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**WEALTH, CREDIT CONDITIONS AND CONSUMPTION:  
EVIDENCE FROM SOUTH AFRICA**

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# Wealth, Credit Conditions and Consumption: Evidence from South Africa

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**Abstract:** There is widespread disagreement about the role of housing wealth in explaining consumption. This paper exploits liquid and illiquid wealth time series from household balance sheet data for South Africa, previously constructed by the authors, to explain fluctuations in the ratios of consumption and household debt to income in South Africa, from 1971 to 2005. The paper emphasizes the role of substantial credit liberalization and of wealth, treating credit conditions as a latent variable with key interactions with drivers of consumption and debt. Credit conditions are proxied by a spline function entering jointly estimated consumption, debt and income expectations equations in a ‘latent interactive variable equation system’ (LIVES). The empirical results corroborate the theory in the paper, confirming that consumption relative to income is driven by credit liberalization, fluctuations in a range of asset values and asset accumulation, uncertainty and income expectations, inter alia. The paper confirms a collateral interpretation of housing wealth on consumption as opposed to a life-cycle interpretation. The paper also throws important light on the monetary policy transmission mechanism in South Africa.

**Keywords** consumption, household debt, credit market liberalization, credit conditions, liquid and illiquid wealth, housing collateral and housing wealth

**JEL** C52, E21, E27, E32, E44, E51, E52, E58

**Codes**

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## 1. Introduction

There is widespread disagreement about the influence of house prices on consumption, and intensive debate on how monetary policy should react to asset price fluctuations in the context of liberalised credit markets (see Rajan (2005) and associated papers from the Jackson Hole symposium, White (2009) and Mishkin (2011)). Housing markets and their consumption interactions have, in recent years, become an active research area.<sup>1</sup>

Unfortunately, much of the empirical literature exploring the consumption and housing wealth link, both macro and micro, is marred by poor controls for the common drivers both of house prices and consumption. Such controls potentially include income, income growth expectations, interest rates, credit supply conditions, other assets and indicators of income uncertainty (such as the change in the unemployment rate). The easing of credit supply conditions, for instance, is often followed by a house price boom. Failure to control for the direct effect of such credit liberalization on consumption can produce over-estimates of the effect of housing wealth or collateral on consumption. Fluctuations in asset prices and changes in access to credit can lead to huge forecasting errors when these variables are absent from the consumption function.

In emerging market economies, understanding the links between consumption, debt and wealth in the context of liberalised credit markets is of increasing policy importance. This paper is a data-intensive exploration of such wealth and collateral effects for South Africa, drawing on time series of wealth estimates on a market value basis developed in Aron and Muellbauer (2006a) and Aron et al. (2006b, 2008). We believe these to be the most comprehensive balance sheet data to date for an emerging market or developing economy (generally lacking even a measure of total net worth), and the first time the consumption implications of wealth and shifting credit market conditions have been investigated for such an economy. An important innovation relative to preceding work on emerging markets is to estimate marginal propensities to consume for a three-way split of assets, liquid, illiquid and housing wealth, emphasising the different “spendability” of such assets.

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<sup>1</sup> There are attempts to introduce housing into DSGE models, Iacoviello (2005), and to give some micro-foundations to the financial accelerator via households, Aoki et al. (2004). Attanasio et al. (2011) use a calibrated partial equilibrium model with a realistic treatment of mortgage constraints to simulate the impact of house prices and income on consumption. Recent multi-country empirical studies of the housing-consumption link on macroeconomic data include Slacalek (2009), Case et al. (2005) and Catte et al. (2004). Earlier studies include Kennedy and Andersen (1994). The role of housing in the financial crisis is discussed by Duca et al. (2010).

Our ‘credit-augmented’ life-cycle consumption function incorporates more complete controls than are generally employed in the literature, including a measure of consumer credit conditions and its interactions with a variety of economic variables such as interest rates, proxies for income uncertainty, and income growth expectations generated by a forecasting model. This coherent treatment of income growth expectations is missing from most published research.

South Africa has experienced substantial credit market liberalization and rises in consumption and debt to income ratios ((Figure 1).<sup>2</sup> However, in the 1980s, this liberalization occurred without an asset price boom, facilitating the identification of the direct effects of credit liberalization on consumption. In other countries, the correlation of credit liberalization with asset price movements impedes the disentangling of the direct effect. We estimate joint debt, consumption and income forecasting equations with an unobservable credit supply indicator entering all three equations. This indicator is proxied by a spline function guided by institutional information on credit market liberalization. The parameters are estimated, subject to cross-equation restrictions, from a joint estimation of the household consumption, debt and income forecasting equations.

We have named this type of equation system a Latent Interactive Variable Equation System (LIVES) since the latent variable enters interactively as well as additively. This method is an innovative approach<sup>3</sup> to proxy a credit conditions indicator (*CCI*).

We distinguish among three effects of credit liberalization on consumption, which earlier literature had not brought out clearly. Liberalization reduces the credit constraints on households engaging in smoothing consumption when they expect significant income growth; it also reduces deposits required of first-time buyers of housing; and it increases the availability of collateral-backed loans for households which already possess collateral, see Miles (1992, 1994). The three facets imply both a shift in the average propensity to consume, and important interaction effects, for example with housing wealth, income growth expectations, and perhaps with interest rates and indicators of uncertainty.

Our empirical evidence supports the three facets of credit liberalization on consumption and suggests that for South Africa, where credit markets are now fairly liberal, the marginal propensity to spend out of housing wealth has, in recent years, exceeded that for

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<sup>2</sup> Low saving rates are a symptom of a persistent structural weakness in South Africa (see Aron and Muellbauer, 2000a), reflected in a continuing dependence on foreign capital inflows.

<sup>3</sup> The first implementation of LIVES in the public domain, of which we are aware, is for South Africa, and is summarised in non-technical form in Aron and Muellbauer (2000a), based on an earlier incarnation of the SA consumption and debt functions in Aron and Muellbauer (2000b).

illiquid financial wealth, but is less than that out of net liquid assets. These estimates complement new evidence for wealth effects when accounting for credit liberalization in the U.S., U.K., Australia and Japan (Aron et al., 2011; Muellbauer and Williams, 2011).

The outline of the paper is as follows. Sections 2 and 3 briefly provide a theoretical background for the econometric specification applied to time series data for South Africa. In section 4, we provide specific evidence through comparisons of well-specified empirical models. Section 5 concludes.

## 2. The Consumption Model

We follow the exposition in Aron et al. (2011) in setting out the modernization of the textbook life-cycle or permanent income consumption function required to analyse an economy where shifts in credit market conditions have been important. This solved-out Friedman-Ando-Modigliani basic aggregate life-cycle/permanent income consumption function has the form:

$$c_t = \gamma^* A_{t-1} + \omega^* y_t^p \quad (1)$$

where  $c$  is real per capita consumption,  $y^p$  is permanent real per capita non-property income<sup>4</sup> and  $A$  is the real per capita level of net wealth. This consumption function requires an income forecasting model to generate permanent non-property income. Unlike the Euler equation, see Hall (1978), it does not ignore long-run information on income and assets, though in the formulation above the distinction between types of assets is ignored. This general approach also has a basic robustness feature missing in the Euler equation. Euler equations require well-informed households continuously and efficiently trading off between consuming now and consuming next period, but fail basic empirical tests.<sup>5</sup> In contrast, the extension of equation (1) discussed below is consistent with a fairly rudimentary comprehension of life-cycle budget constraints. Any household with some notion of wanting to sustain consumption will realize that not all of its assets can be spent now without damaging future consumption, and that future income has a bearing on sustainable

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<sup>4</sup> Non-property income is the relevant income concept in standard life-cycle models where property income is defined by rates of return on assets, and assets are choice variables.

