for these countries. This negative real land-price effect, proxying a house-price effect, is the major reason why the Japanese household saving rate did not fall substantially at the time of the 1980s asset price boom. There is evidence for a weaker, but significant, effect of this type for UK regions, Muellbauer and Murphy (1994). However, the effect is not significant for UK aggregate data, Muellbauer and Murphy (1993b), and the poor quality of house

price data before 1963 limits testing for such effect for the US, Muellbauer and Murphy (1993a).

A positive effect on current consumption of lagged consumption can represent the effects of expectation, habits or adjustment costs.

5. FORECASTING PERFORMANCE

The forecast evaluation of the final model is as follows:

Modelling LAPCna by OLS

The present sample is: 1966 to 1994 less 6 forecasts
The forecast period is: 1989 to 1994

Variable	Coefficient	Std.Error	t-value	HCSE	PartR 2	Instab
Constant	-0.16298	0.0030838	-52.850	0.0043172	0.9950	0.03
DLAPCnam_1	0.29440	0.11304	2.604	0.080562	0.3264	0.36
DHtoYtm_1	0.037732	0.019815	1.904	0.017812	0.2057	0.19
MAPOP15-44m	-5.2969	0.83040	-6.379	0.81937	0.7440	0.05
MARSirm	0.44230	0.15310	2.889	0.20682	0.3735	0.05
MAINFm	0.15379	0.051398	2.992	0.067104	0.3901	0.04
OTOYnam_1	-0.032697	0.013799	-2.369	0.011736	0.2862	0.05
INFuncm_2	0.13392	0.044202	3.030	0.063693	0.3960	0.05
D	-0.045961	0.0083533	-5.502	0.0018546	0.6838	0.04

R2 = 0.943899 F(8,14) = 29.444 [0.0000] SEE = 0.0113685 DW = 2.53
RSS = 0.001809407085 for 9 variables and 23 observations

Instability tests, variance: 0.129202 joint: 1.34275
Information Criteria: SC = -8.22332; HQ = -8.5559; FPE = 0.000179817

Analysis of 1-step forecasts

Date	Actual	Forecast	Y-Yhat	Forecast SE	t-value
1989 1	-0.220337	-0.230268	0.00993077	0.0158305	0.627317
1990 1	-0.238152	-0.222934	-0.0152178	0.0182387	-0.834370
1991 1	-0.263186	-0.260578	-0.00260842	0.0178566	-0.146077
1992 1	-0.279911	-0.280540	0.000629552	0.0199331	0.0315832
1993 1	-0.312611	-0.306550	-0.00606052	0.0214909	-0.282004
1994 1	-0.313693	-0.314037	0.000343352	0.0217985	0.0157512

Tests of parameter constancy over: 1989 to 1994

Forecast Chi 2(6) = 2.8957 [0.8218]
Chow F(6, 14) = 0.26762 [0.9431]

While based on part of the estimation sample, the outcome is consistent with a constant model (see, Figure 8.13).

6. ENCOMPASSING

Encompassing tests evaluate one model against rival models to see if they embody specific information excluded from the model under test (see, Chapter 3 for a more detailed analysis of Encompassing). Thus, the contending model must encompass previous empirical models of the dependent variable. In this section we apply encompassing tests to the models estimated by Rittenberg (1988) and Uygur (1993) and to my model (Equation 3 in Section 4)³⁶.

Rittenberg (1988, pg. 122) estimates a Private Savings function for Turkey for the 1963-1985 period where the dependent variable is the ratio of private savings to private disposable income (PrS/PrY) and the regressors are the log of real private disposable income ($LRPrY$), the growth of real private disposable income ($DLRPrY$), the real short-term deposit rate ($RSir$), the ratio of foreign savings to private disposable income ($FDEF/PrY$), the ratio of public savings to private disposable income (PuS/PrY), a dummy variable equal to 1 for 1981 ($D1981$) and a dummy variable equal to 1 for 1982-1986 ($D82-86$). The dummies have particular importance in Rittenberg's equation as without them other variables are insignificant.

We estimate Rittenberg's model with the dependent variable from her data set (PrS/PrY) and from my data set (SOY) for the period 1963-1985. In fact, $LAPCna = \log(1 - SOY) \cong -SOY$ is such a close approximation here that essentially identical estimates resulted from the two dependent variables (up to all digits reported), so only those from Rittenberg's dependent variable need be recorded. We find the following results:

³⁶ We also consider encompassing Celasun and Tansel's (1993) model with my model, however, their dependent variable is Private Savings in levels so that it is not compatible with my model.

Table 8. 1: Rittenberg's (1988) Model with the dependent variable from Rittenberg's data set (PrS/PrY) (identical to my data set, SOY) (1963-1985)

	MODEL 1A (PrS/PrY) = MODEL 1B (SOY)	
Variables	Coefficient	t-value
Constant	-0.729	-2.25
LRPrY	0.078	2.66
DLRPrY	-0.052	-0.48
Rsir	0.101	1.33
FDEF/PrY	-0.146	-0.53
PuS/PrY	-0.011	-0.03
D1981	-0.066	-2.23
D1982-86	-0.094	-3.02
R2	0.56	
F(7, 15)	2.72 [0.049]	
SEE	0.0188	
DW	1.58	
AR1-2 F(2, 13)	0.94 [0.41]	
ARCH-1 F(1, 13)	0.007 [0.93]	
Norm. Chi2 (2)	3.40 [0.18]	
RESET F(1, 14)	0.04 [0.84]	

The results are exactly the same for Rittenberg's model with the dependent variable from her data set and from my data set. I replicated the results for my model with the dependent variable from Rittenberg's data set and from my data set and find:

Table 8. 2: My Model with the dependent variable from Rittenber's data set (PrS/PrY) (identical to my data set, SOY) (1966-1985)

	MODEL 1C (PrS/PrY) = MODEL 1D (SOY)	
Variables	Coefficient	t-value
Constant	-1.44	-1.94
DLAPCna-1	-0.21	-2.74
DHtoYt-1	-0.01	-0.45
MAPOP15-44	3.68	2.21
MARSir	-0.29	-1.65
MAINF	-0.11	-2.05
D	0.039	6.97
OTOYna-1	0.015	0.63
INFunc-2	-0.12	-1.15
R2	0.93	
F(8, 11)	16.89 [0.00]	
SEE	0.0075	
DW	2.86	
AR1-2 F(2, 9)	2.19 [0.16]	
ARCH-1 F(1, 9)	0.25 [0.63]	
Norm. Chi2 (2)	1.09 [0.58]	
RESET F(1, 10)	0.51 [0.49]	

The results are exactly the same with dependent variables from the different sources. We estimate joint models for the models 1A and 1C, and also for the models 1B and 1D.

Table 8. 3: The Joint Model with the dependent variable from Rittenberg's data set (PrS/PrY) (identical to my data set, SOY) (1966-1985)

Variables	MODEL 1E (PrS/PrY) = MODEL 1F (SOY)	
	Coefficient	t-value
Constant	-0.276	-0.299
LRPrY	-0.070	-0.290
DLRPrY	0.048	0.204
Rsir	-0.013	-0.148
FDEF/PrY	0.039	0.211
PuS/PrY	-0.037	-0.550
D1981	-0.036	-0.876
D1982-86	-0.158	-1.983
DLAPCna-1	-0.087	-0.828
DHtoYt-1	0.049	1.426
MAPOP15-44	3.033	0.496
MARSir	0.084	0.149
MAINF	-0.085	-0.659
D	0.031	4.354
OTOYna-1	-0.079	-0.598
INFunc-2	0.309	1.446
R2	0.98	
F(15, 4)	10.75 [0.02]	
SEE	0.00707	
DW	2.50	
AR1-2 F(2, 2)	1.58 [0.39]	
ARCH-1 F(1, 2)	0.29 [0.64]	
Norm. Chi2 (2)	0.83 [0.66]	
RESET F(1, 3)	0.16 [0.72]	

As the rival theories have collinear explanations some variables are insignificant in the nesting model. However, Rittenberg's set can be deleted without loss from mine. This result is clearer with the whole sample estimation; also, the dummy variable for 1982-1986 becomes insignificant, see Table 8.4.

Table 8. 4: The Joint Model with the dependent variable from Rittenberg's data set (PrS/PrY) (identical to my data set, SOY) (1966-1994)

	MODEL 1G (PrS/PrY) = MODEL 1H (SOY)	
Variables	Coefficient	t-value
Constant	-1.339	-2.224
LRPrY	-0.098	-1.231
DLRPrY	0.123	1.273
R _{sir}	-0.045	-0.666
FDEF/PrY	-0.004	-0.042
PuS/PrY	0.013	0.356
D1981	0.044	1.774
D1982-86	0.016	0.486
DLAPC _{na-1}	-0.211	-3.032
DH _{toYt-1}	-0.033	-1.969
MAPOP15-44	6.067	5.755
MARS _{ir}	-0.523	-1.703
MAINF	-0.202	-3.163
D	0.040	6.126
OTOY _{na-1}	-0.039	-0.704
INFunc-2	-0.075	-2.219
R ²	0.99	
F(15, 13)	73.47 [0.00]	
SEE	0.0082	
DW	2.31	
ARI-2 F(2, 11)	0.67 [0.53]	
ARCH-1 F(1, 11)	0.06 [0.81]	
Norm. Chi2 (2)	4.71 [0.09]	
RESET F(1, 12)	1.13 [0.30]	

We test the reductions from the joint models with the dependent variable from Rittenberg's data set, model 1E, to Rittenberg's model 1A and to my model 1C, which are identical to the reductions from the joint model with the dependent variable from my data set, model 1F, to Rittenberg's model 1B and to my model 1D.

$$\text{Model 1E} \rightarrow \text{1A: } F(8, 4) = 6.9696 [0.0391]^*$$

$$\text{Model 1E} \rightarrow \text{1C: } F(7, 4) = 1.2059 [0.4532]$$

The results of the encompassing F-tests indicate that the reductions to my model from the joint models are accepted, whereas the reductions to Rittenberg's model are rejected. Hence, my model is able to explain the results of Rittenberg's model.

Uygun (1993, pg. 39) estimates the following model for the 1965-1990 period where the dependent variable is the ratio of private savings to private disposable income (SP/PY) and the regressors are *per capita* real private disposable income (PYP), the growth of real private disposable income (GYP), the real one-year deposit interest rate (RIR), the ratio of total time deposits to GNP (RTD), the share of private housing investment in total private investment (SHI), and the ratio of the foreign deficit to GNP (RFD). We estimate Uygun's model with the dependent variable from his data set (PS/PY) and from my data set (SOY) for the period 1965-1990 and find the following results:

Table 8. 5: Uygun's (1993) Model with the dependent variable from Uygun's data set (PS/PY) and from my data set (SOY) (1965-1990)

Variables	MODEL 2A (PS/PY)		MODEL 2B (SOY)	
	Coefficient	t-value	Coefficient	t-value
Constant	-0.045	-1.799	-0.057	-1.850
PYP	0.144	7.157	0.113	4.476
GYP	0.308	3.968	0.393	4.044
RIR	0.043	1.297	-0.004	-0.099
RTD-1	-0.443	-2.933	-0.238	-1.258
SHI-1	0.126	2.340	0.181	2.676
RFD-1	-0.387	-2.035	-0.139	-0.582
R2	0.89		0.83	
F(6, 19)	25.43 [0.00]		15.51 [0.00]	
SEE	0.0136		0.0171	
DW	1.96		1.74	
AR1-2 F(2, 17)	2.32 [0.128]		2.08 [0.155]	
ARCH-1 F(1, 17)	1.46 [0.244]		1.77 [0.201]	
Norm. Chi2 (2)	4.21 [0.12]		2.52 [0.284]	
RESET F(1, 18)	0.19 [0.66]		0.66 [0.426]	

The dependent variables in the above models differ: as in private communication with Uygun, he confirms that he collected the data from different sources, not all of which are in the public domain. If his form of model is fitted to the published data (SOY) (Model 2B), the results significantly change; however, if my form of model is fitted to his data set (PS/PY) (Model 2C), the results do not change apart from DLAPCna-1 and DHtoYt-1 -- as income and consumption measures

should be modified given the different dependent variable (even without doing that, the model performs well).

Table 8. 6: My Model with the dependent variable from Uygur's data set (PS/PY) and from my data set (SOY) (1966-1990)

Variables	MODEL 2C (PS/PY)		MODEL 2D (SOY)	
	Coefficient	t-value	Coefficient	t-value
Constant	-1.898	-5.921	-1.941	-7.803
DLAPCna-1	-0.068	-0.697	-0.192	-2.524
DHtoYt-1	-0.027	-1.368	-0.035	-2.314
MAPOP15-44	4.691	6.426	4.795	8.461
MARSir	-0.365	-2.400	-0.430	-3.365
MAINF	-0.131	-2.548	-0.148	-3.728
D	0.042	4.830	0.040	6.050
OTOYna-1	0.030	2.361	0.031	3.061
INFunc-2	-0.103	-2.350	-0.101	-3.011
R2	0.93		0.96	
F(8, 16)	25.15 [0.00]		44.50 [0.00]	
SEE	0.0118		0.0092	
DW	1.69		2.51	
AR1-1 F(2, 14)	0.114 [0.89]		1.91 [0.18]	
ARCH-1 F(1, 14)	0.762 [0.39]		0.38 [0.55]	
Norm. Chi2 (2)	1.268 [0.53]		1.98 [0.37]	
RESET F(1, 15)	5.879 [0.03]		6.15 [0.03]	

The results of the joint models show that the additional variables from Uygur's model are insignificant if added to my model. Furthermore, the constants in the joint models are closer to the constants in my models.

Table 8. 7: The Joint Model with the dependent variable from the Uygur's data set (PS/PY) and from my data set (SOY) (1966-1990)

Variables	MODEL 2E (PS/PY)		MODEL 2F (SOY)	
	Coefficient	t-value	Coefficient	t-value
Constant	-2.128	-2.533	-1.611	-1.646
PYP	0.072	0.997	0.084	1.001
GYP	-0.176	-1.421	-0.216	-1.495
RIR	0.080	1.777	0.047	0.906
RTD-1	-0.247	-1.320	0.137	0.628
SHI-1	0.178	2.534	0.196	2.383
RFD-1	-0.012	-0.076	0.284	1.575
DLAPCna-1	-0.258	-3.565	-0.283	-3.345
DHtoYt-1	-0.005	-0.350	-0.026	-1.530
MAPOP15-44	5.127	2.316	3.738	1.449
MARSir	-0.755	-2.971	-0.637	-2.149
MAINF	-0.315	-3.464	-0.261	-2.457
D	0.041	6.088	0.045	5.655
OTOYna-1	0.0007	0.042	0.015	0.730
INFunc-2	0.051	1.126	-0.005	-0.099
R2	0.99		0.98	
F(14, 10)	48.022 [0.00]		36.318 [0.00]	

SEE	0.0067	0.0078
DW	2.95	2.57
AR1-1 F(1, 9)	10.11 [0.11]	2.41[0.15]
ARCH-1 F(1, 8)	0.197 [0.67]	0.038 [0.85]
Norm. Chi2 (2)	2.869 [0.24]	3.65 [0.16]
RESET F(1, 9)	0.053 [0.83]	1.70 [0.22]

We test the reductions from the joint models with the dependent variable from Uygur's data set, model 2E to Uygur's model 2A and to my model 2C, and also test the reductions from the joint model with the dependent variable from my data set, model 2F to Uygur's model 2B and to my model 2D.

$$\text{Model 2E} \rightarrow \text{2A: } F(8, 10) = 8.4671 [0.0014]**$$

$$\text{Model 2E} \rightarrow \text{2C: } F(6, 10) = 6.7117 [0.00461]**$$

$$\text{Model 2F} \rightarrow \text{2B: } F(8, 10) = 10.089 [0.0007]**$$

$$\text{Model 2F} \rightarrow \text{2D: } F(6, 10) = 2.0496 [0.1510]$$

The results of the encompassing F-tests indicate that although the reductions from the joint model 2E to my model (2C) are rejected due to differences between the dependent variable and the income and consumption measures of regressors, the reductions from the joint model 2F to my model (2D) are accepted. However, the reductions to Uygur's models (2A and 2B) are rejected in both cases.

These results show that my model is able to encompass the results of the two rival models, furthermore my model is *structural* as it is invariant over extensions of the information set (adding more variables).

7. CONCLUSIONS

The modelling suggests that housing wealth, demographic factors (precautionary savings, uncertainty and borrowing constraints³⁷), inflation and inflation uncertainty, the real interest rates, habits and/or adjustment costs (LAPC-1), and the trend factor (OTOYnam) are important in explaining short run movements in the average propensity to consume, while the constant of the equation represents the long run solution. The model is both congruent and parsimoniously encompasses the general model as well as the previous work on Turkish consumption. The residuals are also innovations against the available information.

Furthermore, the constancy of a conditional model (average propensity to consume) in the face of a changing marginal process (the real interest rates, inflation, etc.) entails that agents do not use expectations models to predict future values of relevant decision variables, because in practice contingent planning dominates forward-looking behaviour. Furthermore, agents may form expectations without using models, but use data-based predictors, perhaps because of high costs of information collection and processing.

8. COMMENTS, DISCUSSION AND FUTURE RESEARCH

I presented Chapter 8 at Nuffield College, Oxford, and at the Central Bank of Turkey, Ankara, as well as at Bilkent University, Ankara. I received many useful comments and suggestions and set out the most important here. There is a correlation between short-term real interest rates and inflation before 1980, since nominal interest

³⁷ Young risk-averse Turkish agents cannot borrow freely to consume in advance of future income, this induces a motive for holding assets (a buffer-stock theory of saving) to shield consumption against unpredictable fluctuations in income. However, no data is available on credit constraints.

rates were fixed before 1980. Thus, the model in Chapter 8 cannot be estimated for the period before 1980, if we wish to include both real interest rates and inflation. The interest rate in the model, which is the interest rate on three month time deposits was the main selection for the appropriate interest rates for the consumption function for Turkey. The Turkish academics strongly argued that the Treasury Bill Rate should have been used in the model instead of the interest rate on three month time deposits, since the Treasury Bill Rate has been positive in real terms compared to the real interest rates on three month time deposits. Despite the Treasury Bill Rate not being available for the period before 1986 there are opportunities for future research: a new Consumption Function for Turkey could be constructed with the quarterly SIS data, which commenced from 1987, using the Treasury Bill Rate and interest rate on three month time deposits. We may even encompass the annual model constructed in Chapter 8, which uses interest rates on three month time deposits, with the quarterly model, which uses two different interest rates.

The population aged 15-44 is used to capture the effects of the demographic factors for Turkey. We allowed 2 lags for the general model and the lag structure was tested and accepted by the model. The Turkish academics argued that I should have used 5 lags of the population aged 15-44 in order to take into account 'exits' and 'enters'. However, the actual variable used was a three-year moving average.

They agreed to the finding of a positive strong effect from the demographic factor on Private Saving in Turkey. There is child-labour in Turkey, which makes the age of the working population younger than the Western Countries; as this combines with an earlier retirement we can say that the population aged 15 to 44 effectively represents the working population of Turkey.

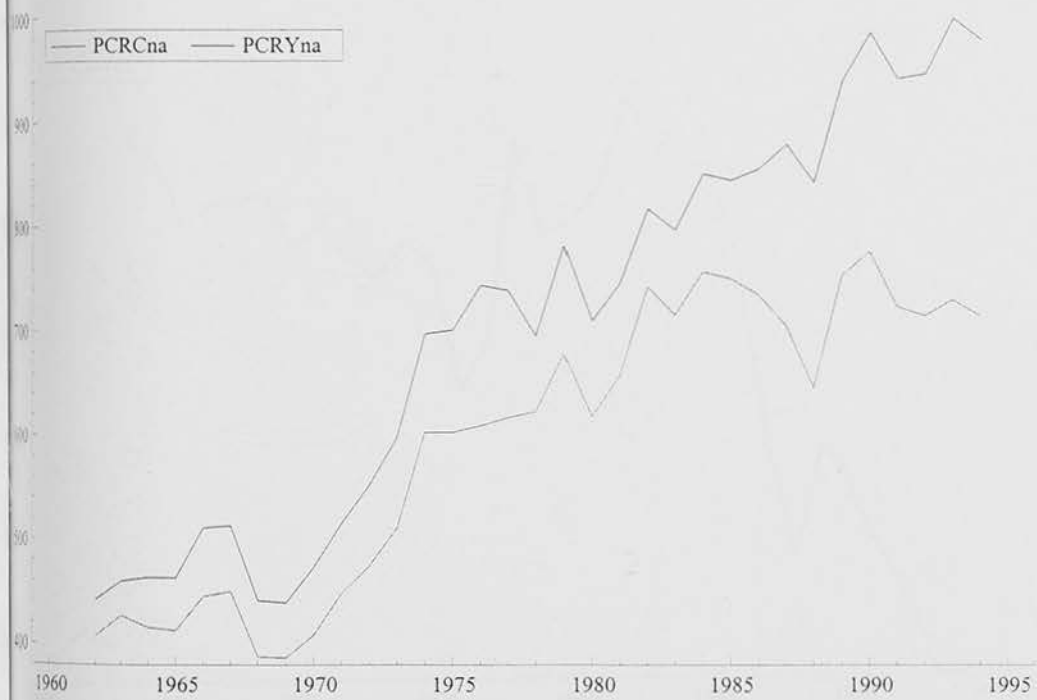


Figure 8. 1: Per Capita Real Private Consumption and Per Capita Real Private Disposable Income



Figure 8. 2: Ratio of Per Capita Real Private Consumption to Per Capita Real Private Disposable Income



Figure 8. 3: Log of the Ratio of Per Capita Real Private Consumption to Per Capita Real Private Disposable Income