<sup>5</sup> The extreme assumption in the Euler equation is one of full rationality: consumers are assumed to face linear budget constraints (they can borrow as much as they like at a given interest rate) and to continuously optimise their spending and portfolio decisions taking full account of all publicly available information. See Campbell and Mankiw (1991) for international evidence rejecting the central prediction of the Euler equation, that consumption growth should be unpredictable given past information.

consumption. As we shall see, practical applications of extensions of equation (1) capture these basic ideas.

Since consumption and income tend to grow exponentially, formulating the consumption function in logs has advantages. The log approximation of equation (1) is:<sup>6</sup>

$$\ln c_t = \alpha_0 + \ln y_t + \gamma A_{t-1}/y_t + \ln(y_t^p/y_t) \quad (2)$$

where  $\gamma = \gamma^* / \omega^*$  and  $\alpha_0 = \omega^*$ .<sup>7</sup> The log ratio of permanent to current income  $\ln(y_t^p/y_t)$  reflects expectations of income growth and in practice can be proxied by functions of forecasted income growth rates.

The difference between log permanent income and log current income in equation (2) can be closely approximated by an expression in logs of expected future non-property incomes:

$$\ln(y_t^p/y_t) = \left( \sum_{s=1}^k \delta^{s-1} E_t \ln y_{t+s} \right) / \left( \sum_{s=1}^k \delta^{s-1} \right) - \ln y_t \quad (3)$$

Here  $\delta$  is a discount factor, for example 0.95, so that future expected incomes are discounted more and more heavily as the horizon extends. This expression is also equivalent to a weighted moving average of forward-looking income growth rates. A dynamic specification of the static form, for instance to introduce habits or adjustment costs, implies a partial adjustment form of equation (2).

If real interest rates are variable, standard consumption theory suggests the real interest rate  $r_t$  enters the model with the usual interpretation of inter-temporal substitution and income effects. Extending the model further to include probabilistic income expectations suggests the introduction of a measure of income uncertainty,  $\theta_t$ . With income uncertainty, the discount factor,  $\delta$ , in expected income growth as measured by  $\ln(y_t^p/y_t)$  should incorporate a risk premium, allowing the possibility that households may discount the future more heavily than by the real rate of interest..

This gives the following generalisation of the canonical permanent income model of consumption in equation (2):

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<sup>6</sup> After taking logs, two approximations are used: first, the fact that  $\ln(1+x) \approx x$  and then the further approximation,  $(y^p - y)/y \approx \ln(y^p/y)$ , see Aron et al. (2011).

<sup>7</sup> One important advantage of equation (2) is that it avoids the log assets formulation employed in many studies of consumption. The log formulation is a poor approximation when asset levels are low, as is true for many

$$\Delta \ln c_t \approx \lambda(\alpha_0 + \alpha_1 r_t + \alpha_2 \theta_t + \ln y_t + \alpha_3 E_t \ln(y_t^p / y_t) + \gamma A_{t-1} / y_t - \ln c_{t-1}) + \varepsilon_t \quad (4)$$

where  $\lambda$  measures the speed of adjustment. In principle, the coefficients  $\alpha_3$ ,  $\delta$  and  $\gamma$  could depend upon the real interest rate,  $r_t$  and on  $\theta_t$ , since discount factors applied to expected incomes will increase with income uncertainty. For simplicity, this complication and the associated potential non-linearities are ignored here.

In practice, there are a number of reasons why income growth expectations embodied in  $\ln(y_t^p / y_t)$  are likely to reflect a relatively limited horizon. With aggregate data it is difficult to forecast income beyond about three years except by reversion to a trend. Furthermore, shorter horizons are suggested if households anticipate future credit constraints, according to the buffer-stock theory of saving explained in Deaton (1991). Precautionary behaviour also generates buffer-stock saving, as in Carroll (2001a,b), where it is argued that plausible calibrations of micro-behaviour can give a practical income forecasting horizon of about three years. This horizon was originally suggested by Friedman in his application of the permanent income hypothesis to aggregate consumption data.

The formulation in equation (4) still needs to split up assets into different types with different spendibilities. One reason is that housing wealth differs fundamentally from financial assets since a roof over one's head gives shelter (has utility value) as well as having an asset value. The second reason is that, with credit constraints, housing wealth has a collateral role see Muellbauer (2007) or Aron et al. (2011) for further discussion.<sup>8</sup> A third reason is that illiquid financial assets, subject to asset price volatility, and in the case of pensions, to trading restrictions, are different from liquid financial assets<sup>9</sup> and debt. Variations in household access to credit induce time variation in key parameters of the

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households, especially in emerging economies. It is also a poor approximation when testing hypotheses on disaggregated assets.

<sup>8</sup> The micro-simulation model by Attanasio et al. (2011) gives a credit interpretation of the effect of housing wealth on consumption. This model makes significant progress towards micro realism in understanding the relationships between house prices, incomes and consumption. The value function for the choices made by households (p. 410), together with the inequality constraints (p. 411-12), incorporate a realistic snapshot of UK mortgage market constraints. These include maximum loan to value and loan to income ratio constraints. Conditional on estimated/calibrated models for individual incomes and for average income and house prices, the authors simulate optimal consumption for each age cohort to illuminate the role of house prices and income. Our consumption function can be thought of as an empirical approximation for aggregate data to a micro-simulation model of this type with extra richness that comes from also distinguishing liquid from illiquid financial assets and linking unemployment and income uncertainty.

<sup>9</sup> Otsuka (2006) has formalised a model in which trading costs for illiquid assets imply a higher spendibility for liquid assets.

consumption function. This suggests the following ‘credit-augmented’ version of the Friedman-Ando-Modigliani consumption function:

$$\Delta \ln c_t \approx \lambda \left( \begin{aligned} &\alpha_{0t} + \alpha_{1t} r_t + \alpha_{2t} \theta_t + \alpha_{3t} \ln(y_t^p / y_t) \\ &+ \gamma_1 NLA_{t-1} / y_t + \gamma_2 IFA_{t-1} / y_t + \gamma_3 HA_{t-1} / y_t \\ &+ \ln y_t - \ln c_{t-1} \end{aligned} \right) + \beta_{1t} \Delta \ln y_t + \beta_{2t} \Delta nr_t (DB_{t-1} / y_t) + \beta_{3t} \Delta \theta_t + \varepsilon_t \quad (5)$$

The time variation in some of the parameters, seen in their time subscripts, and induced by shifts in credit availability, is discussed below.