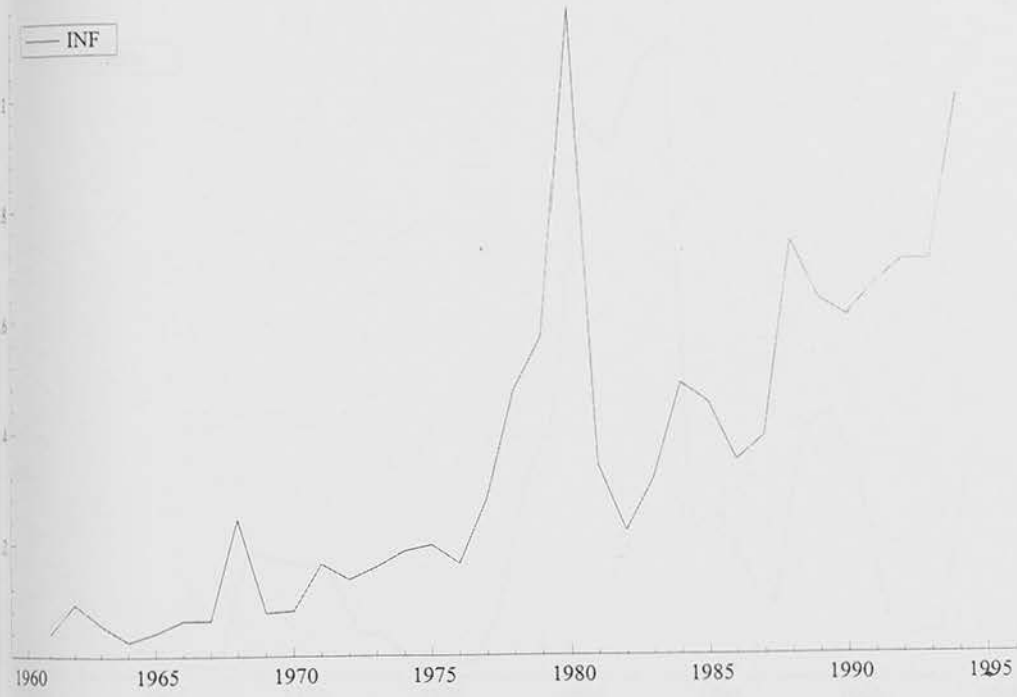


Figure 8. 4: Inflation

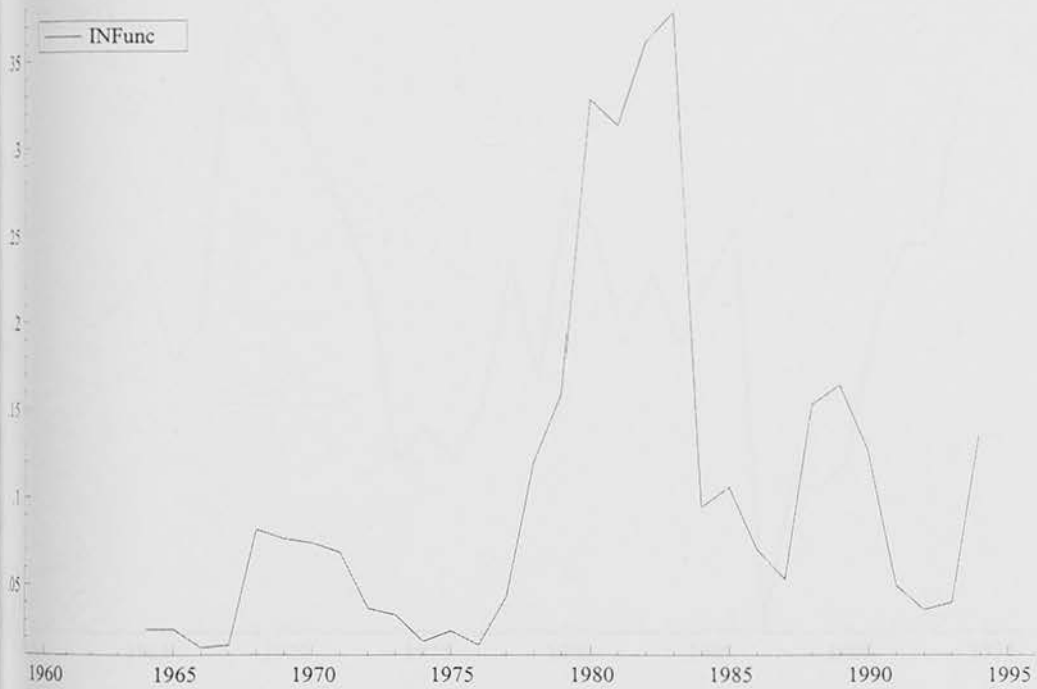


Figure 8. 5: Inflation Uncertainty

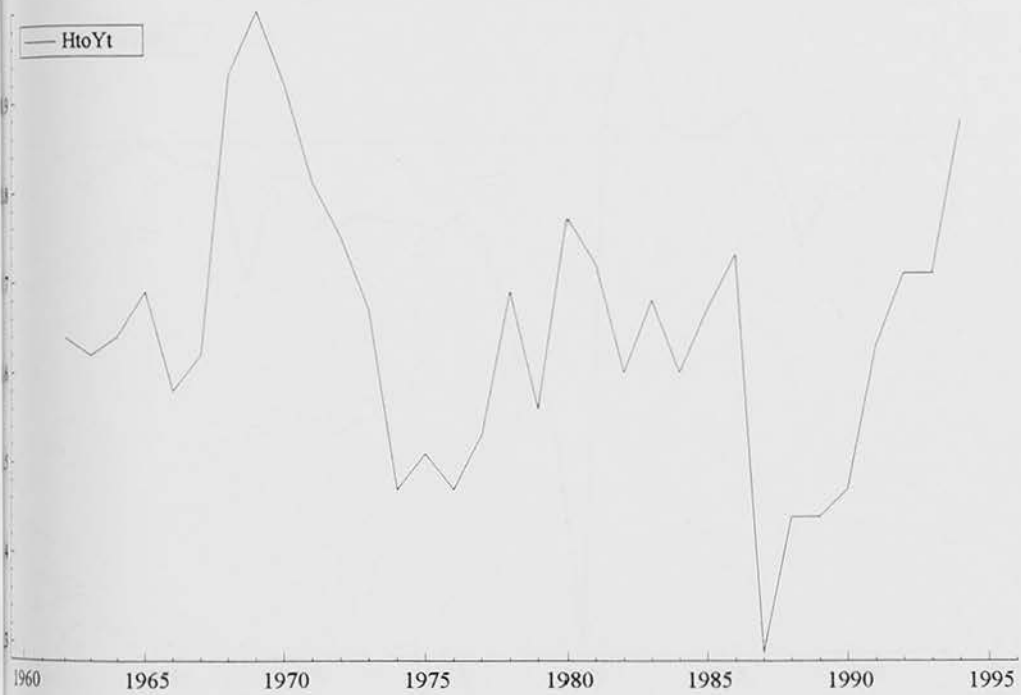


Figure 8. 6: Housing Wealth to Income Ratio

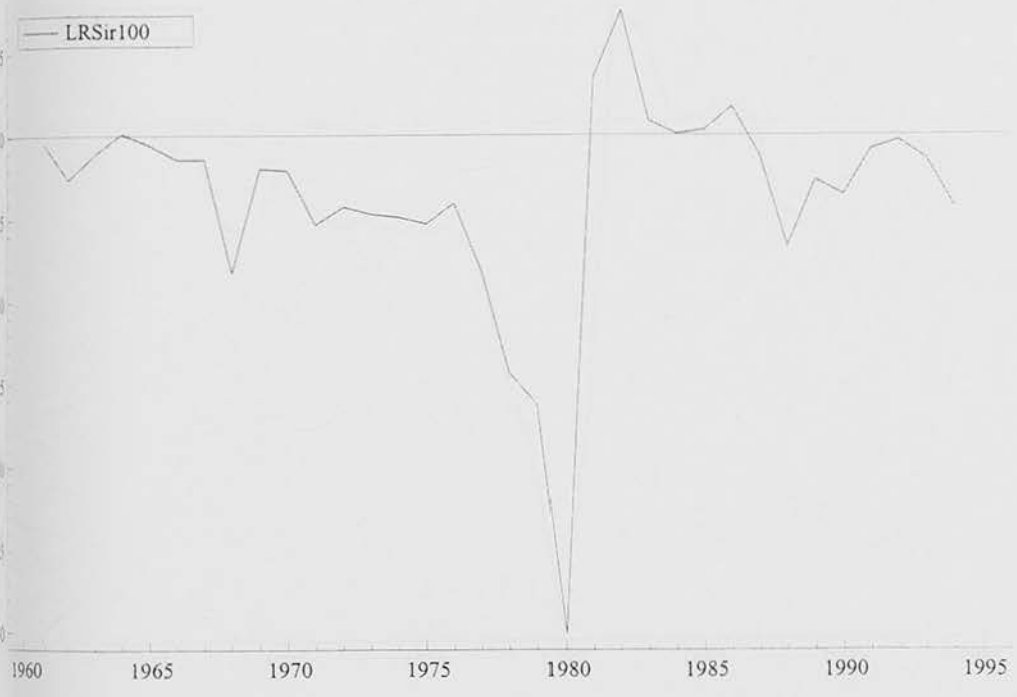


Figure 8. 7: Real Short Term Interest Rates

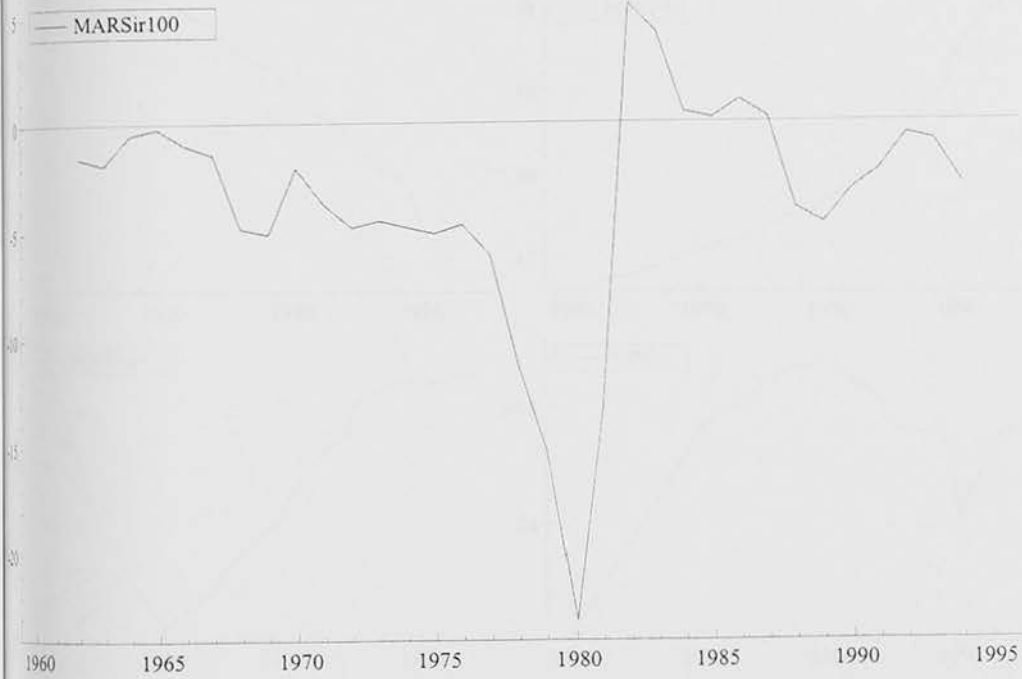


Figure 8. 8: 2 Year Moving Average of Real Short Term Interest Rates

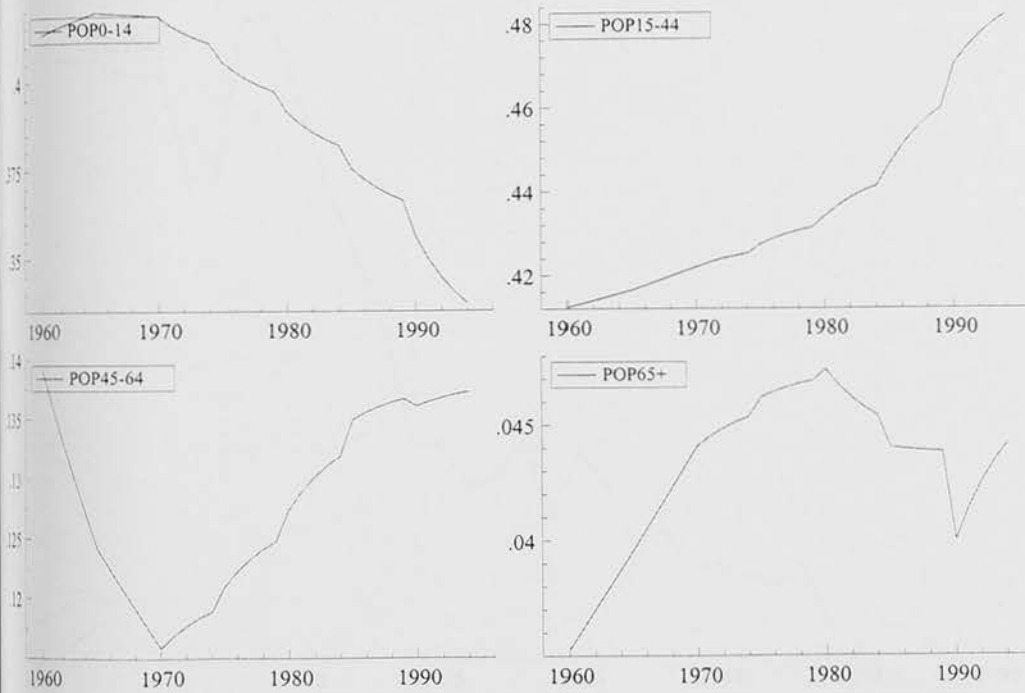


Figure 8. 9: Population Aged 0 and 14 (POP0-14), Population Aged 15 and 44 (POP15-44), Population Aged 45 and 64 (POP45-64) and Population Aged 65+ (POP65+)

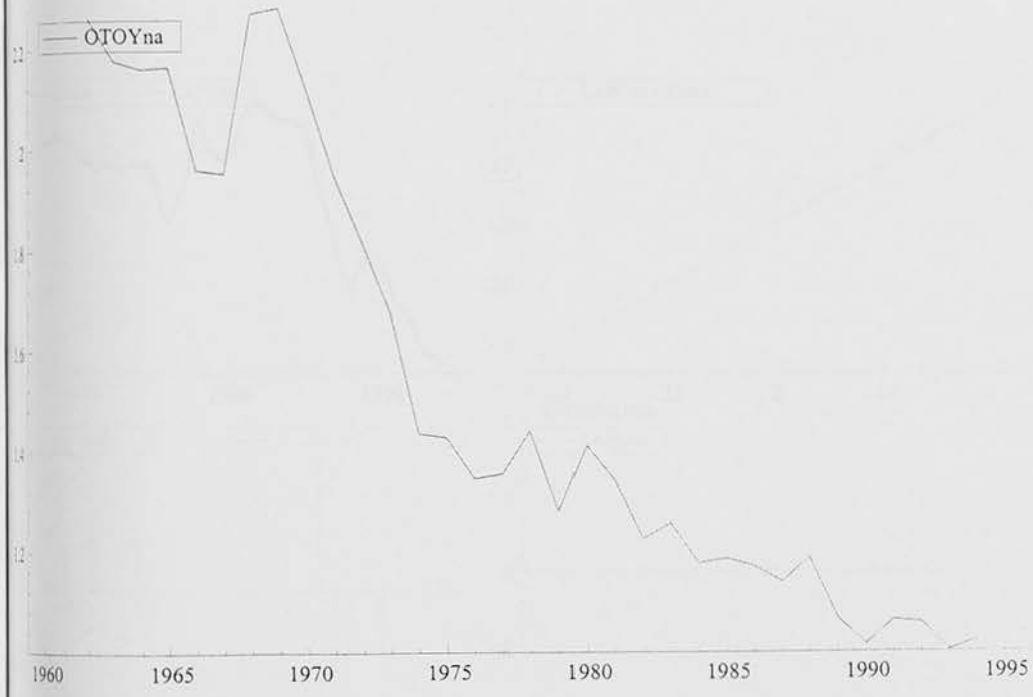


Figure 8. 10: 1000/ Per Capita Real Private Disposable Income

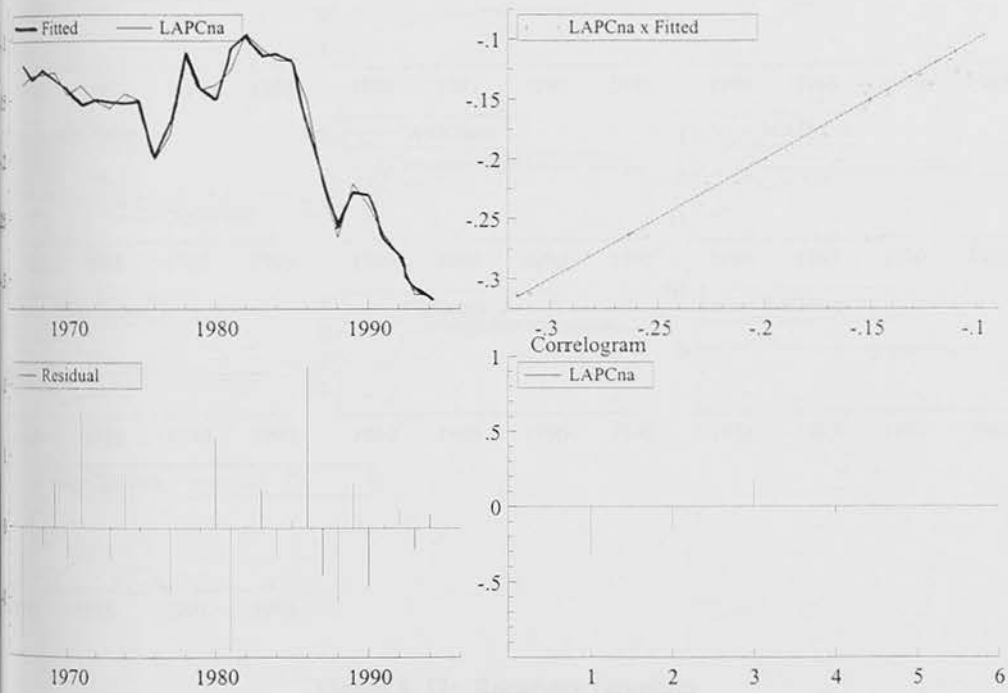


Figure 8. 11: Actual and Fitted Values of the Average Propensity to Consume

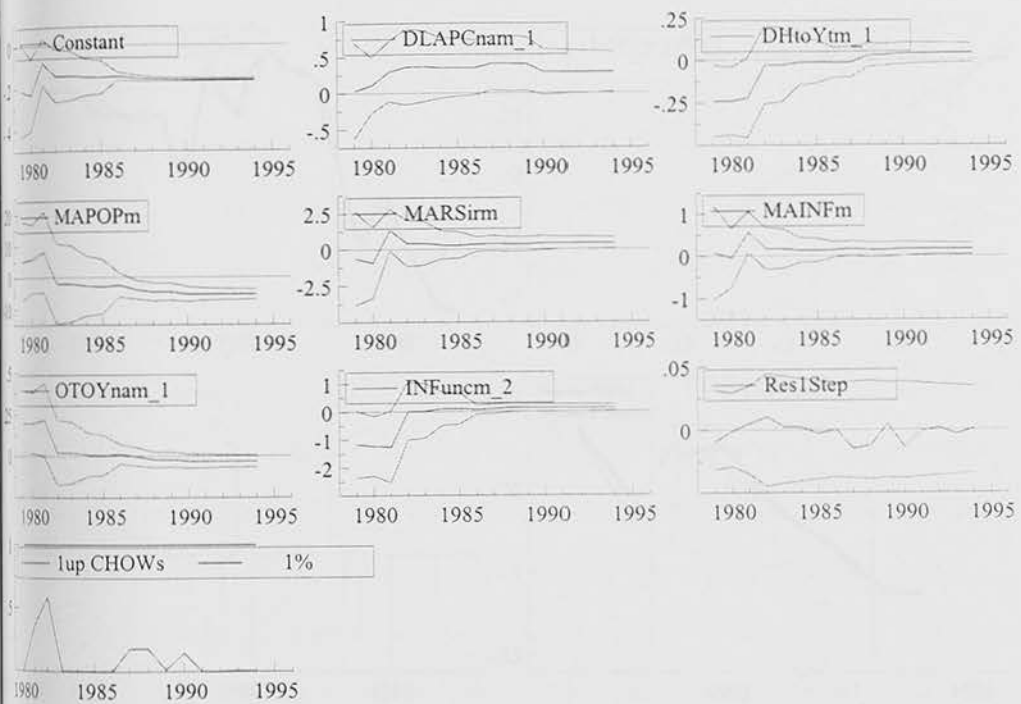


Figure 8.12: Recursive Graphics

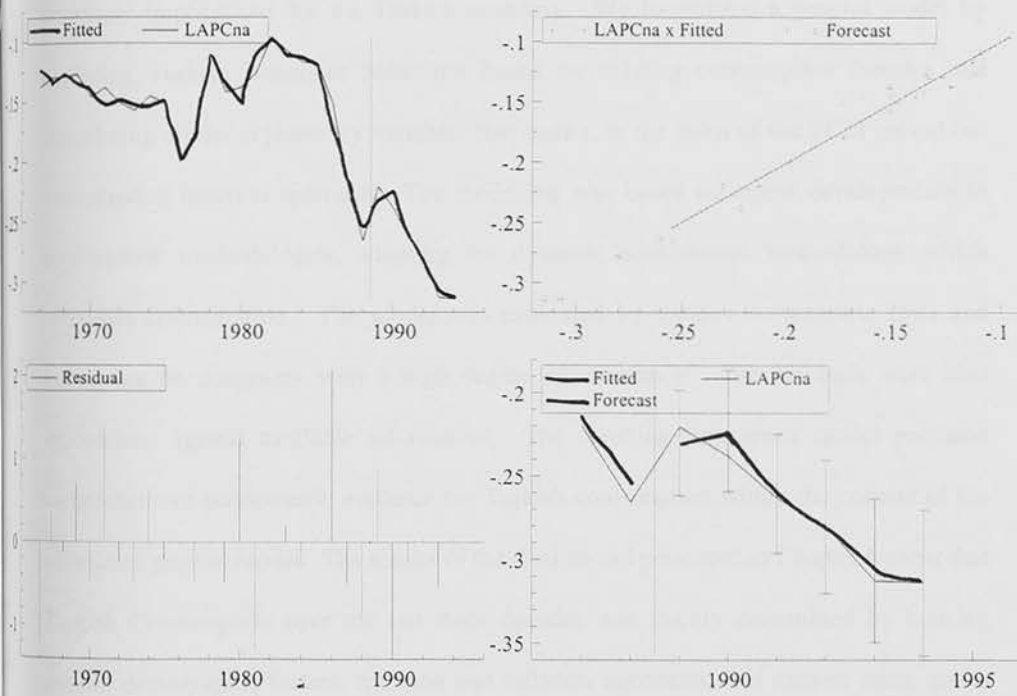


Figure 8. 13: Forecast Graphics

Chapter 9:

CONCLUSIONS

In this thesis, we examined the Turkish Consumption function, which has important implications for the Turkish economy. We formulated a general model by exploring Turkish consumer behaviour based on existing consumption theories and considering all the explanatory variables that matter, in the spirit of the ECM solved out consumption function approach. The modelling was based on recent developments in econometric methodologies, adopting the dynamic econometric methodology which embodies cointegration. The model was evaluated by various econometric tests and turned out to be congruent with a high degree of constancy. The residuals were also innovations against available information. The resulting time-series model provided comprehensive econometric evidence for Turkish consumption within the context of the postulated general model. The results of the final model presented in Chapter 8 show that Turkish Consumption over the last three decades was mainly determined by housing wealth, demographic factors, inflation and inflation uncertainty, real interest rates, habits and/or adjustment costs and a trend factor (inverse income). The constant of the equation represented the long-run solution. These effects have meaningful and interesting economic interpretations, which capture the main aspects of consumer behaviour over the three decades in Turkey, and yield some policy implications as explored in Chapter 8.

We started the thesis with a literature survey on the theory of consumption in Chapter 2 to provide a theoretical basis for the research. Especially, the Life Cycle

hypothesis/Permanent-Income hypothesis and Euler approach are discussed and their various extensions are reviewed. Theory can deliver ideas about permanent relationships in economics, but it should be supported by empirical findings, since theory alone is insufficient to determine the actual economic relationship. Hence, Chapter 3 focuses on theoretical and applied modelling issues to construct a theory-consistent, congruent and encompassing consumption function.

The small-sample properties of the data are investigated in Chapter 4 by using Monte Carlo simulations. In this framework, an unrestricted VAR considered with small-samples of noisy data combined with a high real growth rate and nominal inflation. The effects of different ratios of intercepts relative to standard deviations, which determine the relative growth and error co-variances against zero as the baseline are taken into account. This is to see how the relative drift dominates in explaining the informativeness of the data, or to explore the possibility of learning more from high variance data in a system. The sample size effects considered are for $T=40$, 80 and $T=500$, the last to check for a close match with known asymptotic theory results.

We summarise the results by using response surfaces to relate the biases to sample size and to the design variables, and we also look at the ratio of standard deviations to standard errors in each equation. The importance of high variances in VARs is shown by the impacts of the system error variances in these response surfaces.

The Monte Carlo results show that actual biases are small for $I(0)$ and $I(1)$ effects, but SE's are large for intercepts. Cointegration effects are well determined, but SE's less accurate in the first equation studied for both $I(0)$ and $I(1)$ effects. We found a large

impact of the noise, and of a function of the signal to noise ratio, and cross-equation correlation, but less effect from the relative drift.

Results from Chapter 4 show that in terms of better determination of the constant terms, the equilibrium-correction model (ECM) seems preferable to the VAR; the insignificance of the irrelevant dynamics indicates that the marginalisation step must be taken in econometric modelling, supporting the approach of dynamic econometric methodology, that incorporates parsimonious modelling, which is used in estimating the consumption function for Turkey in Chapter 8.

Chapter 5 is an overview of Turkey's economic development, especially over the sample period, 1960-1994. It makes broad references to its institutional and economic structural characteristics, especially giving an emphasis on private savings behaviour.

The Turkish data not only suffers from unreliability and inconsistency but also missing observations. Chapter 6 constructs housing wealth data by using the available information on the housing stock or total number of households; this data has been published by the SIS every five years since 1960. The data used included: the CPI index; nominal private disposable income; and nominal private investment in the housing sector. We intended to develop a model that gave a housing stock series which was consistent with the published data. The generated series uses several identities and a recursive calculation assuming various ratios for the initial conditions and growth rates. Combinations of these are selected to match the intermittent observed time series. We also found that the nominal housing stock and nominal wealth are cointegrating subject to the real housing stock (Official figures), since the measurement errors are cointegrating by construction.

We started by constructing a data-base and analysing the Turkish National Accounts in Chapter 7. We constructed the GDP by expenditure component from five different resources. The three measures of GDP – expenditure, output and income are found not to have the same results due to the measurement errors which ‘creep in’ at the various stages of the calculations. Sefton and Weale (1995) suggest that the problem of data inconsistency can be solved by applying the concept of reliability to the income/expenditure components and this method is used to allocate the corrections across the series which make up the national accounts. The linear regression approach is applied for allocating Turkish accounting residuals. The results show that the GDP-by-output measure is more reliable than the GDP-by-expenditure measure for Turkey. However, the expenditure measure has the largest mean growth rate. In addition, its standard deviation is also the largest, indicating relative information in the data. Thus, if the income and expenditure measures are believed to provide better indicators of long-run trends, this result is not surprising. Furthermore, given the very small residuals between output and expenditure measures and the strong correlation between the average and balanced estimates, the quality of the expenditure measure of *GDP* should be treated cautiously. Nevertheless, the large drop in the consumption-to-income ratio in the late 1980s is a genuine drop rather than mis-measurement. These results are also consistent with our findings in Chapter 8 that consumption (an expenditure component of *GDP*) and income (an output component of *GDP*) data are corrected by the SPO in a related way to avoid divergence, which suggests an $I(0)$ measurement error for the ratio between them.

Chapter 8 was devoted to time series modelling and evidence. The results of the finally selected time-series model presented in Chapter 8 can be summarised as: The

average propensity to consume in Turkey is mainly determined by income, housing wealth, population aged 15-44, inflation and inflation uncertainty, short-term real interest rates on time deposits and lagged consumption, that represents the effects of expectations, habits or adjustment costs. One-period lagged inverse *per capita* private disposable income explains the fall in C/Y by the rise in Y , such that the long-run income elasticity of expenditure is unity, but only in an equilibrium with very high income levels - otherwise it is less than unity.

The percentage of population aged between 15 and 44 is found to have a strong negative effect on private consumption in Turkey. There was a good chance of picking up the effects of the changing age distribution on coefficients in the equation due to a big variation in the age-distribution data over the sample period. An increasing population of the young (aged 15-44) and a decreasing relative population of children in Turkey mean that the effect of the young will dominate in the short term so that demographics will decrease the consumption to income ratio in Turkey. However, the coefficient here may reflect unmodelled factors. A positive association of real interest rates with consumption can be explained by financial liberalisation. In terms of the standard micro-economic argument, a strong positive real interest rate effect points to a traditional income effect outweighing the traditional substitution effect. This indicates the developments in the real asset markets after 1980, since before 1980 this date, interest rates had been almost constant.

The inflation rate as well as inflation uncertainty both have positive and significant effects on the average propensity to consume in Turkey. The private consumption data includes durable as well as non-durable consumer expenditure. Hence,

if we consider the possibility of buying durable goods over a year with an interest-free instalment then it will not be surprising to find a positive association of inflation with consumption. Thus, inflation will lead to higher spending on consumer durables in developing countries in the absence of adequately indexed financial instruments. The positive and significant effect of inflation uncertainty is explained by 'impatience', the nature of Turkish inflation and consumption of durable goods.

I find a significant change-in-wealth effect. The value of 0.037 for the change in housing wealth to income ratio is consistent with the ECM solved-out approach, suggesting that consumption is related to life-cycle wealth. This result suggests that Turkish consumers behaves as is suggested by the LCH, as described in Chapter 2. A positive effect on current consumption of lagged consumption can represent the effects of expectations, habits or adjustment costs. However, the constant of the equation represents the long-run solution.

One of the most important implications of the empirical model is that the rational expectations hypothesis (REH) is incorrect. Under the REH, forecasting next period's price level (or inflation rate) is straightforward, assuming that everyone is making the fullest use of all available information about the structure of the economy and the policy measures of the government so that there are no systematic errors in making price forecasts. However, it was impossible for Turkish consumers or at least for some, to correctly project the inflation rate in Turkey over the last three decades, since perfect information has been unavailable.

As discussed in Chapter 3, one of the main objectives of the empirical model is that it should be useful for policy analysis. Thus, the finding of the strong positive effects

of inflation and interest rates on consumption should be analysed in the policy context. The first suggestion would be that inflation control should be strengthened and improved for consumption stabilisation. In particular, higher spending on durable goods, when inflation is high, and if the payment is spread over a long period, suggests that financial instruments should be indexed adequately. Furthermore, interest rate policy also has an important role to play. Although the adjustments to the short-term nominal interest rates on time deposits have been small in magnitude, so that the real interest rate has been dominated by the inflation rate, the adjustments to other interest rates, such as Treasury bill rate and overnight interest rates have been large in magnitude giving rise to a large portfolio choice. This explains why private agents in Turkey do not "panic spend" when facing high inflation and the real interest rates, since the real interest rates correctly reflect inflation and nominal assets do not get eroded when inflation is high. However, as suggested by some endogenous growth theories, a higher saving rate may also generate more investment via lower interest rates, if international capital markets are imperfect, and hence more growth, suggesting a low lending rate is needed in order to increase productive investments.

The ratio of the last observation in 1994 of nominal consumption of roughly 1,800,000 million TL to the first observation in 1962 of 45 million TL, is more than 40,000 fold; the log ratio is almost 11. An explanation of consumption behaviour must account for such enormous growth. Here, the final model has a standard error of under 2 *per cent* of consumption, or 0.02 in log terms, which is relatively constant over 30 years - and much of that is measurement error. The reason for such good results is explained in Chapter 8 with hidden cointegration. Thus, I(1) measurement errors on the levels must

cointegrate to $I(0)$ if the observed series are to cointegrate in the same way as the latent variables when the measurement errors are $I(0)$ on growth rates. Nowak (1990) calls a failure to observe the observed series to cointegrate when the cointegrated latent series is $I(0)$ a problem of hidden cointegration. We believe that consumption and income are likely to have connected measurement errors and that the SIS and SPO correct the data (the national accounts) on such series, in a related way to avoid divergence, which suggests an $I(0)$ measurement error for the ratio of them. When we generated housing wealth, we saw the same result in a constructed example.

Thus, neither theory alone nor empirical evidence alone are an adequate basis for determining how economic agents behave. We have attempted to use both together in this thesis to glean whatever conclusions are feasible. The match between them must increase our confidence in both – since conflicts could have occurred but did not appear sufficiently important to induce rejection.

APPENDIX A

JOHNSON'S MATCHING LIKELIHOOD METHOD OF ESTIMATING AND TESTING FOR COINTEGRATING VECTORS

APPENDICES

APPENDIX 3. A

JOHANSEN'S MAXIMUM LIKELIHOOD METHOD OF ESTIMATING AND TESTING FOR COINTEGRATING VECTORS

Within the framework of Engle and Granger there is no means of addressing questions concerning the number of cointegrating vectors that may exist between a set of variables. Also, the limiting distributions of the test statistics are non-standard and typically of low power so that one might be wary of accepting the unit root null that the variables in question do not cointegrate. Johansen (1988) suggests a method that enables all the cointegrating vectors that exist in statistics to be well-defined and invariant limiting distributions. Hence, testing for cointegration is facilitated by this approach. Furthermore, the Johansen procedure enables restrictions on the cointegrating vectors to be easily tested.

Johansen (1988) defines a general polynomial distributed lag model of a vector of variables X as:

$$A(L)X_t = \varepsilon_t \quad (\text{A.1})$$

where $A(L)$ is a $(k+1)$ order polynomial in L , X_t is $p \times 1$ and ε_t is NID $(0, \Omega)$. If there are unit roots in $|A(L)|$, then $A(1) = I - A_1 - A_2 \dots - A_k$, the long-run or cointegrating matrix, is of less than full rank. The rank of $A(1)$, denoted r , is the number of linearly independent cointegrating vectors. The model can be reformulated as:

$$\Delta X_t = \Pi_1 \Delta X_{t-1} + \dots + \Pi_{k-1} \Delta X_{t-k+1} + \Pi_k X_{t-k} + \varepsilon_t \quad (\text{A.2})$$

where

$$\Pi_i = -I + A_1 + \dots + A_i, \text{ or } I - \Pi_1 - \Pi_2 - \dots - \Pi_k = \Pi \quad i=1 \text{ to } k$$

and

$$-\Pi_k = \Pi = A(1)$$

which gives an explicit parameterisation to the cointegrating matrix that embodies the cross equation restrictions of the cointegrating vectors. We may denote $A(1)=A$ for simplicity.

The existence of r cointegrating vectors can be formulated as the hypothesis that

$$H_0: \Pi = \alpha\beta' \text{ where } \alpha, \beta \text{ are } p \times r \text{ matrices.} \quad (\text{A.3})$$

The rows of β are the *cointegrating vectors*. The columns of α are the *loading vectors*, where each element weights each cointegrating vector in a particular equation.

Johansen derives the likelihood ratio test for the hypothesis given by (A.3) and derives the maximum likelihood estimator of the cointegration space. Then he finds the likelihood estimator of the cointegrating space is restricted to lie in a certain subspace, representing the linear restrictions that one may want to impose on the cointegrating vectors. The estimation of β is performed by first regressing ΔX_t and X_{t-k} on the lagged differences. From the residuals of these $2p$ regressions we calculate a $2p \times 2p$ matrix of product moments. It is shown that the estimate of β is the empirical canonical variate of X_{t-k} with respect to ΔX_t , corrected for the lagged differences.

The likelihood ratio test is now a function of certain eigenvalues of the product moment matrix corresponding to the smallest squared canonical correlations. The test of the linear restrictions involve yet another set of eigenvalues of a reduced product moment matrix. The asymptotic distribution of the first test statistic involves an

integral of a multivariate Brownian motion with respect to itself, and turns out to depend on just one parameter which can be tabulated by simulation. The second test statistic is asymptotically distributed as χ^2 with the proper degrees of freedom.

The method of estimation is to concentrate the likelihood function with respect to the free parameters Π_I , $I=1$ to $k-1$, by regressing

$$\Delta X_t \text{ on } \Delta X_{t-1}, \Delta X_{t-2}, \dots, \Delta X_{t-k+1}$$

$$X_t \text{ on } \Delta X_{t-1}, \Delta X_{t-2}, \dots, \Delta X_{t-k+1}$$

to give residual vectors R_{0t} and R_{kt} respectively.

The likelihood function can then be written as being proportional to

$$L(\alpha, \beta, \Omega) = |\Omega|^{-T/2} \exp\left\{-\frac{1}{2} \sum_{t=1}^T (R_{0t} + \alpha\beta'R_{kt})' \Omega^{-1} (R_{0t} + \alpha\beta'R_{kt})\right\} \quad (\text{A.4})$$

which can be maximised over α and Ω for fixed β , by regressing R_{0t} on $-\beta'R_{kt}$.

The first order conditions are set to be zero, that is:

$$\frac{\partial \log L}{\partial \Omega} = 0 \text{ and } \frac{\partial \log L}{\partial \alpha} = 0$$

Expressions for $\hat{\alpha}(\beta)$ and $\hat{\Omega}(\beta)$ can be derived in terms of the product moment matrices of the residuals,

$$S_{ij} = T^{-1} \sum_{t=1}^T R_{jt} R_{it}' \quad i, j = 0, k$$

written as:

$$\hat{\Omega}(\beta) = S_{00} - S_{0k} \beta (\beta' S_{kk} \beta)^{-1} \beta' S_{k0} \quad (\text{A.5})$$

$$\hat{\alpha}(\beta) = -S_{0k} \beta (\beta' S_{kk} \beta)^{-1}. \quad (\text{A.6})$$

By substitution of $\hat{\Omega}(\beta)$ and $\hat{\alpha}(\beta)$ in the concentrated likelihood function (A.4),

$$L(\beta) = |\hat{\Omega}(\beta)|^{-T/2} = |S_{00} - S_{0k}\beta(\beta'S_{kk}\beta)^{-1}\beta'S_{k0}|^{-T/2} \quad (\text{A.7})$$

so that maximising (A.7) with respect to β amounts to minimising $|\hat{\Omega}(\beta)|$.

The estimation of $\hat{\beta}$ through this minimisation can be accomplished by noting the following theorem concerning the determinant of a partitioned matrix, which is that,

$$\begin{aligned} \begin{vmatrix} S_{00} & S_{0k}\beta \\ \beta'S_{k0} & \beta'S_{kk}\beta \end{vmatrix} &= |S_{00}| |\beta'S_{kk}\beta - \beta'S_{k0}S_{00}^{-1}S_{0k}\beta| \\ &= |\beta'S_{kk}\beta| |S_{00} - S_{0k}\beta(\beta'S_{kk}\beta)^{-1}\beta'S_{k0}| \end{aligned}$$

provided that $|S_{00}| \neq 0$, and $|\beta'S_{kk}\beta| \neq 0$, which clearly hold. Then the minimisation problem is based on minimising

$$|\beta'S_{kk}\beta - \beta'S_{k0}S_{00}^{-1}S_{0k}\beta| / |\beta'S_{kk}\beta| \quad (\text{A.8})$$

with respect to β .

Define a diagonal matrix D which consists of the ordered eigenvalues $\hat{\lambda}_1 > \dots > \hat{\lambda}_p$ of $S_{k0}S_{00}^{-1}S_{0k}$ with respect to S_{kk} , i.e. the solution of

$$|\lambda S_{kk} - S_{k0}S_{00}^{-1}S_{0k}| = 0, \quad (\text{A.9})$$

and E to be the corresponding matrix of eigenvectors so that

$$S_{kk}ED = S_{k0}S_{00}^{-1}S_{0k}E$$

where E is normalised such that

$$E'S_{kk}E = I.$$

The estimator β is now given as the first r columns of E , that is as the first r eigenvectors of $S_{k0}S_{00}^{-1}S_{0k}$ with respect to S_{kk} . The first r eigenvectors can be seen to be the same as the r canonical variates between R_{0r} and R_{kr} corresponding to the

largest r squared-partial canonical correlations between residuals. The values of $\hat{\Omega}$ and $\hat{\alpha}$ can be found from (A.5) and (A.6) by substitution of the expression for $\hat{\beta}$.

The maximised likelihood becomes:

$$L^{-2/T} \max = |\hat{\Omega}(\beta)| = |S_{00}| \prod_{i=1}^r (1 - \lambda_i) \quad (\text{A.10})$$

which clearly does not depend on β which has been maximised out.

The indeterminacy of β is apparent in that β can be chosen as $\beta = \hat{\beta}\omega$ where ω is any $r \times r$ non-singular matrix.

The likelihood under the null that $H_0: \Pi = \alpha\beta'$ can be compared with the likelihood in the absence of the constraint, that is, when $r=p$ and $\beta = I$ in the expressions for $\hat{\Omega}$ and $\hat{\alpha}$ which are substituted into the likelihood function. In that case

$$L^{-2/T} \max = |S_{00}| \prod_{i=1}^p (1 - \hat{\lambda}_i) \quad (\text{A.11})$$

This immediately suggests a test for the number of cointegration vectors as the ratio of the two likelihoods,

$$-2 \ln(Q) = -T \sum_{i=r+1}^p \ln(1 - \hat{\lambda}_i) \quad (\text{A.12})$$

which is a test that there are at most r cointegration vectors, where the $\hat{\lambda}_i$, $i=r+1$ to p correspond to the $p-r$ smallest eigenvalues of the matrix D .

Johansen (1988) has shown that the ML procedure yields consistent estimates of the parameters of interest. Johansen and Juselius (1990) show that the asymptotic distributions of the test statistics depend on whether a constant term is included in the model given by (A.2), and how the constant term enters the model. They provide

three tables of critical values to cover the possible cases. It is shown that under the null hypothesis given by (A.3), the inclusion of a constant in (A.2) leads to a linear trend component in the non-stationary X_t . Alternatively, the model can be estimated in such a way that the linear trend component is absent by restricting it to enter through the EC mechanism. In the case when we are allowing the presence of a linear trend, the constant term is simply included in the set of regressors (that is, along with the lagged differences ΔX_{t-i} , $i=1$ to $k-1$) in the calculation of R_{0t} and R_{kt} .

Johansen and Juselius (1990) show that the restriction that the linear trend is absent is equivalent to $\mu = \alpha\tau'$, when μ denotes the constant term. This hypothesis can be formulated as

$$H_0^*: \Pi = \alpha\beta' \quad \text{and} \quad \mu = \alpha\tau'$$

(compare to H_0 as given by (A.3) where the constant term is unrestricted). The restriction can be implemented by moving the constant term from the set of regressors to become the last element of the vector $X_{t-k}^* = [X'_{t-k}, 1]'$. The residual vector R_{kt}^* is now of dimension $(p+1) \times 1$, and the product moment matrices of the residuals have the following dimensions; S_{kk} is $(p+1) \times (p+1)$, S_{0k} is $p \times (p+1)$ and S_{00} is unchanged at $p \times p$.