The net worth to income ratio has been disaggregated into three elements:  $NLA/y$  is the ratio of liquid assets minus debt to non-property income,  $IFA/y$  is the ratio of illiquid financial assets to non-property income, and  $HA/y$  is the ratio of housing wealth to non-property income, all in real terms. The term  $\Delta nr_t (DB_{t-1} / y_t)$ , where  $nr$ , the nominal interest rate on debt,  $DB$ , measures the cash flow impact on indebted households from changes in nominal rates. The speed of adjustment is given by  $\lambda$ , and the  $\gamma$  parameters measure the marginal propensity to consume ( $mpc$ ) for each of the three types of assets. The evidence from several countries is that the change in the unemployment rate is a good proxy for income uncertainty,  $\theta_t$ , or for a shift in income uncertainty. The term in the log change of income allows for the possibility that some households’ spending growth follows current income growth more closely than implied by equation (2). This could also be because some, perhaps less sophisticated, households take current income growth as an indicator for future income growth. Equation (5) has the most basic life-cycle model (i.e. equation (2)) as a special case<sup>10</sup>.

The credit channel is reflected in the consumption function through the different  $mpcs$  for net liquid assets and for housing; through the cash flow effect for borrowers; and by allowing for possible parameter shifts stemming from credit market liberalization. Credit market liberalization potentially should: (i) raise the intercept  $\alpha_0$ , implying a higher level of  $\ln(c/y)$ , mainly because of reduced saving for a housing down-payment – the direct effect

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<sup>10</sup> Note that  $\lambda = 1$ ,  $\alpha_{1t} = \alpha_{2t} = 0$ ,  $\gamma_1 = \gamma_2 = \gamma_3$ ,  $\beta_{1t} = \beta_{2t} = \beta_{3t} = 0$  and  $\alpha_{3t} = 1$  are the restrictions which result in equation (2). Equation (5) also encompasses (is more general than, but has as a special case) equation (4).



of liberalization; (ii) make the real interest rate coefficient,  $\alpha_1$ , more negative as scope for inter-temporal substitution rises; (iii) lower  $\alpha_2$  and  $\beta_3$  because of reduced concern with income uncertainty, though higher debt levels could cancel this tendency; (iv) raise  $\alpha_3$  by increasing the impact of expected income growth; (v) increase the *mpc* for housing collateral,  $\gamma_3$  with greater access to home equity loans; (vi) lower the current income growth effect,  $\beta_1$ , because fewer credit-constrained households reduces the role of current income; and (vii) lower the cash flow impact,  $\beta_2$ , of the change in the nominal rate since refinancing becomes easier.

With a measurable indicator of the degree of credit market liberality, a credit conditions index (*CCI*), it would be possible to make each potentially time-varying parameter a linear function of the *CCI* and test these hypotheses about time variation.

This equation satisfies long-run homogeneity in income and assets: doubling both, doubles consumption. The long run coefficient on  $\ln y$  is set to 1. This means that the income endogeneity issues which Hall (1978) highlights are not of concern for the measurement of the long-run income and asset effects: variations in asset to income ratios are dominated by movements in lagged asset prices, so that the endogeneity of income is practically irrelevant, except possibly for the estimation of the coefficient on  $\Delta \ln y_t$ .

### 3. A Debt Equation

In contrast to the vast literature on consumption, little systematic econometric work exists on household debt, see the review in Fernandez-Corugedo and Muellbauer (2006). The canonical REPIH model of the representative consumer has little to contribute to understanding the determination of aggregate household debt. In that model there is only a single asset, so that it can explain only the evolution of aggregate net wealth. In practice, consumers have multiple motives for holding debt. These include first, consumption-smoothing through temporary income downturns; second, acquiring debt in anticipation of higher future income; third, borrowing to finance the acquisition of consumer durables and housing, human capital investment through education or training, or portfolio investment in financial assets when return prospects look favourable; and finally, using debt to offset what could otherwise be excessive amounts of saving implied by occupational pension rules.

Given asymmetric information between lenders and borrowers, assets have an important collateral role. Most debt is backed by collateral in the form of durables, housing and other assets. In a closed financial system, much of household saving in liquid asset form is recycled by the financial system into lending for other households, suggesting that at the aggregate level, current end-of-period household debt should increase with liquid and illiquid asset stocks, including housing, at the end of the previous period. Variables such as income, interest rates and proxies for income uncertainty, reflecting economic conditions during the period, will also influence current debt. We use a log formulation, linking the log debt to income ratio with log ratios to income of the various assets, and to the log of real income to obtain the following long-run equation for debt:

$$\begin{aligned} \ln debt_t = & \delta_{0t} + \delta_{1t} r_t + \delta_{2t} \ln nr_t + \delta_{3t} \theta_t + \delta_{4t} \ln(y_t^p / y_t) + \delta_5 \ln y_t \\ & + \phi_{1t} \ln(HA_{t-1} / y_t) + \phi_{2t} \ln(LA_{t-1} / y_t) + \phi_3 \ln(IFA_{t-1} / y_t) + \phi_4 DEMOG \end{aligned} \quad (6)$$

This equation incorporates both a real interest rate and the  $\log^{11}$  of the nominal rate,  $nr$ . The latter incorporates the cash-flow constraint on the ability to finance debt and both would be expected to have negative coefficients. The equation also incorporates income uncertainty, the log ratio of permanent to current income, log income, three log asset to income ratios and demographic composition since a younger age structure should be associated with higher levels of debt.

Credit market liberalization should impact in several ways on this long-run relationship. A direct, positive effect on debt should result from the different facets of credit liberalization, with, for example, more freely available credit card loans, lower housing down-payments as a fraction of house values, and housing equity loans more freely available to existing owners. This is why  $\delta_0$  should increase with  $CCI$ . There may also be interaction effects from credit liberalization reflected in time subscripts on some parameters in equation (6): for example, real interest rates may matter more with liberalization, making  $\delta_{1t}$  more negative, while nominal ones perhaps matter less, making  $\delta_{2t}$  less negative. Income uncertainty may matter less after liberalization, making  $\delta_{3t}$  less negative. If households borrow more when they have

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<sup>11</sup> Note that the debt service ratio, defined by the product of the nominal mortgage rate and debt, scaled by current income, is a cash-flow measure of affordability. The log formulation makes sense since the dependent variable is in logs and plausibly depends on the log of the nominal interest rate and on log income.

positive income growth expectations, one might expect the effect of income expectations on debt to increase with  $CCI$ , increasing  $\delta_{4t}$ .

More liberal use of housing wealth as collateral for a mortgage should increase the coefficient on housing wealth to income, so that  $\phi_1$  increases with  $CCI$ . A reduced coefficient on liquid assets is likely, as bank lending then becomes less constrained by liquid deposit holdings of the personal sector, so that  $\phi_2$  decreases with  $CCI$ . Indeed, at the micro-level, households holding significant levels of liquid assets have less need to borrow, suggesting a negative relationship between current debt and lagged liquid assets. On the practical implementation, see below, we adopt an equilibrium correction formulation which adds some short term dynamics.

## 4. Empirical Results for South Africa

Variables are defined in Table 1. Stationarity tests<sup>12</sup> indicate that all variables are non-stationary and  $I(1)$ , except for the real prime rate and the ratio of property income to non-property income,  $(y^{prop} / y)$ .