The cointegration matrix β , once sufficient valid restrictions have been imposed to ensure unique identification, should be such that the resulting characterisation of the long run matches that of the DGP and is constant over prolonged periods of time. Then β would constitute structural knowledge. To identify the structural cointegration vectors β certainly necessitates both careful formulation of the long-run economic analysis and thorough testing of the requisite

restrictions. However, once an identifiable β is determined, it is unique under expansions of the information set: a set of cointegrating vectors will still cointegrate even after augmentation. In sum, the identified (implies 'uniqueness', 'correspondence to the desired entity' and 'satisfying the assumed interpretation') β represents one aspect of structure that may be determinable without omniscience.

Hargreaves (1994) compares six estimators of cointegrating relations- OLS, Augmented OLS, Fully-Modified, Three-Step, Johansen MLE and Box Tiao. The results found that the Johansen estimator was best as long as the sample was reasonably large (about 100) and the model was accurately specified. Given correct specifications, the results implied using the Johansen method to try and determine the number of cointegrating vectors, and if there is at least one, then to start with OLS, assess the model, move up to FM, and assess any changes in the results. If the cointegrating rank is erroneously underestimated, then the Johansen estimator fared worse than the single-equation estimators.

APPENDIX 3. B

Evaluation and design criteria [see Hendry (1995)]

Information Set	Null Hypothesis	Alternative Hypothesis	Sources
relative past of own data	innovation errors	first-order residual autocorrelation	Durbin and Watson (1950, 1951)
"	"	jth-order residual autocorrelation	Box and Pierce (1970), Godfrey (1978), Harvey (1981a)
"	"	invalid parameter restrictions	Johnston (1972)
"	"	jth-order ARCH	Engle (1982a)
"	"	heteroscedasticity quadratic in regressors	White (1980), Nicholls and Pagan (1983)
"	"	jth-order RESET	Ramsey (1969)
"	normality of the errors	skewness and excess kurtosis	Jarque and Bera (1980), Doornik and Hansen (1994)
relative present	weakly exogenous regressors	invalid conditioning	Sargan (1958, 1980a), Engle <i>et al.</i> (1983)
relative future	constant parameters; adequate forecasts	Parameter non-constancy; predictive failure	Fisher (1922a), Chow (1960), Brown, Durbin and Evans (1975), Hendry (1979)
economic theory	theory consistency; cointegration	'implausible' coefficients; no cointegration;	Engle and Granger (1987)
measurement system	data accuracy, admissibility	'impossible' observations	Hendry and Richard (1982)
relative past of rival data	variance dominance	relative poor fit	Hendry and Richard (1982)
"	variance encompassing	inexplicable observed error variance	Cox (1961, 1962), Pesaran (1974), Hendry (1983a)
"	parameter encompassing	significant additional variables	Johnston (1963), Mizon and Richard (1986)
relative present	exogeneity encompassing	inexplicable valid conditioning	Hendry (1988)
relative future	MSFE dominance	poor relative forecasts	
"	forecast encompassing	informative forecasts from alternative model	Chong and Hendry (1986)
"	forecast-model encompassing	regressors valuable in forecasting	Ericsson (1992b)

APPENDIX 4. A.

I. GENERAL MODELS FOR BIASES

a) Intercepts

Variables	$\sqrt{T}(\hat{k}_1 - k_{10})$				$\sqrt{T}(\hat{k}_2 - k_{20})$			
	Coefficient	St. Error	HCSE	t-Stat	Coefficient	St. Error	HCSE	t-Stat
Constant	0.072	0.039	0.053	1.8	0.096	0.045	0.056	2.144
$\frac{1}{\sqrt{T}}$	1.632	0.557	0.508	2.93	2.27	0.629	0.624	3.609
$\frac{\alpha}{\sqrt{T}}$	-0.042	2.008	0.701	-0.02	-0.647	2.270	0.939	-0.29
$\frac{\phi_{a,b}/\sigma_{a,b}}{\sqrt{T}}$	-0.051	0.208	0.069	-0.25	-0.744	0.227	0.345	-3.28
$\frac{\sigma_a^2}{\sqrt{T}}$	2.267	0.489	0.258	4.634	2.277	0.553	0.306	4.116
$\frac{\sigma_b^2}{\sqrt{T}}$	-1.101	0.246	0.130	-4.48	-1.106	0.278	0.154	-3.98
$\frac{\sigma_{ab}}{\sqrt{T}}$	0.138	0.491	0.438	0.282	-0.101	0.556	0.432	-0.18
R^2	0.95				0.94			
DW	2.56				2.57			
F	F(6,32)=104				F(6,32)=87			
SEE	0.10				0.11			
Normality	$\chi^2(2)=4.9$				$\chi^2(2)=3.1$			
X_i^2	F(10,21)=5**				F(10,21)=5**			
RESET	F(1,31)=188**				F(1,31)=59**			

b) Coefficients of I(0) Effects

Variables	$\sqrt{T}(\hat{\pi}_{11} - \pi_{110})$				$\sqrt{T}(\hat{\pi}_{21} - \pi_{210})$			
	Coefficient	St. Error	HCSE	t-Stat	Coefficient	St. Error	HCSE	t-Stat
Constant	-0.00054	0.024	0.015	-0.02	-0.011	0.024	0.015	-0.44
$\frac{1}{\sqrt{T}}$	-1.465	0.342	0.368	-4.28	0.123	0.336	0.366	0.365
$\frac{\alpha}{\sqrt{T}}$	2.523	1.233	1.083	2.047	2.539	1.210	1.042	2.099
$\frac{\phi_{a,b} / \sigma_{a,b}}{\sqrt{T}}$	0.261	0.124	0.107	2.115	0.259	0.121	0.104	2.139
$\frac{\sigma_a^2}{\sqrt{T}}$	1.482	0.300	0.409	4.934	0.152	0.294	0.407	5.154
$\frac{\sigma_b^2}{\sqrt{T}}$	-0.740	0.151	0.205	-4.90	-0.759	0.148	0.204	-5.12
$\frac{\sigma_{ab}}{\sqrt{T}}$	-1.345	0.301	0.497	-4.46	-1.356	0.296	0.499	-4.58
R^2	0.83				0.68			
DW	1.31				1.39			
F	F(6,32)=25				F(6,32)=11.1			
SEE	0.06				0.06			
Normality	$\chi^2(2)=2.14$				$\chi^2(2)=2.42$			
X_i^2	F(10,21)=1.75				F(10,21)=1.98			
RESET	F(1,31)=4.74*				F(1,31)=74**			

c) Coefficients of I(1) Effects

Variables	$T(\hat{\pi}_{12} - \pi_{120})$				$T(\hat{\pi}_{22} - \pi_{220})$			
	Coefficient	St. Error	HCSE	t-Stat	Coefficient	St. Error	HCSE	t-Stat
Constant	1.311	0.432	0.449	3.034	-0.044	0.439	0.458	-0.10
$\frac{1}{T}$	-0.041	0.013	0.014	-1.17	-0.051	0.013	0.013	-3.91
α	-2.433	1.739	1.321	-1.39	-2.409	1.769	1.293	-1.37
$\phi_{a,b} / \sigma_{a,b}$	-0.230	0.174	0.137	-1.33	-0.221	0.177	0.134	-1.25
σ_a^2	-2.184	0.424	0.392	-5.15	-2.251	0.431	0.390	-5.22
σ_b^2	1.078	0.213	0.196	5.061	1.112	0.216	0.196	5.131
σ_{ab}	1.261	0.426	0.519	2.962	1.310	0.433	0.530	3.025
R^2	0.86				0.86			
DW	1.66				1.64			
F	F(6,32)=33.62				F(6,32)=33.99			
SEE	0.76				0.77			
Normality	$\chi^2(2)=1.089$				$\chi^2(2)=1.605$			
X_i^2	F(9,22)=0.784				F(9,22)=0.85			
Xi*Xj	F(16,15)=2.5*				F(16,15)=2.9*			
RESET	F(1,31)=0.013				F(1,31)=0.254			

II. GENERAL MODELS FOR LOG (SE/SD)

a) Intercepts

Variables	log(SE/SD _{k₁})				log(SE/SD _{k₂})			
	Coefficient	St. Error	HCSE	t-Stat	Coefficient	St. Error	HCSE	t-Stat
Constant	0.0087	0.011	0.009	0.79	0.0156	0.013	0.009	1.223
$\frac{1}{T}$	-2.126	1.409	0.909	-1.51	-3.469	1.629	1.083	-2.13
$\frac{\alpha}{T}$	-0.234	5.675	1.973	-0.04	-0.472	6.559	2.244	-0.07
$\frac{\phi_{a,b}/\sigma_{a,b}}{T}$	0.325	0.567	0.192	0.573	0.116	0.656	0.235	0.178
$\frac{\sigma_a^2}{T}$	-2.284	1.383	0.335	-1.65	-3.241	1.598	0.455	-2.03
$\frac{\sigma_b^2}{T}$	1.089	0.695	0.173	1.567	1.558	0.804	0.233	1.939
$\frac{\sigma_{ab}}{T}$	-0.241	1.389	1.464	-0.17	0.239	1.606	1.719	0.149
R ²	0.85				0.87			
DW	1.83				2.07			
F	F(6,32)=31.10				F(6,32)=35.77			
SEE	0.04				0.05			
Normality	$\chi^2(2)=19^{**}$				$\chi^2(2)=22^{**}$			
X _i ²	F(10,21)=23 ^{**}				F(10,21)=25 ^{**}			
RESET	F(1,31)=349 ^{**}				F(1,31)=293 ^{**}			

b) Coefficients of I(0) Effects

Variables	log(SE/SD _{π₁₁})				log(SE/SD _{π₂₁})			
	Coefficient	St. Error	HCSE	t-Stat	Coefficient	St. Error	HCSE	t-Stat
Constant	-0.0047	0.0014	0.0009	-3.33	0.0008	0.0012	0.0007	0.704
$\frac{1}{T}$	2.2974	0.182	0.115	12.59	0.865	0.157	0.142	5.497
$\frac{\alpha}{T}$	-0.080	0.734	0.365	-0.11	-1.021	0.633	0.547	-1.61
$\frac{\phi_{a,b}/\sigma_{a,b}}{T}$	-0.033	0.073	0.036	-0.45	-0.117	0.063	0.055	-1.85
$\frac{\sigma_a^2}{T}$	0.628	0.179	0.205	3.510	-0.321	0.154	0.210	-2.08
$\frac{\sigma_b^2}{T}$	-0.315	0.089	0.103	-3.50	0.158	0.077	0.105	2.045
$\frac{\sigma_{ab}}{T}$	0.247	0.179	0.191	1.372	0.508	0.155	0.256	3.278
R ²	0.94				0.84			
DW	2.38				2.07			
F	F(6,32)=87.33				F(6,32)=27.93			
SEE	0.005				0.005			
Normality	$\chi^2(2)=25^{**}$				$\chi^2(2)=3.618$			
X _i ²	F(10,21)=0.95				F(10,21)=4 ^{**}			
RESET	F(1,31)=2.36				F(1,31)=5.62*			

c) Coefficients of I(1) Effects

Variables	log(SE / SD _{π_{12}})				log(SE / SD _{π_{22}})			
	Coefficient	St. Error	HCSE	t-Stat	Coefficient	St. Error	HCSE	t-Stat
Constant	-0.005	0.0012	0.0009	-4.32	0.0007	0.0015	0.0009	0.498
$\frac{1}{T}$	1.303	0.151	0.101	8.613	0.159	0.193	0.188	0.826
$\frac{\alpha}{T}$	-0.299	0.609	0.348	-0.49	-0.989	0.775	0.559	-1.28
$\frac{\phi_{a,b} / \sigma_{a,b}}{T}$	-0.042	0.061	0.034	-0.69	-0.111	0.078	0.056	-1.43
$\frac{\sigma_a^2}{T}$	-0.576	0.149	0.124	-3.88	-1.130	0.189	0.269	-5.98
$\frac{\sigma_b^2}{T}$	0.288	0.075	0.062	3.861	0.562	0.095	0.135	5.920
$\frac{\sigma_{ab}}{T}$	0.013	0.149	0.164	0.088	0.429	0.189	0.281	2.258
R^2	0.94				0.82			
DW	1.72				2.46			
F	F(6,32)=75.94				F(6,32)=23.5			
SEE	0.004				0.005			
Normality	$\chi^2(2)=8.83^*$				$\chi^2(2)=1.372$			
X_i^2	F(10,21)=5**				F(10,21)=2.07			
RESET	F(1,31)=13**				F(1,31)=13**			

III. FINAL MODELS FOR BIASES

a) Intercepts

Variables	$\sqrt{T}(\hat{k}_1 - k_{10})$				$\sqrt{T}(\hat{k}_2 - k_{20})$			
	Coefficient	St. Error	HCSE	t-Stat	Coefficient	St. Error	HCSE	t-Stat
Constant	0.072	0.381	0.051	1.876	0.096	0.044	0.054	2.206
$\frac{1}{\sqrt{T}}$	1.637	0.436	0.437	3.753	2.204	0.538	0.545	4.095
$\frac{\alpha}{\sqrt{T}}$								
$\frac{\phi_{a,b}/\sigma_{a,b}}{\sqrt{T}}$					-0.716	0.200	0.319	-3.58
$\frac{\sigma_a^2}{\sqrt{T}}$	2.342	0.423	0.244	5.538	2.313	0.503	0.288	4.601
$\frac{\sigma_b^2}{\sqrt{T}}$	-1.1383	0.213	0.123	-5.35	-1.124	0.253	0.146	-4.45
$\frac{\sigma_{ab}}{\sqrt{T}}$								
R^2	0.95				0.94			
DW	2.55				2.57			
F	F(6,32)=103.7				F(6,32)=138.6			
SEE	0.096				0.11			
Normality	$\chi^2(2)=4.915$				$\chi^2(2)=3.004$			
X_i^2	F(10,21)=12**				F(8,25)=6.3**			
RESET	F(1,31)=197**				F(1,33)=62**			

b) Coefficients of I(0) Effects

Variables	$\sqrt{T}(\hat{\pi}_{11} - \pi_{110})$				$\sqrt{T}(\hat{\pi}_{21} - \pi_{210})$			
	Coefficient	St. Error	HCSE	t-Stat	Coefficient	St. Error	HCSE	t-Stat
Constant								
$\frac{1}{\sqrt{T}}$	-1.469	0.278	0.321	-5.3				
$\frac{\alpha}{\sqrt{T}}$	2.523	1.214	1.068	2.079	2.588	1.216	0.942	2.298
$\frac{\phi_{a,b} / \sigma_{a,b}}{\sqrt{T}}$	0.261	0.122	0.105	2.148	0.268	0.097	0.095	2.776
$\frac{\sigma_a^2}{\sqrt{T}}$	1.482	0.296	0.403	5.011	1.501	0.254	0.360	5.911
$\frac{\sigma_b^2}{\sqrt{T}}$	-0.741	0.149	0.202	-4.98	-0.750	0.128	0.181	-5.88
$\frac{\sigma_{ab}}{\sqrt{T}}$	-1.346	0.297	0.490	-4.46	-1.333	0.238	0.386	-5.6
R^2	0.95				0.77			
DW	1.31				1.40			
F	NA				NA			
SEE	0.06				0.059			
Normality	$\chi^2(2)=2.14$				$\chi^2(2)=2.44$			
X_i^2	F(12,20)=2.8*				F(10,23)=4**			
RESET	F(1,32)=2.23				F(1,33)=47**			

c) Coefficients of I(1) Effects

Variables	$T(\hat{\pi}_{12} - \pi_{120})$				$T(\hat{\pi}_{22} - \pi_{220})$			
	Coefficient	St. Error	HCSE	t-Stat	Coefficient	St. Error	HCSE	t-Stat
Constant	0.975	0.369	0.404	2.636				
$\frac{1}{T}$	-0.041	0.013	0.013	-3.13	-0.057	0.0117	0.010	-4.89
α								
$\phi_{a,b} / \sigma_{a,b}$								
σ_a^2	-1.961	0.400	0.377	-4.84	-1.709	0.266	0.266	-6.43
σ_b^2	0.955	0.201	0.189	4.737	0.840	0.134	0.134	6.29
σ_{ab}	1.525	0.399	0.517	3.821	1.396	0.365	0.413	3.827
R^2	0.85				0.86			
DW	1.70				1.77			
F	F(4,34)=48.71				NA			
SEE	0.77				0.78			
Normality	$\chi^2(2)=1.619$				$\chi^2(2)=3.628$			
X_i^2	F(6,27)=1.479				F(6,28)=1.638			
RESET	F(1,33)=0.336				F(1,34)=0.137			

III. FINAL MODELS FOR BIASES

c) Intercepts

Variables	$\sqrt{T}(\hat{k}_1 - k_{10})$				$\sqrt{T}(\hat{k}_2 - k_{20})$			
	Coefficient	St. Error	HCSE	t-Stat	Coefficient	St. Error	HCSE	t-Stat
Constant	0.072	0.381	0.051	1.876	0.096	0.044	0.054	2.206
$\frac{1}{\sqrt{T}}$	1.637	0.436	0.437	3.753	2.204	0.538	0.545	4.095
$\frac{\alpha}{\sqrt{T}}$								
$\frac{\phi_{a,b} / \sigma_{a,b}}{\sqrt{T}}$					-0.716	0.200	0.319	-3.58
$\frac{\sigma_a^2}{\sqrt{T}}$	2.342	0.423	0.244	5.538	2.313	0.503	0.288	4.601
$\frac{\sigma_b^2}{\sqrt{T}}$	-1.1383	0.213	0.123	-5.35	-1.124	0.253	0.146	-4.45
$\frac{\sigma_{ab}}{\sqrt{T}}$								
R^2	0.95				0.94			
DW	2.55				2.57			
F	F(6,32)=103.7				F(6,32)=138.6			
SEE	0.096				0.11			
Normality	$\chi^2(2)=4.915$				$\chi^2(2)=3.004$			
X_i^2	F(10,21)=12**				F(8,25)=6.3**			
RESET	F(1,31)=197**				F(1,33)=62**			

d) Coefficients of I(0) Effects

Variables	$\sqrt{T}(\hat{\pi}_{11} - \pi_{110})$				$\sqrt{T}(\hat{\pi}_{21} - \pi_{210})$			
	Coefficient	St. Error	HCSE	t-Stat	Coefficient	St. Error	HCSE	t-Stat
Constant								
$\frac{1}{\sqrt{T}}$	-1.469	0.278	0.321	-5.3				
$\frac{\alpha}{\sqrt{T}}$	2.523	1.214	1.068	2.079	2.588	1.216	0.942	2.298
$\frac{\phi_{a,b} / \sigma_{a,b}}{\sqrt{T}}$	0.261	0.122	0.105	2.148	0.268	0.097	0.095	2.776
$\frac{\sigma_a^2}{\sqrt{T}}$	1.482	0.296	0.403	5.011	1.501	0.254	0.360	5.911
$\frac{\sigma_b^2}{\sqrt{T}}$	-0.741	0.149	0.202	-4.98	-0.750	0.128	0.181	-5.88
$\frac{\sigma_{ab}}{\sqrt{T}}$	-1.346	0.297	0.490	-4.46	-1.333	0.238	0.386	-5.6
R^2	0.95				0.77			
DW	1.31				1.40			
F	NA				NA			
SEE	0.06				0.059			
Normality	$\chi^2(2)=2.14$				$\chi^2(2)=2.44$			
X_i^2	F(12,20)=2.8*				F(10,23)=4**			
RESET	F(1,32)=2.23				F(1,33)=47**			

c) Coefficients of I(1) Effects

Variables	$T(\hat{\pi}_{12} - \pi_{120})$				$T(\hat{\pi}_{22} - \pi_{220})$			
	Coefficient	St. Error	HCSE	t-Stat	Coefficient	St. Error	HCSE	t-Stat
Constant	0.975	0.369	0.404	2.636				
$\frac{1}{T}$	-0.041	0.013	0.013	-3.13	-0.057	0.0117	0.010	-4.89
α								
$\hat{\phi}_{a,b} / \sigma_{a,b}$								
σ_a^2	-1.961	0.400	0.377	-4.84	-1.709	0.266	0.266	-6.43
σ_b^2	0.955	0.201	0.189	4.737	0.840	0.134	0.134	6.29
σ_{ab}	1.525	0.399	0.517	3.821	1.396	0.365	0.413	3.827
R^2	0.85				0.86			
DW	1.70				1.77			
F	F(4,34)=48.71				NA			
SEE	0.77				0.78			
Normality	$\chi^2(2)=1.619$				$\chi^2(2)=3.628$			
X_i^2	F(6,27)=1.479				F(6,28)=1.638			
RESET	F(1,33)=0.336				F(1,34)=0.137			

APPENDIX 7. B

DATA SET

EXPERIMENT	π_{110}	π_{120}	k_{10}	π_{210}	π_{220}	k_{20}
E1	0	1	0.07	0	1	0.05
E2	0	1	0.14	0	1	0.10
E3	0	1	0.28	0	1	0.28
E4	0.1	0.9	0.07	0.1	0.9	0.05
E5	0.3	0.7	0.07	0.3	0.7	0.05
E6	0	1	0.07	0	1	0.05
E7	0	1	0.07	0	1	0.05
E8	0	1	0.07	0	1	0.05
E9	0	1	0.07	0	1	0.05
E10	0	1	0.07	0	1	0.05
E11	0	1	0.07	0	1	0.05
E12	0	1	0.07	0	1	0.05
E13	0	1	0.07	0	1	0.05
E14	0	1	0.07	0	1	0.05
E15	0	1	0.14	0	1	0.10
E16	0	1	0.28	0	1	0.20
E17	0.1	0.9	0.07	0.1	0.9	0.05
E18	0.3	0.7	0.07	0.3	0.7	0.05
E19	0	1	0.07	0	1	0.05
E20	0	1	0.07	0	1	0.05
E21	0	1	0.07	0	1	0.05
E22	0	1	0.07	0	1	0.05
E23	0	1	0.07	0	1	0.05
E24	0	1	0.07	0	1	0.05
E25	0	1	0.07	0	1	0.05
E26	0	1	0.07	0	1	0.05
E27	0	1	0.07	0	1	0.05
E28	0	1	0.14	0	1	0.10
E29	0	1	0.28	0	1	0.20
E30	0.1	0.9	0.07	0.1	0.9	0.05
E31	0.3	0.7	0.07	0.3	0.7	0.05
E32	0	1	0.07	0	1	0.05
E33	0	1	0.07	0	1	0.05
E34	0	1	0.07	0	1	0.05
E35	0	1	0.07	0	1	0.05
E36	0	1	0.07	0	1	0.05
E37	0	1	0.07	0	1	0.05
E38	0	1	0.07	0	1	0.05
E39	0	1	0.07	0	1	0.05

EXPERIMENT

EXPERIMENT	$\hat{\pi}_{11}$	$\hat{\pi}_{12}$	\hat{k}_1	$\hat{\pi}_{21}$	$\hat{\pi}_{22}$	\hat{k}_2
E1	-0.0429890	1.039500	0.078226	-0.00648210	1.002500	0.058486
E2	-0.0434250	1.042800	0.144420	-0.00702350	1.006100	0.103880
E3	-0.0435340	1.043500	0.283960	-0.00719440	1.007000	0.201930
E4	0.0568540	0.939910	0.077969	0.09335100	0.902980	0.058078
E5	0.2566100	0.740580	0.077518	0.29310000	0.703790	0.057360
E6	-0.0405350	0.997890	0.146050	-0.00347440	0.957540	0.129340
E7	-0.0397300	0.932510	0.262650	-0.00393510	0.895090	0.243320
E8	-0.1096900	1.106000	0.080761	-0.07381400	1.070900	0.058017
E9	-0.0415350	0.996220	0.149760	-0.00437860	0.957920	0.129230
E10	-0.0394980	0.931890	0.263400	-0.00366280	0.894880	0.243280
E11	-0.0769180	1.073300	0.079325	-0.04032900	1.036900	0.058068
E12	-0.0410680	0.997100	0.147900	-0.00393620	0.957750	0.129280
E13	-0.0396140	0.932200	0.263030	-0.00379900	0.894990	0.243300
E14	-0.0258510	1.024700	0.074055	-0.00648720	1.005400	0.053636
E15	-0.0251370	1.024800	0.142810	-0.00593270	1.005600	0.101970
E16	-0.0247700	1.024700	0.282950	-0.00561400	1.005600	0.201330
E17	0.0741450	0.924770	0.073973	0.09350800	0.905470	0.053491
E18	0.2741400	0.724890	0.073826	0.29351000	0.705610	0.053235
E19	-0.0239310	1.012300	0.101790	-0.00441220	0.992350	0.082517
E20	-0.0221050	0.972360	0.191120	-0.00286360	0.952570	0.169560
E21	-0.0600200	1.058400	0.076255	-0.04107740	1.039900	0.054597
E22	-0.0249400	1.012800	0.103160	-0.00542450	0.993420	0.082388
E23	-0.0220320	0.972130	0.191550	-0.00278010	0.952520	0.169530
E24	-0.0439450	1.042600	0.075101	-0.02464800	1.023500	0.054064
E25	-0.0244300	1.012600	0.102470	-0.00492020	0.992880	0.082450
E26	-0.0220690	0.972250	0.191330	-0.00282170	0.952540	0.169540
E27	-0.0033385	1.003300	0.070161	-0.00085662	1.000800	0.050189
E28	-0.0033310	1.003300	0.140020	-0.00085400	1.000800	0.099998
E29	-0.0033266	1.003300	0.280050	-0.00085292	1.000900	0.199930
E30	0.0966610	0.903310	0.070151	0.09914300	0.900830	0.050173
E31	0.2966600	0.703320	0.070134	0.29914000	0.700840	0.050144
E32	-0.0029905	1.002800	0.072398	-0.00048769	1.000300	0.052746
E33	-0.0029958	0.999860	0.099507	-0.00046816	0.997350	0.080232
E34	-0.0079048	1.007900	0.070321	-0.00543610	1.005400	0.050218
E35	-0.0031778	1.002900	0.072509	-0.00067558	1.000500	0.052723
E36	-0.0030019	0.999850	0.099644	-0.00047401	0.997350	0.080243
E37	-0.0057270	1.005700	0.070216	-0.00324830	1.003200	0.050178
E38	-0.0030845	1.002900	0.072454	-0.00058184	1.000400	0.052734
E39	-0.0029988	0.999850	0.099576	-0.00047109	0.997350	0.080237

EXPERIMENT	$\sqrt{T}(\hat{\pi}_{11} - \pi_{110})$	$T(\hat{\pi}_{12} - \pi_{120})$	$\sqrt{T}(\hat{k}_1 - k_{10})$
E1	-0.27189	1.58000	0.05203
E2	-0.27464	1.71200	0.02795
E3	-0.27533	1.74000	0.02505
E4	-0.27288	1.59640	0.05040
E5	-0.27442	1.62320	0.04755
E6	-0.25637	-0.08440	0.48098
E7	-0.25127	-2.69960	1.21843
E8	-0.69374	4.24000	0.06806
E9	-0.26269	-0.15120	0.50445
E10	-0.24981	-2.72440	1.22317
E11	-0.48647	2.93200	0.05898
E12	-0.25974	-0.11600	0.49268
E13	-0.25054	-2.71200	1.22083
E14	-0.23122	1.97600	0.03627
E15	-0.22483	1.98400	0.02513
E16	-0.22155	1.97600	0.02639
E17	-0.23125	1.98160	0.03554
E18	-0.23130	1.99120	0.03422
E19	-0.21405	0.98400	0.28434
E20	-0.19771	-2.21120	1.08333
E21	-0.53684	4.67200	0.05595
E22	-0.22307	1.02400	0.29659
E23	-0.19706	-2.22960	1.08718
E24	-0.39306	3.40800	0.04562
E25	-0.21851	1.00800	0.29042
E26	-0.19739	-2.22000	1.08521
E27	-0.07465	1.65000	0.00360
E28	-0.07448	1.65000	0.00045
E29	-0.07439	1.65000	0.00112
E30	-0.07466	1.65500	0.00338
E31	-0.07468	1.66000	0.00300
E32	-0.06687	1.40000	0.05362
E33	-0.06699	-0.07000	0.65980
E34	-0.17676	3.95000	0.00718
E35	-0.07106	1.45000	0.05610
E36	-0.06712	-0.07500	0.66286
E37	-0.12806	2.85000	0.00483
E38	-0.06897	1.45000	0.05487
E39	-0.06706	-0.07500	0.66134

EXPERIMENT	$\sqrt{T}(\hat{\pi}_{21} - \pi_{210})$	$T(\hat{\pi}_{22} - \pi_{220})$	$\sqrt{T}(\hat{k}_2 - k_{20})$
E1	-0.040996	0.100000	0.053670
E2	-0.044421	0.244000	0.024539
E3	-0.045501	0.280000	-0.493758
E4	-0.042052	0.119200	0.051090
E5	-0.043639	0.151600	0.046549
E6	-0.021974	-1.698400	0.501790
E7	-0.024888	-4.196400	1.222663
E8	-0.466841	2.836000	0.050704
E9	-0.027693	-1.683200	0.501095
E10	-0.023166	-4.204800	1.222410
E11	-0.255063	1.476000	0.051027
E12	-0.024895	-1.690000	0.501411
E13	-0.024027	-4.200400	1.222537
E14	-0.058023	0.432000	0.032521
E15	-0.053064	0.448000	0.017620
E16	-0.050213	0.448000	0.011896
E17	-0.058066	0.437600	0.031224
E18	-0.058048	0.448800	0.028935
E19	-0.039464	-0.612000	0.290841
E20	-0.025613	-3.794400	1.069377
E21	-0.367407	3.192000	0.041117
E22	-0.048518	-0.526400	0.289687
E23	-0.024866	-3.798400	1.069109
E24	-0.220458	1.880000	0.036350
E25	-0.044008	-0.569600	0.290242
E26	-0.025238	-3.796800	1.069198
E27	-0.019155	0.400000	0.004226
E28	-0.019096	0.400000	-0.000045
E29	-0.019072	0.450000	-0.001565
E30	-0.019163	0.415000	0.003868
E31	-0.019230	0.420000	0.003220
E32	-0.010905	0.150000	0.061402
E33	-0.010468	-1.325000	0.676008
E34	-0.121555	2.700000	0.004875
E35	-0.015106	0.250000	0.060888
E36	-0.010599	-1.325000	0.676254
E37	-0.072634	1.600000	0.003980
E38	-0.013010	0.200000	0.061134
E39	-0.010534	-1.325000	0.676120

EXPERIMENT	$SE\hat{\pi}_{11}$	$SE\hat{\pi}_{12}$	$SE\hat{k}_1$	$SE\hat{\pi}_{21}$	$SE\hat{\pi}_{22}$	$SE\hat{k}_2$
E1	0.453400	0.453820	0.0336190	0.42168	0.42206	0.0311760
E2	0.453510	0.453630	0.0368870	0.42187	0.42198	0.0342460
E3	0.453510	0.453550	0.0483220	0.42190	0.42193	0.0449100
E4	0.453410	0.453780	0.0335850	0.42171	0.42204	0.0311460
E5	0.453440	0.453710	0.0335280	0.42177	0.42201	0.0310960
E6	0.289320	0.296150	0.1042100	0.23686	0.24221	0.0841500
E7	0.286990	0.302440	0.2382500	0.23423	0.24619	0.1906800
E8	0.555780	0.556970	0.0411810	0.41620	0.41708	0.0307680
E9	0.296610	0.304180	0.1069400	0.23691	0.24270	0.0842010
E10	0.287720	0.303320	0.2387100	0.23424	0.24628	0.1905800
E11	0.508910	0.509700	0.0377360	0.42098	0.42162	0.0310650
E12	0.293000	0.300190	0.1055900	0.23689	0.24245	0.0841760
E13	0.287350	0.302880	0.2384800	0.23423	0.24624	0.1906300
E14	0.314170	0.314180	0.0184780	0.29244	0.29245	0.0171900
E15	0.314210	0.314200	0.0214100	0.29246	0.29245	0.0199160
E16	0.314220	0.314210	0.0305430	0.29246	0.29246	0.0284180
E17	0.314180	0.314180	0.0184700	0.29244	0.29245	0.0171820
E18	0.314190	0.314180	0.0184550	0.29246	0.29245	0.0171680
E19	0.200870	0.201940	0.0561720	0.16507	0.16594	0.0460620
E20	0.199970	0.204660	0.1539900	0.16390	0.16768	0.1257600
E21	0.384490	0.384620	0.0225860	0.28797	0.28807	0.0168980
E22	0.220596	0.207140	0.0575950	0.16508	0.16602	0.0460490
E23	0.200490	0.205220	0.1543200	0.16390	0.16771	0.1257000
E24	0.352340	0.352410	0.0207150	0.29156	0.29162	0.0171120
E25	0.203440	0.204560	0.0568890	0.16508	0.16598	0.0460560
E26	0.200230	0.204940	0.1541600	0.16390	0.16770	0.1257300
E27	0.121350	0.121350	0.0056686	0.11275	0.11275	0.0052664
E28	0.121350	0.121350	0.0070530	0.11275	0.11275	0.0065520
E29	0.121350	0.121350	0.0109690	0.11275	0.11275	0.0101920
E30	0.121350	0.121350	0.0056681	0.11275	0.11275	0.0052659
E31	0.121350	0.121350	0.0056673	0.11275	0.11275	0.0052651
E32	0.077977	0.077985	0.0165640	0.06378	0.06379	0.0135430
E33	0.077952	0.078071	0.0498960	0.06375	0.06385	0.0407870
E34	0.150630	0.150630	0.0070294	0.11237	0.11237	0.0052431
E35	0.080015	0.080023	0.0169940	0.06378	0.06379	0.0135410
E36	0.078158	0.078279	0.0500320	0.06375	0.06385	0.0407900
E37	0.136850	0.136860	0.0063900	0.11266	0.11266	0.0052588
E38	0.079003	0.079011	0.0167800	0.06378	0.06379	0.0135420
E39	0.078055	0.078175	0.0499640	0.06375	0.06385	0.0407890