### 4.1 Wealth Data

The quarterly disaggregated wealth estimates on a market value basis used in this paper were constructed in Aron and Muellbauer (2006a) and Aron et al. (2006b, 2008) and appear to be the first systematic attempt to construct comprehensive balance sheet data for an emerging market economy. The South African Reserve Bank has now taken over production and updating of these data, publishing an aggregate measure of net wealth (Kuhn, 2010).

The estimates of illiquid and liquid personal wealth are shown in Figure 2. The ratio of household liquid assets minus debt relative to non-property income seems to have been relatively stable in the 1970s. From the mid-1980s to the late 1990s, however, this household

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<sup>12</sup> For a variable  $X$ , the augmented Dickey-Fuller statistic is the  $t$  ratio on  $\pi$  from the regression:  $\Delta X_t = \pi X_{t-1} + \sum_{i=1,k} \theta_i \Delta X_{t-i} + \psi_0 + \psi_1 t + \varepsilon_t$ , where  $k$  is the number of lags on the dependent variable,  $\psi_0$  is a constant term, and  $t$  is a trend. The  $k$ th-order augmented Dickey-Fuller statistic is examined, where  $k$  is the last significant lag of the lags employed. The trend is included if significant. For null order  $I(2)$ ,  $\Delta X$  replaces  $X$  in the equation above. Stationarity tests are performed for the variables in levels before time-transformation. (These tests are available from the authors on request.)

net liquid assets ratio fell sharply.<sup>13</sup> This coincided with both a drop in the personal saving ratio, as implied by the income and expenditure accounts, and a switch to saving in pension and retirement funds offering superior returns to those on liquid assets.

Pension wealth has grown relative to income since the 1980s.<sup>14</sup> Between 1987 and 2005, pension wealth was the single biggest asset, given the decline of housing wealth relative to income in the later 1980s and the 1990s, though since 2000 there has been a strong rise in housing wealth relative to income.<sup>15</sup>

## 4.2 Credit Liberalization

Although the implications of credit liberalization have aroused interest, controversy, and a growing literature, there are few satisfactory applied analyses of these implications in the consumption literature. One major difficulty has been to find an indicator of credit market deregulation, *CCI*, with which to model the direct and interaction effects of credit liberalization. Proxying *CCI* by the ratio of debt to income, as in Bayoumi (1993a, 1993b) and Sarno and Taylor (1998), is not ideal because this ratio is endogenous and responds with a lag to deregulation and depends too on income expectations, asset levels, uncertainty, and interest rates. Bandiera et al. (2000) propose the technique of principal components to summarize the composite information in a set of dummy variables reflecting different facets of credit liberalization. However, the weights do not reflect the *behavioural* impact of credit liberalization. A flexible technique linking institutional information with behavioural responses is needed.

Our innovation is to treat credit liberalization as a ‘latent variable’, an unobservable indicator entering household debt, consumption and income forecasting equations. The indicator, *CCI*, is proxied by a non-linear spline function whose parameters are estimated

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<sup>13</sup> Financial liberalization from 1983 into the 1990s is partly responsible for the decline, as it reduced the precautionary, buffer-stock and consumption smoothing motives for holding liquid assets. Political credibility effects probably induced currency substitution away from domestic assets and toward illegal foreign assets, especially after 1976 until the democratic elections of 1994. However, the main factor is the negative real after-tax return on liquid assets from the early 1970s to the early 1990s - apart from a brief spell in 1984-5 (see Prinsloo, 2000, p.17). Higher returns help explain the renewed rise in the liquid asset to income ratio from the late 1990s.

<sup>14</sup> Much of the rise in the ratio of pension assets to income can be explained by a weighted average of total returns indices for equities and bonds. However, there are other factors, including the relaxation of restrictions on official pension funds (for government employees), which had prevented their holding of equities (Mouton Report 1992); improvement in the returns on government and parastatal bonds with deregulation of interest rates after 1980 and declining inflation in the 1990s; and relaxation of prescribed holdings of government bonds for all pension funds. Tax incentives have also favoured investment in pensions over directly held financial securities.

jointly in the three equations. The common latent variable enters the equations interactively, introducing time variation in key parameters, as well as additively. Hence we term this type of equation system a Latent Interactive Variable Equation System (LIVES).

We briefly summarise the key episodes of credit market liberalization. The government initiated liberalization following the de Kock Commission reports (1978, 1985) advocating a more market-oriented monetary policy. Interest and credit controls were removed from 1980, and banks' liquidity ratios were reduced substantially between 1983 and 1985. There may have been a temporary reversal after the third quarter of 1985 as a result of South Africa's international debt crisis, when net capital inflows dropped sharply. Competition intensified in the mortgage market following the 1986 Building Societies Act, and amendments to the Act in 1987-88. Demutualization and takeovers in 1989-90 consolidated the stronger competition in the credit market. In the 1990s pensions were increasingly used to provide additional collateral for housing loans; while from 1995, special mortgage accounts ("access bond accounts") allowed households to borrow and pay back flexibly from these accounts up to an agreed limit set by the value of their housing collateral. After the 1994 elections more black South Africans obtained formal employment, particularly in the public sector, gaining access to credit that they may previously have been denied. Exchange controls on non-residents were eliminated in early 1995: large non-resident capital inflows from mid-1994 induced a temporary endogenous financial liberalization. Exchange controls on domestic residents, in existence since before the 1960s, were partially relaxed after 1997. After the Asian financial crisis in 1997, followed by the Russian default, capital flows to emerging markets shrank. This plausibly led to a decline in access to credit by South African households. In 1998, tougher capital requirements were imposed on banks where mortgage lending exceeded an 85 percent loan to value ratio. In May 2002, one of South Africa's micro-lenders, Saambou Bank, had to be rescued; although there was no wider banking crisis, it is likely that bank supervision was tightened as a result. A National Credit Regulator was created in 2005 and a series of Credit Acts, e.g. in 2005 and 2007, regulated lenders. The banking system in South Africa has escaped the global financial crisis relatively unimpaired suggesting well-managed financial regulation and supervision (see Nel, 2009).

This qualitative portrait has implications for our univariate measure of credit liberalization, *CCI*. The first is of a mainly monotonic rise in the indicator until around 1998, with plausible exceptions of a temporary episode after the debt crisis in 1985 and in the early

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<sup>15</sup> For further discussion of trends, see Aron and Muellbauer (2006a) and Aron et al. (2006b, 2008).

1970s when the decline in real interest rates led to increased rationing of credit.<sup>16</sup> The second is for particularly strong rises in 1981-84, and after 1986, some consolidation in the early 1990s, and a renewed rise after 1994, followed by a possible contraction in 1997 and the early 2000s. Unfortunately, available information on institutional changes does not permit further quantitative or qualitative implications to be drawn.

We define *CCI* using a non-linear spline function. Define a step-dummy, *D8I*, which is zero up to 1980Q4 and is 1 from 1981Q1. The 4-quarter moving average, *D8IM*, then takes the values 0.25, 0.5, 0.75 and 1 in the 4 quarters, respectively, of 1981, and the value 1 thereafter. Now take the 5-quarter moving average of *D8IM*, denoted *D8IMM*. This smoothed step dummy makes an S-shaped transition from zero to one from 1980Q4 to 1982Q4. The same method was used to generate smoothed step dummies for all the years from 1973 to 2004. A linear combination of these smoothed step dummies defines the *CCI* function as a kind of ‘spline’ function:

$$CCI = d73 \times D73MM + d74 \times D74MM + \dots + d04 \times D04MM - d73 \quad (7)$$

where up to 32 parameters (i.e. *d73* to *d04*) could be estimated. By subtracting *d73*, *CCI* is normalised to be zero in the years following 1973-4, before turning up later. The *CCI* function has the property that if the parameter *dT* for year T is positive (negative), then *CCI* increases (decreases) for the next seven quarters. This property makes it easy to impose the constraint (where relevant) that the parameters be non-negative (i.e. that there is no reversal in financial liberalization, except in the early 1970s, in 1985-86, and from 1997). Where these institutional priors were violated, the *dT* coefficients were set to zero. In the process of reduction of the whole system to a parsimonious form, insignificant values were sequentially set to zero.

Potentially there could be identification problems in estimating such a richly parameterised system. To avoid convergence problems a set of prior constraints on key parameters in the three equations were imposed. These included sign priors on interest rate effects and interaction effects, as discussed above. For the consumption function, estimates were constrained to lie in the following broad ranges: 0.07 to 0.25 for net liquid assets, 0.015-0.06 for illiquid financial assets and 0.015-0.20 for housing wealth at the end of the period.

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<sup>16</sup> In other countries such as the U.S., U.K. and Australia there was a decline in credit availability in around 1991-2 linked with new Basel regulations and bad loans in the banking industry. It is questionable whether South Africa would have experienced anything similar as it was still exposed to financial sanctions, though after the release of Nelson Mandela in February 1990 the international climate softened. Nevertheless, the possibility of a small contraction in the early 1990s was tested for.

These ranges include most estimates that can be found in the international literature. For the debt equation, negative wealth effects were excluded, and the long-run scale elasticity (to the combination of income and different kinds of wealth) was constrained to lie in the range 1 to 1.6.. The minimum value of 1 implies that debt grows at least in line with the scale of the economy. The maximum value of 1.6 exceeds estimates for the UK by Fernandez-Corugedo and Muellbauer (2006) and earlier studies, and for Australia by Muellbauer and Williams (2011).

In practice, twelve parameters were needed to define the *CCI* in estimation from 1971Q2 to 2005Q4. Details of the *CCI* parameters are shown in Table 5, following the consumption and debt function results in Tables 3 and 4. Figure 3 shows two versions of the estimated credit conditions index: they reveal a small fall from 1973, strong rises from the early 1980s until just before the debt crisis of 1985, then a temporary reversal, strong rises in 1987-89 and from 1994-95. Interestingly, there is no sign of further liberalization after 1996, when *CCI* has reached its peak value of 0.66 (or 0.73 on the alternative measure discussed further below). Indeed, estimated *CCI* declines from 1997 to 2003 and finally appears to rise slightly from 2004. These patterns are consistent with the evolving institutional picture painted earlier.

### 4.3 The Income-forecasting Equation

During the 1980s in South Africa, there were significant regime changes with the move to new operating procedures for monetary policy and a series of internal financial liberalizations. Periodically, serious political crises entailed the increasing international isolation of South Africa, reflected in diminished trade and finance, while its mineral dependency as a primary exporter gives an important role to terms of trade shocks in determining income growth.

We derive a forecasting model for the rate of growth of real per capita disposable non-property income,  $\log(y_{perm} / y)$ , as defined in equation (3). Split trends are used to capture the long-run changes in productivity growth expected in an economy subject to such regime changes. By incorporating these shifts, the consumption function including the income growth forecasts should be robust to the Lucas critique (Lucas, 1976).

The model has the following form:

$$\ln(yperm_t / y_t) = \alpha_0 + Split_t + \alpha_1 \ln y_t + \sum_{i=2}^n \alpha_i X_{i,t} + \sum_{i=1}^n \sum_{s=0}^k \beta_{is} \Delta X_{i,t-s} + \varepsilon_t \quad (8)$$

where  $y_t$  is real per capita disposable non-property income;  $Split_t$  are split trends reflecting the evolution of the capacity of the economy to produce and to sustain per capita personal incomes; and the  $X_i$ s for  $i=2\dots n$  indicate other explanatory variables excluding  $\ln y$ , where  $\Delta X_1 = \Delta \ln y$ , and  $k$  is the maximum lag length considered on changes in the  $X_i$ s.

This equation can be reformulated as an equilibrium correction formulation with a long-run solution given by

$$\ln yperm = -(\alpha_0 + Split + (1 + \alpha_1) \ln y + \sum_{i=2}^n \alpha_i X_i) \quad (9)$$

The broad set of explanatory variables in a general formulation from which a parsimonious model was selected include: the level of real interest rates and changes in nominal interest rates, the government surplus to GDP ratio, capacity utilization (as a proxy for the unemployment rate), terms of trade, a measure of trade openness, the real exchange rate, the growth rate of OECD industrial production, domestic credit growth in South Africa, real house prices and a real stock market price index. The changing sensitivity of income growth to interest rates as the monetary policy regime changed is captured by a dummy indicator based on prescribed liquid asset requirements for commercial banks, see Aron and Muellbauer (2002).

To construct log permanent income using equation (3), a 40 quarter horizon was adopted and a quarterly discount factor of 0.95, equivalent to an annual discount rate of about 20 percent. We used actual data on personal per capita income to 2010Q4 and assumed a quarterly growth rate of 0.6 percent thereafter.

The log ratio of permanent to current income  $\log yperm / y$  was modelled<sup>17</sup> on quarterly data for 1968-2005, though with a restricted lag structure.<sup>18</sup> The included split time trends reflect a slowdown beyond 1984 stemming from the 1985 debt crisis, and faster growth after the release of Nelson Mandela in 1990Q1 and the democratic elections in 1994Q2 after which capital flows increased. In model selection, explanatory variables were

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<sup>17</sup> Model selection for the equation for permanent income was performed on data from 1968. The FIML estimation for 1971-2005 of the three equation system consisting of equations for consumption, debt and log permanent income/current income was performed in Hall, Cummins and Schnake's Time Series Processor (TSP 4.5) package.

<sup>18</sup> For lags longer than three, we restricted the dynamics to fourth differences or four-quarter moving averages, to prevent over-parameterisation.



retained if they satisfied sign priors as well as being significant: asset price and terms of trade price effects should be positive, real interest rate effects negative, the real exchange rate effect negative, the effect of domestic credit growth positive, and trade openness positive.

Table 2 shows estimates of the resulting parsimonious equation and Figure 4 plots fitted and actual values of  $\ln y_{perm} / y$ .<sup>19</sup> The figure shows a notable increase in the actual and fitted values of  $\ln y_{perm} / y$  from the early 1990s. The model has three long-run effects: log real gold prices, log real house prices and the real prime rate of interest. Similar results are obtained using the terms of trade in place of the real gold price. In the dynamics, only changes in log income, changes in nominal interest rates and their interaction with a dummy for prescribed liquidity ratios matter. There are reasons to think that the influence of house prices on future income rose with credit market liberalization. One reason is a general equilibrium argument. If credit liberalization increases the effect of housing wealth on consumption, then, since consumption is of the order of 70 percent of GDP, one might expect an effect on future income from the interaction of real house prices with CCI. Indeed, the interaction effect of log real house prices with CCI is more significant than log real house prices alone. However, the results for the other equations are similar for the alternative specifications of the real house price effect.