EXPERIMENT	$SD\hat{\pi}_{11}$	$SD\hat{\pi}_{12}$	$SD\hat{k}_1$	$SD\hat{\pi}_{21}$	$SD\hat{\pi}_{22}$	$SD\hat{k}_2$
E1	0.414980	0.416810	0.0329660	0.4031900	0.4039700	0.0316850
E2	0.416330	0.417120	0.0352040	0.4040800	0.4043700	0.0340600
E3	0.416950	0.417320	0.0447090	0.4044400	0.4045700	0.0438200
E4	0.415000	0.416700	0.0329270	0.4032700	0.4039800	0.0316100
E5	0.415030	0.416530	0.0328660	0.4034100	0.4040000	0.0314870
E6	0.256150	0.278310	0.1207100	0.2255800	0.2419700	0.1075900
E7	0.255520	0.280370	0.4190400	0.2278500	0.2490300	0.3926100
E8	0.501720	0.505510	0.0402010	0.3729000	0.3757700	0.0299460
E9	0.262550	0.287710	0.1255200	0.2241900	0.2429400	0.1072400
E10	0.256040	0.281150	0.4203600	0.2276000	0.2487900	0.3922100
E11	0.455170	0.458270	0.0363050	0.3847600	0.3868000	0.0304780
E12	0.259340	0.282950	0.1230800	0.2248800	0.2424000	0.1074000
E13	0.255780	0.280760	0.4197000	0.2277200	0.2489100	0.3924100
E14	0.303290	0.303600	0.0184310	0.2847500	0.2847200	0.0171940
E15	0.303480	0.303640	0.0209980	0.2850300	0.2850100	0.0200290
E16	0.303570	0.303650	0.0293980	0.2851500	0.2851400	0.0283620
E17	0.303280	0.303580	0.0184250	0.2847600	0.2847300	0.0171850
E18	0.303260	0.303530	0.0184150	0.2847800	0.2847400	0.0171700
E19	0.193490	0.196070	0.0597000	0.1597100	0.1614800	0.0493530
E20	0.192120	0.203700	0.2766800	0.1584700	0.1718200	0.2559400
E21	0.377380	0.378090	0.0236000	0.2806100	0.2812000	0.0174520
E22	0.198580	0.201280	0.0617040	0.1594300	0.1612100	0.0490010
E23	0.192670	0.204270	0.2766300	0.1584800	0.1717800	0.2550700
E24	0.341020	0.341640	0.0209640	0.2814300	0.2817900	0.0170850
E25	0.196050	0.198690	0.0606930	0.1595700	0.1613400	0.0491590
E26	0.192400	0.203990	0.2766600	0.1584700	0.1718000	0.2555100
E27	0.121390	0.121420	0.0051800	0.1123100	0.1123200	0.0048280
E28	0.121400	0.121410	0.0065210	0.1123300	0.1123300	0.0061350
E29	0.121400	0.121400	0.0104480	0.1123300	0.1123300	0.0098200
E30	0.121390	0.121410	0.0051790	0.1123100	0.1123200	0.0048290
E31	0.121390	0.121410	0.0051790	0.1123100	0.1123200	0.0048300
E32	0.077954	0.078082	0.0155910	0.0634860	0.0635210	0.0123210
E33	0.077843	0.078422	0.0526410	0.0633270	0.0635040	0.0425250
E34	0.149370	0.149410	0.0066530	0.1118700	0.1119000	0.0049020
E35	0.079969	0.080103	0.0160260	0.0635510	0.0635940	0.0123130
E36	0.078049	0.078633	0.0528370	0.0633340	0.0635170	0.0425360
E37	0.136690	0.136730	0.0059040	0.1127100	0.1127400	0.0048020
E38	0.078969	0.079100	0.0158100	0.0635200	0.0635580	0.0123160
E39	0.077946	0.078528	0.0527390	0.0633300	0.0635110	0.0425310

EXPERIMENT $\log(SE / SD_{\bar{x}_{11}})$ $\log(SE / SD_{\bar{x}_{12}})$ $\log(SE / SD_{k_1})$

E1	0.0384543494	0.0369455016	0.0085185369
E2	0.0371491613	0.0364407543	0.0202813234
E3	0.0365028896	0.0361559726	0.0337499448
E4	0.0384429976	0.0370218503	0.0085931890
E5	0.0384403382	0.0371320651	0.0086607969
E6	0.0528840962	0.0269829257	-0.0638338540
E7	0.0504418655	0.0329076878	-0.2452225718
E8	0.0444415008	0.0421020522	0.0104600321
E9	0.0529737663	0.0241756985	-0.0695727508
E10	0.0506622331	0.0329629595	-0.2457507706
E11	0.0484673546	0.0461932059	0.0167894221
E12	0.0529981138	0.0256865226	-0.0665646977
E13	0.0505446184	0.0329353629	-0.2454870062
E14	0.0153066209	0.0148767681	0.0011060637
E15	0.0150899273	0.0148471980	0.0084387359
E16	0.0149749737	0.0148467173	0.0165939066
E17	0.0153347639	0.0149053787	0.0010593989
E18	0.0153772276	0.0149769135	0.0009423263
E19	0.0162565550	0.0128112031	-0.0264544440
E20	0.0173922686	0.0020419408	-0.2544852480
E21	0.0081061688	0.0074366726	-0.0190726792
E22	0.0456621269	0.0124633481	-0.0299285357
E23	0.0172786185	0.0020150944	-0.2534770621
E24	0.0141820999	0.0134795103	-0.0051892134
E25	0.0160695005	0.0126447053	-0.0281103050
E26	0.0173240797	0.0020178539	-0.2539746710
E27	-0.0001431308	-0.0002504479	0.0391460527
E28	-0.0001789061	-0.0002146784	0.0340596836
E29	-0.0001789061	-0.0001789061	0.0211338726
E30	-0.0001431308	-0.0002146784	0.0391915927
E31	-0.0001431308	-0.0002146784	0.0391302917
E32	0.0001281179	-0.0005398524	0.0262912503
E33	0.0006076974	-0.0019481717	-0.0232583998
E34	0.0036480951	0.0035318103	0.0239007336
E35	0.0002497443	-0.0004339528	0.0254704755
E36	0.0006060946	-0.0019595762	-0.0236902872
E37	0.0005080582	0.0004127219	0.0343545093
E38	0.0001869447	-0.0004889250	0.0258600866
E39	0.0006068949	-0.0019566468	-0.0234746911

EXPERIMENT $\log(SE/SD_{\bar{x}_{21}})$ $\log(SE/SD_{\bar{x}_{22}})$ $\log(SE/SD_{k_2})$

E1	0.0194732511	0.019025080	-0.0070333187
E2	0.0187112874	0.018512940	0.0023652087
E3	0.0183554237	0.018246730	0.0106706818
E4	0.0194179843	0.018993750	-0.0064222166
E5	0.0193290261	0.018941377	-0.0054267565
E6	0.0211911326	0.000430545	-0.1067177872
E7	0.0119934855	-0.004981260	-0.3136562139
E8	0.0477096925	0.045297260	0.0117604466
E9	0.0239671558	-0.000429251	-0.1050395560
E10	0.0124888017	-0.004403775	-0.3134413399
E11	0.0390715477	0.037434739	0.0082848932
E12	0.0225958953	0.000089573	-0.1058159969
E13	0.0122413433	-0.004683742	-0.3135488183
E14	0.0115730425	0.011633651	-0.0001010457
E15	0.0111759028	0.011191528	-0.0024571489
E16	0.0109930997	0.011008330	0.0008566572
E17	0.0115577910	0.011618398	-0.0000758218
E18	0.0115569900	0.011603145	-0.0000505905
E19	0.0143360416	0.011832345	-0.0299707661
E20	0.0146318956	-0.010592449	-0.3085956369
E21	0.0112441026	0.010482716	-0.0140098985
E22	0.0151244141	0.012768432	-0.0269847396
E23	0.0146044910	-0.010413639	-0.3073241045
E24	0.0153575509	0.014891729	0.0006857884
E25	0.0147432152	0.012313708	-0.0283168234
E26	0.0146318956	-0.010490097	-0.3079689864
E27	0.0016981233	0.001659456	0.0377465807
E28	0.0016207917	0.001620792	0.0285593217
E29	0.0016207917	0.001620792	0.0161479272
E30	0.0016981233	0.001659456	0.0376154021
E31	0.0016981233	0.001659456	0.0374594934
E32	0.0020065501	0.001808042	0.0410689209
E33	0.0028776494	0.002332612	-0.0181225594
E34	0.0019367428	0.001820294	0.0292148340
E35	0.0015553169	0.001309226	0.0412868586
E36	0.0028296462	0.002250518	-0.0182029420
E37	-0.0001927029	-0.000308284	0.0394644985
E38	0.0017740255	0.001555146	0.0412131292
E39	0.0028570759	0.002284743	-0.0181625360

EXPERIMENT	T	$\frac{1}{T}$	$\frac{1}{\sqrt{T}}$	α	$\frac{\alpha}{T}$	$\frac{\alpha}{\sqrt{T}}$
E1	40	0.025	0.1581139	0	0	0
E2	40	0.025	0.1581139	0	0	0
E3	40	0.025	0.1581139	0	0	0
E4	40	0.025	0.1581139	0.1	0.0158114	0.0025
E5	40	0.025	0.1581139	0.3	0.0474342	0.0075
E6	40	0.025	0.1581139	0	0	0
E7	40	0.025	0.1581139	0	0	0
E8	40	0.025	0.1581139	0	0	0
E9	40	0.025	0.1581139	0	0	0
E10	40	0.025	0.1581139	0	0	0
E11	40	0.025	0.1581139	0	0	0
E12	40	0.025	0.1581139	0	0	0
E13	40	0.025	0.1581139	0	0	0
E14	80	0.013	0.1118034	0	0	0
E15	80	0.013	0.1118034	0	0	0
E16	80	0.013	0.1118034	0	0	0
E17	80	0.013	0.1118034	0.1	0.0111803	0.00125
E18	80	0.013	0.1118034	0.3	0.033541	0.00375
E19	80	0.013	0.1118034	0	0	0
E20	80	0.013	0.1118034	0	0	0
E21	80	0.013	0.1118034	0	0	0
E22	80	0.013	0.1118034	0	0	0
E23	80	0.013	0.1118034	0	0	0
E24	80	0.013	0.1118034	0	0	0
E25	80	0.013	0.1118034	0	0	0
E26	80	0.013	0.1118034	0	0	0
E27	500	0.002	0.0447214	0	0	0
E28	500	0.002	0.0447214	0	0	0
E29	500	0.002	0.0447214	0	0	0
E30	500	0.002	0.0447214	0.1	0.0044721	0.0002
E31	500	0.002	0.0447214	0.3	0.0134164	0.0006
E32	500	0.002	0.0447214	0	0	0
E33	500	0.002	0.0447214	0	0	0
E34	500	0.002	0.0447214	0	0	0
E35	500	0.002	0.0447214	0	0	0
E36	500	0.002	0.0447214	0	0	0
E37	500	0.002	0.0447214	0	0	0
E38	500	0.002	0.0447214	0	0	0
E39	500	0.002	0.0447214	0	0	0

EXPERIMENT	$\phi_{a,b}/\sigma_{a,b}$	$\frac{\phi_{a,b}/\sigma_{a,b}}{T}$	$\frac{\phi_{a,b}/\sigma_{a,b}}{\sqrt{T}}$	σ_u^2	$\frac{\sigma_a^2}{T}$	$\frac{\sigma_a^2}{\sqrt{T}}$
E1	1	0.1581139	0.025	0.0004	6.32456E-05	0.000010
E2	2	0.3162278	0.050	0.0004	6.32456E-05	0.000010
E3	4	0.6324555	0.100	0.0004	6.32456E-05	0.000010
E4	1	0.1581139	0.025	0.0004	6.32456E-05	0.000010
E5	1	0.1581139	0.025	0.0004	6.32456E-05	0.000010
E6	1	0.1581139	0.025	0.0100	1.58114E-03	0.000250
E7	1	0.1581139	0.025	0.1000	1.58114E-02	0.002500
E8	1	0.1581139	0.025	0.0004	6.32456E-05	0.000010
E9	1	0.1581139	0.025	0.0100	1.58114E-03	0.000250
E10	1	0.1581139	0.025	0.1000	1.58114E-02	0.002500
E11	1	0.1581139	0.025	0.0004	6.32456E-05	0.000010
E12	1	0.1581139	0.025	0.0100	1.58114E-03	0.000250
E13	1	0.1581139	0.025	0.1000	1.58114E-02	0.002500
E14	1	0.1118034	0.013	0.0004	4.47214E-05	0.000005
E15	2	0.2236068	0.025	0.0004	4.47214E-05	0.000005
E16	4	0.4472136	0.050	0.0004	4.47214E-05	0.000005
E17	1	0.1118034	0.013	0.0004	4.47214E-05	0.000005
E18	1	0.1118034	0.013	0.0004	4.47214E-05	0.000005
E19	1	0.1118034	0.013	0.0100	1.11803E-03	0.000125
E20	1	0.1118034	0.013	0.1000	1.11803E-02	0.001250
E21	1	0.1118034	0.013	0.0004	4.47214E-05	0.000005
E22	1	0.1118034	0.013	0.0100	1.11803E-03	0.000125
E23	1	0.1118034	0.013	0.1000	1.11803E-02	0.001250
E24	1	0.1118034	0.013	0.0004	4.47214E-05	0.000005
E25	1	0.1118034	0.013	0.0100	1.11803E-03	0.000125
E26	1	0.1118034	0.013	0.1000	1.11803E-02	0.001250
E27	1	0.0447214	0.002	0.0004	1.78885E-05	0.000001
E28	2	0.0894427	0.004	0.0004	1.78885E-05	0.000001
E29	4	0.1788854	0.008	0.0004	1.78885E-05	0.000001
E30	1	0.0447214	0.002	0.0004	1.78885E-05	0.000001
E31	1	0.0447214	0.002	0.0004	1.78885E-05	0.000001
E32	1	0.0447214	0.002	0.0100	4.47214E-04	0.000020
E33	1	0.0447214	0.002	0.1000	4.47214E-03	0.000200
E34	1	0.0447214	0.002	0.0004	1.78885E-05	0.000001
E35	1	0.0447214	0.002	0.0100	4.47214E-04	0.000020
E36	1	0.0447214	0.002	0.1000	4.47214E-03	0.000200
E37	1	0.0447214	0.002	0.0004	1.78885E-05	0.000001
E38	1	0.0447214	0.002	0.0100	4.47214E-04	0.000020
E39	1	0.0447214	0.002	0.1000	4.47214E-03	0.000200