#### 4.4 The Estimated Consumption Equation

Section 2 explained the various extensions required to the aggregate consumption equation (3) to incorporate different aspects of financial liberalization and a range of weights for different types of assets.<sup>20</sup>

We analyse quarterly data for 1971-2005, constrained by the availability of wealth stock data (Section 4.1). Several other data issues arise. Although self-employment is part of the theoretical definition of non-property income, these data are not separately available in the South African national accounts. The real, per capita, non-property income measure,  $y$ ,

<sup>19</sup> Given the overlapping nature of the dependent variable, the residuals of the equation, as expected, are autocorrelated, as the Durbin-Watson test and LM tests (not shown) confirm.

<sup>20</sup> The South African Reserve Bank's core forecasting model, see Smal et al. (2007), uses an equilibrium correction model linking log consumption with log personal disposable income, log net worth and the real interest rate using data from 1985 to 2005. This is an important advance on earlier models which omitted the role of assets. However, the (commonly-made) assumption that all components of wealth have the same effect on consumption runs counter to economic theory. Housing is a consumption good as well as an asset. Thus, inter-temporal consumption theory implies that a rise in house prices, unlike a rise in the stock market prices,

consists of tax-adjusted income from employment and transfers from the government. To obtain a proxy for income from self-employment, we assume that it is a constant share of mixed property and self-employment income. If tax-adjusted, self-employment income were a constant fraction  $\phi$  of property income,  $y^{prop}$ , we could replace  $y$  by  $y + \phi y^{prop} = y(1 + \phi y^{prop} / y)$ . In our log-formulation, this suggests  $(y^{prop} / y)$  as an additional regressor.

A second measurement issue concerns developing a proxy for the change in the unemployment rate, an indicator of  $\Delta\theta$ , a measure of increased uncertainty. South African data on the unemployment rate are thought to be unreliable. The rate of growth of employment is an alternative proxy (with the opposite sign). However, between the early 1990s and 2004, the sampling frame for the employer-based survey of employment became increasingly out of date, resulting in a likely downward bias in the measured growth rate of employment. We therefore adjust the published series slightly<sup>21</sup>.

The resulting consumption equation, corresponding to equation (5), but with minor additions, takes the following form (see Table 1 for variable definitions). A few impulse dummies are also included.<sup>22</sup>

$$\begin{aligned}
\Delta \ln c_t = & \lambda[(\alpha_0 + \alpha_{0c} \times CCI_t) + (\alpha_1 + \alpha_{1c} \times CCI_t)(rma_t)^* \\
& + (\alpha_3 + \alpha_{3c} \times CCI_t)E_t \ln(yperm_t / y_t)^* + \alpha_4(y^{prop} / y)_t \\
& + \gamma_1 NLA_{t-1} / y_t + \gamma_2 DHIFA_{t-1} / y_t + \gamma_3 PA_{t-1} / y_t \\
& + (\gamma_3 + \gamma_{3c} \times CCI_t)(HA_{t-1} / y_t)^* \\
& + \ln y_t - \ln c_{t-1}] \\
& + (\beta_1 + \beta_{1c} \times CCI_t)(\Delta \ln y_t)^* + (\beta_2 + \beta_{2c} \times CCI_t)(\Delta_4 nr_t \times debt_{t-1} / y_t)^* \\
& + (\beta_3 + \beta_{3c} \times CCI_t)(\Delta_4 \ln empl_t)^* \\
& + \beta_4 \Delta_2 \ln pc_t + \beta_5 \Delta \ln c_{t-1} + dummies + \varepsilon_{1t}
\end{aligned} \tag{10}$$

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has both an income and substitution effect and a wealth effect on consumption, see Muellbauer (2007). Moreover, liquid assets are necessarily more spendable than, say, pension wealth.

<sup>21</sup> We adjust the annual growth rate up by 2 percent between 1992:3 and 2004:3 and adjust for breaks in the data in 2002Q3 and 2004Q4. The 2 percent adjustment is phased in gradually between 1992Q1 and 1993Q4. The adjustment lessens the notable dip in the measured growth rate of employment from around 1992 to 2003.

<sup>22</sup> To simplify the expression we exclude details of the dummies from this equation. The dummies are Q1DU75, D751, GST78, GST84. Note that Q1DU75 is a pre-1976 seasonal to reflect mis-measured seasonal correction in the data before that date. D751 captures an outlier in 1975Q1 and GST78 and GST84 are dummies taking values +1, -1 in successive quarters, reflecting shifting of expenditure in anticipation of increases in sales tax in 1978 and in 1984.

In the long-run part of the equation, the speed of adjustment is given by  $\lambda$  while  $\alpha_{0c}$  measures the shift in the level of consumption due to the easing of credit conditions. The variable  $rma$  is the 4-quarter moving average of the real prime rate of interest, which moves closely with the mortgage rate. The star superscript on this and other variables means that the variable is defined as the deviation from its end of 1980 value, just before the rise in  $CCI$ .<sup>23</sup> The next two terms are income terms. The ratio of property to non-property income,  $(y^{prop} / y)$ , was discussed above. They should have positive coefficients, and the interaction coefficient,  $\alpha_{3c}$ , should also be positive. Three asset terms follow and include an interaction effect with housing assets. Illiquid financial assets are split between directly-held,  $DHIFA$ , and pension assets,  $PA$ , and both are represented by the 4-quarter moving average. This fits better than the end-of-previous quarter value and implies a longer lag in the consumption response. Some of the response of consumption to changes in pension wealth comes from altered contribution rates, where institutional lags are likely.

The remaining terms are the dynamic terms and dummies. As noted above, the uncertainty indicator,  $\Delta\theta$ , is replaced by the adjusted growth rate of employment. However, the inflation rate could also be an uncertainty indicator, with a negative coefficient,  $\beta_4$ . Especially before 2002, South Africa suffered relatively high and volatile inflation compared to advanced industrial countries. The recent inflation rate could also be a proxy for negative expected income growth effects because nominal wages lag behind prices, or an indicator of an expected rise in interest rates with negative growth consequences. There could be some negative feedback from the previous quarter's consumption growth onto the current quarter represented by the lagged change in log consumption. This equation corresponds closely to the theory discussed in section 2 and tests of more general dynamics all accept this specification, though a number of dynamic and interaction effects prove to be insignificant.

The latent variable  $CCI$  could pick up omitted variables unrelated to credit conditions. This is why it is important that all plausible controls, such as income expectations, income uncertainty and interest rate effects are included in or at least tested in the empirical model. Failure to control for them could result in biases in the estimates of wealth or collateral effects and in mis-measurement of  $CCI$ . One of the most significant and unexpected events, perhaps the most significant in South Africa's history in this period, was the release from prison of Nelson Mandela in February 1990. This signaled a sea-change in politics towards

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<sup>23</sup> The purpose of this normalisation is to simplify the interpretation of the intercept-shift effect of changes in  $CCI$  from their interaction effects, since the latter will be zero at the end of 1980.

reconciliation, the abandonment of Apartheid, and the transition to democratic elections. The behavior of consumption and to a lesser extent of debt in the period immediately after 1990Q1 looks anomalous, suggesting a kind of temporary euphoria. This seems to be hard to explain either as a shift in credit conditions or as a shift in income expectations. The equation system was therefore estimated omitting the observations for 1990Q1 to 1991Q1, and these results are shown in Table 3 column 1.<sup>24</sup>

The speed of adjustment  $\lambda$  is estimated at 0.45 (t=10.9), similar to estimates for the UK, US and Australia, suggesting a well-determined long-run solution for consumption. The long-run coefficient,  $\alpha_{0c}$ , on  $CCI$  is highly significant (t=9.0), indicating its crucial direct importance for the long-run behavior of the ratio of consumption to income. Of the interaction effects with  $CCI$ , two are well determined: the interaction with income growth expectations (discussed further below) and with housing wealth (t=3.5). Otherwise, the interactions with the real interest rate and the income uncertainty proxy are not significant, while the debt/income weighted change in the nominal base rate interest and its interaction have the right signs, but are statistically insignificant.

In 2005,  $CCI$  is estimated to be 0.38 (or 0.47 on an alternative measure, see below) with a peak in 1996 of 0.62 (0.68). The peak estimate of  $CCI$  of 0.62 is based on a version of the model, under which the maximum value of the coefficient,  $(\alpha_3 + \alpha_{3c} \times CCI_t)$  on  $E_t \ln(yperm_t / y_t)$  is constrained by the value implied by the permanent income hypothesis.<sup>25</sup>

Housing wealth when not interacted with  $CCI$  is completely insignificant, supporting the collateral interpretation of housing wealth for consumption as against a wealth effect according to life-cycle theory without credit constraints (see Aron et al. (2011) for more detail). It is encouraging that Aron et al. (2011) obtain the same result for the U.K. and the U.S., and Muellbauer and Williams (2011) find it for Australia. The estimated  $mpc$  for housing collateral in South Africa in 2005 was  $0.248 \times 0.38 = 0.09$  and would have been around 0.15 at the  $CCI$  peak in 1996. These estimates are far higher than peak estimates of the order of 0.05 for the U.K., U.S. and Australia, and this is further discussed below. The  $mpc$  out of net liquid assets is estimated at 0.17 (t=3.6), near the value Muellbauer and Williams (2011)

<sup>24</sup> Estimating the equation with a single dummy for these quarters produced similar results, but with a slightly worse fit.

<sup>25</sup> Since  $\ln(yperm_t)$  is defined as permanent income at t+1, using a 0.95 discount factor, log permanent income at t is defined as  $\ln y_t + 0.95 E_t \ln(yperm_t)$ . This implies that the peak value of  $(\alpha_3 + \alpha_{3c} \times CCI_t)$  should not exceed 0.95. However, the freely estimated value is about 0.99. With the constraint imposed that  $(\alpha_3 + \alpha_{3c} \times peakCCI_t) = 0.95$  we obtain the estimates shown in Table 3, column 1.

find for Australia, and a little higher than UK and US estimates. Out of illiquid financial assets, the *mpc* is estimated at 0.025 (t=3.2), a little higher than in the Anglo-Saxon economies.

Figures 5a and 5b show the fitted contributions of the main long-run factors to explaining variations in the log consumption to income ratio. The large contribution of the fitted value of  $(\alpha_3 + \alpha_{3c} \times CCI_t)E_t \ln(yperm_t / y_t)$  since around 1990 to the rise in  $\ln c/y$  is notable and is offset by the notable decline in the estimated value of *CCI* after 1996. If households were not quite as forward-looking, so that  $(\alpha_3 + \alpha_{3c} \times CCI_t)E_t \ln(yperm_t / y_t)$  made a smaller contribution, then the estimated *CCI* might fall less after 1996 and this could also affect the estimated *mpc* out of housing wealth and out of other assets

To examine the consequences of slightly less forward-looking households, the system was therefore re-estimated under the constraint  $(\alpha_3 + \alpha_{3c} \times peakCCI_t) = 0.75$  which implies that at the peak *CCI*, 20 percent of consumption (=0.95 minus 0.75) is governed by current income rather than permanent income. This hypothesis is acceptable with probability of 7 percent against the alternative that consumption is entirely governed by permanent income. Under this hypothesis, the alternative *CCI* shown in Figure 3 is estimated, peaking at 0.68 and with a value of 0.47 in 2005. Then the estimated coefficient on the interaction of *CCI* and the housing wealth to income ratio in  $(\gamma_{3c} \times CCI_t)HA_{t-1} / y_t$  is 0.158 so that the peak *mpc* is estimated as 0.107, and 0.074 in 2005, while the estimated *mpc* out of net liquid assets drops slightly to 0.16, but the *mpc* out of illiquid financial assets is little changed. Splitting illiquid financial assets gives point estimates of around 0.03 for directly held securities and around 0.02 for pension assets, but the differences are not significant.

The level of the real prime rate has a strongly significant negative effect on consumption (t=-4.2) and employment growth, an indicator of shifting income uncertainty, is also significant (t=4.4), paralleling strong effects for changes in the unemployment rate for the U.K., U.S. and Australia. Its interaction effect with *CCI* is not significant, however. The change in the nominal interest rate weighted by the debt to income ratio has a negative point estimate, offset by a positive one for the interaction with *CCI*, but neither is significant. This is similar to Australia, but different from the U.K. where consumer debt-to-income ratios are far higher, and where a larger proportion of households may be vulnerable to changes in nominal rates. However, there is a significantly negative effect on consumption of inflation over the previous two quarters (t=-3.3) which may be an indicator of higher interest rates in prospect. The lagged change in log consumption has a significant negative coefficient (t=-

6.2). This could be a reaction to overspending in the previous period and could also reflect the inclusion of durable goods in consumption expenditure, where the need for replacement spending declines if recent purchases were high.

The stability of these estimates for samples 1974Q1 to 2005Q4 and for 1971Q2 to 1994Q1, omitting the 1990Q1 to 1991Q1 period, is demonstrated in columns 3 and 4. LM tests for residual autocorrelation up to the fourth order are satisfactory.

One can ask the question of how much the interaction effects add to the fit of the system. To do this, all (three) interaction effects can be set to zero in both the consumption and debt equations while relaxing two restrictions, that on the  $E_t \ln(yperm_t / y_t)$  term, and the zero restriction on the *mpc* out of housing wealth not interacted with *CCI*. Though *CCI* remains highly significant, the log likelihood of the system drops by 17.5. Since twice the difference in the log likelihood is asymptotically chi-squared, this is a highly significant rejection. Moreover the estimated ‘housing wealth effect’ is then *minus* 0.06 ( $t=-2.0$ ). Speeds of adjustment are somewhat lower. Two other radical differences in this ‘no interaction effects’ model are in the lower contribution of  $E_t \ln(yperm_t / y_t)$  with a coefficient of 0.49, suggesting that only 54 percent ( $0.49 + 0.05$ ) of consumption is governed by current permanent income. The *CCI* also falls after 1996, but shows a sharper and somewhat implausible rise from 2003 to a level not far below its 1996 peak.

If all *CCI* terms including the intercept effects are omitted, the long-run properties of the model effectively collapse, whether or not the assets are disaggregated. The speed of adjustment for consumption is no longer significant, the fit is far worse and two out of three wealth effects are negative. Most of the short-run effects still hold up, however, for example, the change in log employment, inflation, and the dummies.