EXPERIMENT	σ_b^2	$\frac{\sigma_b^2}{T}$	$\frac{\sigma_b^2}{\sqrt{T}}$	σ_{ab}	$\frac{\sigma_{ab}}{T}$	$\frac{\sigma_{ab}}{\sqrt{T}}$
E1	0.0025	0.0003953	0.000063	0	0	0
E2	0.0025	0.0003953	0.000063	0	0	0
E3	0.0025	0.0003953	0.000063	0	0	0
E4	0.0025	0.0003953	0.000063	0	0	0
E5	0.0025	0.0003953	0.000063	0	0	0
E6	0.0200	0.0031623	0.000500	0	0	0
E7	0.2000	0.0316228	0.005000	0	0	0
E8	0.0025	0.0003953	0.000063	0.0008	0.0001265	0.00002
E9	0.0200	0.0031623	0.000500	0.0008	0.0001265	0.00002
E10	0.2000	0.0316228	0.005000	0.0008	0.0001265	0.00002
E11	0.0025	0.0003953	0.000063	0.0004	6.325E-05	0.00001
E12	0.0200	0.0031623	0.000500	0.0004	6.325E-05	0.00001
E13	0.2000	0.0316228	0.005000	0.0004	6.325E-05	0.00001
E14	0.0025	0.0002795	0.000031	0	0	0
E15	0.0025	0.0002795	0.000031	0	0	0
E16	0.0025	0.0002795	0.000031	0	0	0
E17	0.0025	0.0002795	0.000031	0	0	0
E18	0.0025	0.0002795	0.000031	0	0	0
E19	0.0200	0.0022361	0.000250	0	0	0
E20	0.2000	0.0223607	0.002500	0	0	0
E21	0.0025	0.0002795	0.000031	0.0008	8.944E-05	0.000010
E22	0.0200	0.0022361	0.000250	0.0008	8.944E-05	0.000010
E23	0.2000	0.0223607	0.002500	0.0008	8.944E-05	0.000010
E24	0.0025	0.0002795	0.000031	0.0004	4.472E-05	0.000005
E25	0.0200	0.0022361	0.000250	0.0004	4.472E-05	0.000005
E26	0.2000	0.0223607	0.002500	0.0004	4.472E-05	0.000005
E27	0.0025	0.0001118	0.000005	0	0	0
E28	0.0025	0.0001118	0.000005	0	0	0
E29	0.0025	0.0001118	0.000005	0	0	0
E30	0.0025	0.0001118	0.000005	0	0	0
E31	0.0025	0.0001118	0.000005	0	0	0
E32	0.0200	0.0008944	0.000040	0	0	0
E33	0.2000	0.0089443	0.000400	0	0	0
E34	0.0025	0.0001118	0.000005	0.0008	3.578E-05	0.0000016
E35	0.0200	0.0008944	0.000040	0.0008	3.578E-05	0.0000016
E36	0.2000	0.0089443	0.000400	0.0008	3.578E-05	0.0000016
E37	0.0025	0.0001118	0.000005	0.0004	1.789E-05	0.0000008
E38	0.0200	0.0008944	0.000040	0.0004	1.789E-05	0.0000008
E39	0.2000	0.0089443	0.000400	0.0004	1.789E-05	0.0000008

APPENDIX 7:

OLD DATA SET (SPO) IN CONSTANT PRICES

YEARS	OUT88	EXP88	LOUT88	LEXP88	RES88spo	DLOUT8	DLEXP88	DRES88spo	DGM88spo	DGDP88spo
1962	24978.1663	23898.3527	10.125757	10.081565	0.044193					
1963	27312.2994	26268.7111	10.215092	10.176134	0.038959	0.089335	0.094569	-0.00523397	0.0919520	0.09029987
1964	28406.8796	27522.4779	10.254387	10.222758	0.031628	0.039294	0.046625	-0.00733029	0.0429594	0.04064549
1965	29122.2342	28255.5726	10.279257	10.249046	0.030211	0.024871	0.026288	-0.00141706	0.0255791	0.02513181
1966	32492.5144	31632.9300	10.388765	10.361954	0.026811	0.109508	0.112908	-0.00340018	0.1112079	0.11013458
1967	34014.3742	33333.6495	10.434538	10.414323	0.020216	0.045773	0.052369	-0.00659525	0.0490711	0.04698924
1968	36317.5184	35820.6630	10.500056	10.486280	0.013775	0.065517	0.071958	-0.00644051	0.0687373	0.06670426
1969	38280.1698	37950.4160	10.552687	10.544036	0.008652	0.052632	0.057756	-0.00512378	0.0551937	0.05357629
1970	39922.6465	40033.9296	10.594699	10.597483	-0.002784	0.042012	0.053447	-0.01143513	0.0477293	0.04411969
1971	43427.9015	42959.4753	10.678857	10.668013	0.010845	0.084158	0.070530	0.01362848	0.0773441	0.08164611
1972	46287.8901	44126.4860	10.742636	10.694815	0.047820	0.063778	0.026803	0.03697529	0.0452906	0.05696222
1973	48296.1820	46901.8751	10.785108	10.755813	0.029295	0.042472	0.060997	-0.01852533	0.0517348	0.04588709
1974	52149.2718	50790.8475	10.861865	10.835471	0.026394	0.076758	0.079659	-0.00290081	0.0782081	0.07729244
1975	56870.7590	56298.7649	10.948537	10.938428	0.010109	0.086671	0.102956	-0.01628534	0.0948138	0.08967313
1976	62302.4662	62069.1225	11.039756	11.036004	0.003752	0.091220	0.097576	-0.00635634	0.0943979	0.09239143
1977	65039.7458	64140.1138	11.082754	11.068825	0.013929	0.042998	0.032821	0.01017622	0.0379094	0.04112166
1978	66836.0581	71292.6957	11.109998	11.174549	-0.064551	0.027244	0.105724	-0.07847974	0.0664840	0.04171112
1979	66067.0931	70924.3520	11.098426	11.169369	-0.070943	-0.011572	-0.005180	-0.00639191	-0.0083760	-0.01039366
1980	65069.9860	69578.8222	11.083219	11.150216	-0.066997	-0.015207	-0.019154	0.00394621	-0.0171805	-0.01593483
1981	67965.1312	72739.1770	11.126750	11.194635	-0.067885	0.043531	0.044420	-0.00088848	0.0439756	0.04369518
1982	71653.7783	76619.5655	11.179601	11.246608	-0.067007	0.052851	0.051972	0.00087874	0.0524117	0.05268910
1983	74878.7611	74815.7187	11.223626	11.222783	0.000842	0.044024	-0.023824	0.06784886	0.0101000	0.03151714
1984	78766.0611	78996.3179	11.274237	11.277157	-0.002919	0.050612	0.054373	-0.00376132	0.0524926	0.05130528
1985	82790.7811	82905.0289	11.324072	11.325451	-0.001379	0.049835	0.048294	0.00154003	0.0490645	0.04955062
1986	90110.8452	90193.4189	11.408796	11.409712	-0.000916	0.084724	0.084261	0.00046307	0.0844923	0.08463845
1987	96617.3495	95557.6683	11.478514	11.467485	0.011028	0.069718	0.057773	0.01194434	0.0637456	0.06751598
1988	100827.2000	99737.7000	11.521163	11.510299	0.010864	0.042650	0.042814	-0.00016398	0.0427318	0.04268006
1989	100676.7814	101292.6025	11.519670	11.525769	-0.006098	-0.001493	0.015470	-0.01696260	0.0069883	0.00163393

NEW DATA SET (SPO AND SIS) IN CONSTANT PRICES

YEARS	OUT87spo	EXP87spo	LOUT87spo	LEXP87spo	RES87sis	DLOUT87spo	DLEXP87spo	DRES87spo	DGM87spo	DGDP87spo
1987	74722	74721.6	11.22152984	11.22152449	0.0000054					
1988	76306	78094.8	11.24250685	11.26567875	-0.0231719	0.0209770	0.0441543	-0.0231719012	0.0325656392	0.028175635
1989	76498	73686.3	11.24501988	11.20757217	0.0374477	0.0025130	-0.0581066	0.0374477035	-0.0277967778	-0.016314818
1990	83578	79848.38	11.33353561	11.28788487	0.0456507	0.0885157	0.0803127	0.0456507411	0.0844142121	0.085967949
1991	84353	81788.59	11.34276565	11.31189303	0.0308726	0.0092300	0.0240082	0.0308726271	0.0166191039	0.013819981
1992	89401	86700.61	11.40088715	11.37021620	0.0306709	0.0581215	0.0583232	0.0306709483	0.0582223328	0.058184133
1993	96089	92056.52	11.47303012	11.43015802	0.0428721	0.0721430	0.0599418	0.0428721091	0.0660423971	0.068353419
1994	91397	89437.17	11.42296793	11.40129165	0.0216763	-0.0500622	-0.0288664	0.0216762876	-0.0394642794	-0.043478980

YEARS	OUT87sis	EXP87sis	LOUT87sis	LEXP87sis	RES87sis	DLOUT87sis	DLEXP87sis	DRES87sis
1987	74722	74416	11.22152984	11.21742625	0.0041036			
1988	76306	76143	11.24250685	11.24036843	0.0021384	0.0209770	0.0229422	-0.0019652
1989	76498	76364	11.24501988	11.24326666	0.0017532	0.0025130	0.0028982	-0.0003852
1990	83578	83371	11.33353561	11.33105581	0.0024798	0.0885157	0.0877891	0.0007266
1991	84353	84041	11.34276565	11.33906005	0.0037056	0.0092300	0.0080042	0.0012258
1992	89401	88274	11.40088715	11.38820089	0.0126863	0.0581215	0.0491408	0.0089807
1993	96089	95027	11.47303012	11.46191634	0.0111138	0.0721430	0.0737154	-0.0015725
1994	91397	90561	11.42296793	11.41377894	0.0091890	-0.0500622	-0.0481374	-0.0019248

APPENDIX 8. A.

THE SOURCES OF THE VARIABLES

Cna: The Total Private Consumption – adjusted series, Main Economic Indicators, State Planning Organisation (SPO), various issues.

Yna: The Private Disposable Income – adjusted series, Main Economic Indicators, State Planning Organisation (SPO), various issues.

HtoYt: Housing wealth to Income ratio, calculated by the author.

h: The housing stock series, Statistical Yearbook of Turkey (1928-1998), State Institute of Statistics (SIS).

I: Nominal private investment in the housing sector, Main Economic Indicators, State Planning Organisation (SPO), various issues.

PrHIoTPrHI: The share of private housing investment in total private investment, Main Economic Indicators, State Planning Organisation (SPO), various issues.

N: Population, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

F: Family size, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

INF: The inflation rate, calculated from the CPI (1987=1), Statistical Yearbook of Turkey (1928-1998), State Institute of Statistics (SIS).

Sir: The short-term interest rates (the three-month interest rates on time deposits), Monthly Statistical Bulletin, The Central Bank of the Republic of Turkey, various issues.

Lir: The long-term interest rates (one-year interest rates on time deposits), Monthly Statistical Bulletin, The Central Bank of the Republic of Turkey, various issues.

UNEMP: Unemployment rate, Statistical Yearbook of Turkey (1928-1998), State Institute of Statistics (SIS).

DIVOR: Divorce Rate, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

TOTPART: Total Labour Participation rate, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

MALPART: Male Participation rate, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

FEMPART: Female Participation rate, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

D.RATE: Death rate, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

LIFEEXP: Percentage of Death 65+ in Total Death, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

LIT.RATE: Literacy rate, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

0-14ADR: Age Dependency Ratio of 0-14 years old, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

65+ADR: Age Dependency Ratio of 65 years of age and above, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

TAGEDR: Total Age Dependency Ratio, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

POP0-19: The % of the population which is aged between 0 and 19, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

POP15-19: The % of the population which is aged between 15 and 19, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

POP15-44: The % of the population which is aged between 15 and 44, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

POP20-24: The % of the population which is aged between 20 and 24, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

POP20-34: The % of the population which is aged between 20 and 34, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

POP25-34: The % of the population which is aged between 25 and 34, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

POP20-64: The % of the population which is aged between 20 and 64, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

POP20-44: The % of the population which is aged between 20 and 44, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

POP25-34: The % of the population which is aged between 25 and 34, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

POP35-44: The % of the population which is aged between 35 and 44, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

POP45-64: The % of the population which is aged between 45 and 65, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

POP64+: The % of the population which is aged 64+, Statistical Indicators (1923-1995), State Institute of Statistics (SIS).

CAD/Y: Current account deficit to GNP ratio (both in current prices), Annual Statistical Bulletin, The Central Bank of the Republic of Turkey, various issues.

FDEF/Y: Foreign deficit to GNP both in current prices, Main Economic Indicators, State Planning Organisation (SPO), various issues.

M2/GNP: Broad Money (M2) to GNP ratio, Annual Statistical Bulletin, The Central Bank of the Republic of Turkey, various issues.

PrCREDIT/GNP: Total credits to the private sector as a percentage of GNP, Annual Statistical Bulletin, The Central Bank of the Republic of Turkey, various issues.

GDEF/Y: The government deficit (Government Revenues - Government Expenditure) to GNP ratio (in current prices), Statistical Yearbook of Turkey (1928-1998), State Institute of Statistics (SIS).

YK/YL: The Distributional Indicator - the ratio of non-wage income (YK) to wage-income (YL) within the non-agricultural sector: Income Distribution, Taxation and Macro-Economic Indicators in Turkey, Ozmucur, S. (1995).

APPENDIX 8. B.

DATA SET

YEARS	Sir	CPI87	Ht/Yt	RYna	PCRYna	PRCna	PCRCna	POP15-44	INF	RSir
1960	0.035	0.0034							0.41	
1961	0.03	0.0035							0.41	0.042 0.989
1962	0.03	0.0038	1.64	12693.49	442.277	11703.906	407.797		0.41	0.094 0.941
1963	0.03	0.0041	1.62	13517.24	459.861	12556.650	427.181		0.41	0.057 0.974
1964	0.03	0.0042	1.64	13953.96	463.459	12515.108	415.670		0.42	0.027 1.003
1965	0.03	0.0044	1.69	14269.20	462.700	12728.966	412.755		0.42	0.043 0.987
1966	0.03	0.0046	1.58	16138.44	510.890	14065.011	445.252		0.42	0.064 0.968
1967	0.03	0.0049	1.62	16594.32	512.829	14565.923	450.143		0.42	0.065 0.967
1968	0.03	0.0061	1.93	14629.80	441.317	12854.560	387.766		0.42	0.245 0.827
1969	0.03	0.0066	2	14911.03	439.065	13128.550	386.578		0.42	0.078 0.955
1970	0.03	0.0072	1.92	16452.51	472.871	14217.877	408.644		0.42	0.082 0.952
1971	0.03	0.0083	1.81	18363.31	515.149	15989.209	448.548		0.42	0.165 0.884
1972	0.03	0.0095	1.75	20168.78	552.185	17341.772	474.787		0.42	0.137 0.906
1973	0.04	0.0110	1.67	22365.79	597.616	19108.280	510.575		0.42	0.159 0.897
1974	0.06	0.0130	1.47	26735.35	697.172	23121.166	602.925		0.43	0.187 0.893
1975	0.06	0.0156	1.51	27541.61	700.872	23681.178	602.633		0.43	0.198 0.885
1976	0.06	0.0182	1.47	29939.49	743.434	24515.952	608.761		0.43	0.164 0.911
1977	0.06	0.0233	1.53	30472.91	738.365	25460.017	616.901		0.43	0.279 0.828
1978	0.06	0.0343	1.69	29398.54	695.063	26332.847	622.582		0.43	0.472 0.720
1979	0.08	0.0537	1.56	33864.06	781.196	29376.164	677.666		0.43	0.568 0.689
1980	0.08	0.1158	1.77	31526.30	709.528	27457.891	617.964		0.43	1.156 0.501
1981	0.45	0.1550	1.72	33928.92	745.296	29901.954	656.838		0.44	0.339 1.083
1982	0.45	0.1893	1.60	38111.46	816.740	34619.123	741.898		0.44	0.221 1.187
1983	0.34	0.2487	1.68	38098.67	796.505	34215.182	715.315		0.44	0.314 1.020
1984	0.49	0.3691	1.60	41684.14	850.067	37081.471	756.204		0.44	0.484 1.001
1985	0.46	0.5350	1.67	42427.52	844.006	37691.546	749.794		0.45	0.449 1.007
1986	0.40	0.7202	1.73	44045.32	854.665	37858.065	734.606		0.45	0.346 1.040
1987	0.35	1.0000	1.29	46388.06	878.282	37232.558	705.000		0.45	0.389 0.972
1988	0.49	1.7370	1.44	46002.75	842.262	35274.069	645.888		0.46	0.737 0.858
1989	0.54	2.8360	1.44	50515.79	938.365	40522.643	752.801		0.46	0.633 0.940
1990	0.48	4.5460	1.47	54144.83	984.642	42666.858	775.979		0.47	0.603 0.921
1991	0.63	7.5440	1.63	53102.17	940.828	40810.685	723.119		0.47	0.659 0.980
1992	0.69	12.8310	1.71	54576.81	945.148	41248.329	714.391		0.48	0.701 0.992
1993	0.65	21.8255	1.71	59246.63	997.379	43337.146	729.617		0.48	0.701 0.968
1994	0.81	43.5840	1.88	58458.55	977.434	42714.423	714.253		0.48	0.997 0.906

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