The long-run properties of our credit-augmented life-cycle consumption function were checked in a cointegration analysis. If the direct and interaction effects of the credit conditions index are combined into a single index, there are then five variables integrated of order one,  $I(1)$ . These are the log consumption to income ratio, net liquid assets to income ratio, illiquid assets to income ratio, the log permanent income to income ratio and the composite *CCI* effect. The composite *CCI* effect is defined as  $COMPCCI_t = \alpha_{0c} \times CCI_t + \alpha_{3c} \times CCI_t E_t \ln(yperm_t / y_t)^* + \gamma_{3c} \times CCI_t (HA_{t-1} / y_t)^*$ . The  $I(0)$  variables are the real interest rate, the ratio of property to non-property income, the change in log income, the inflation rate, income uncertainty as measured by the adjusted change in log employment and some impulse dummies. In a VAR for the five  $I(1)$  variables, with the  $I(0)$

variables entering unrestrictedly, a lag-length of 2 is acceptable against longer or shorter lags. There is just one cointegrating vector with beta weights close to the long-run coefficients reported in Table 4. The alpha coefficients, measuring the adjustment of each of the I(1) variables to the cointegrating vector, have clear implications: only the coefficient for the log consumption to income ratio is significant (with a t ratio of 7.5). The other four I(1) variables are thus weakly exogenous with respect to the log consumption to income ratio.<sup>26</sup> It might be argued that inclusion of the composite CCI term may bias the cointegration test towards a positive finding, but it is necessary to control for the structural breaks which otherwise would destroy the long-run relationship between consumption, income and wealth.

#### 4.5 The Estimated Debt Equation

An equilibrium correction formulation of the long-run debt equation given by equation (6) is shown in equation (11).

$$\begin{aligned}
\Delta \ln debt_t = & \delta[(\delta_0 + \delta_{0c} \times CCI_t) + (\delta_1 + \delta_{1c} \times CCI_t)(rma\delta_{t-1})^* \\
& (\delta_2 + \delta_{2c} \times CCI_t)(\ln nr_t)^* + (\delta_4 + \delta_{4c} \times CCI_t)E_t \ln(yperm_t / y_t)^* \\
& + \delta_5 \ln y_t + \delta_6 (y^{prop} / y)_t + \varphi_1 \ln(HA_{t-1} / y_t) + \varphi_2 \ln(LA_{t-1} / y_t) \\
& + (\varphi_{1c} \times CCI_t)(\ln(HA_{t-1} / y_t)^* - \ln(LA_{t-1} / y_t)^*) \\
& + \varphi_3 \ln(DIFAma_{t-1} / y_t) + \varphi_{3a} \ln(PAma_{t-1} / y_t) - \ln rdebt_{t-1}] \\
& + (\eta_1 + \eta_{1c} \times CCI_t)(\Delta \ln y_t)^* + (\eta_2 + \eta_{2c} \times CCI_t)(\Delta \ln nr_t)^* \\
& + (\eta_3 + \eta_{3c} \times CCI_t)(\Delta_4 \ln empl_t)^* \\
& + \eta_4 \Delta \ln debt_{t-1} + \eta_5 \Delta_3 \ln pc_t \\
& + \eta_6 \Delta_8 \ln(popma_t) + dummies + \varepsilon_{2t}
\end{aligned} \tag{11}$$

Beginning with the long-run part of the model, the speed of adjustment is given by  $\delta$ , while  $\delta_{0c}$  measures the shift in debt levels due to the easing of credit conditions. The real interest rate,  $rma\delta$ , enters as an 8-quarter moving average, after checking the validity of the implied dynamic restrictions. Its coefficient,  $\delta_1$ , is expected to be negative and the interaction effect,  $\delta_{1c}$ , should also be negative, since future considerations should matter more with easier credit availability. As in the consumption equation, the star superscripts denote that the

<sup>26</sup> We tested whether the current dated I(0) variables were weakly exogenous and found their reactions to the lagged cointegrating vector were insignificant. While it seems implausible that the current change in income should be weakly exogenous with respect to consumption alone, exogeneity with respect to the ratio of consumption to income, as found in the data, is plausible.

variable is measured as the deviation from its 1980Q4 value. The log of the nominal rate,  $nr$ , should also have a negative coefficient,  $\delta_2$ , but since short-run cash flow considerations are reduced with easier credit, the interaction coefficient  $\delta_{2c}$  is likely to be positive.

The next three terms are in income growth expectations, income and the ratio of property to non-property income. Their coefficients  $\delta_4, \delta_5$  and  $\delta_6$  would all be expected to be non-negative as would the single interaction coefficient  $\delta_{4c}$ . The following four terms are the log ratios of assets to income, with coefficients  $\varphi_1, \varphi_2, \varphi_3, \varphi_{3a}$  where directly-held securities are distinguished from pensions, plus an interaction term. The sign on directly-held securities  $\varphi_3$  is ambiguous since households with such disposable wealth are less likely to need large mortgages. However, pension wealth should have a positive coefficient,  $\varphi_{3a}$ , for two reasons. The first is that such illiquid wealth provides future financial security against which borrowing can make sense. The second is that in South Africa, a portion of pension assets can be pledged as collateral for mortgages, see Ling (2009) on the pension-secured mortgage market. Thus, an increase in the size of retirement funds is likely to boost mortgage debt levels.

The following term captures important interactions effects with log ratios of housing and liquid assets to income (measured relative to end-1980 reference values):  $(\varphi_{lc} \times CCI_t)(\ln(HA_{t-1} / y_t)^* - \ln(LA_{t-1} / y_t)^*)$  Mortgage market liberalization should increase the effect of housing collateral on debt, while credit liberalization reduces the constraint on lending from household liquid asset deposits. The restriction that the two effects are of equal and opposite magnitudes is easily accepted. If the time-variation cancels out then this preserves the long-run relationship between debt and income and assets  $(\delta_5 + \varphi_{1t} + \varphi_{2t} + \varphi_3 + \varphi_{3a})$  to be constant. The last term in the long-run part of the model is log real per capita debt at time t-1.

In the short-run dynamics, there are terms in the change in logs of real per capita non-property income, of nominal interest rate, of employment, of the price level and finally in population. The evidence in Fernandez-Corugedo and Muellbauer (2006) suggests a positive effect on debt from the proportion of the adult population in younger age brackets e.g. 20-35 or 20-39. In the absence of reliable time series data on the age distribution of the South African population, we use the population growth rate as a proxy, since faster growth rates will be associated with a younger age structure. With interpolated annual data, the two-year change of the four-quarter moving average should smooth artificial jumps in the series.



Table 4 provides estimates corresponding to columns 1-4 of the consumption estimates in Table 3. The speed of adjustment is high at 22 percent per quarter. For a mortgage debt equation, this would be implausibly high, but for total debt, the sum of flexible, unsecured debt and less flexible mortgage debt, as in the equation, this is not unreasonable. It confirms that there is a strong long-run solution. The only significant interaction effect concerns housing and liquid assets. Both nominal and real interest rate effects are significant and negative. The scale effect ( $\delta_s + \varphi_{1t} + \varphi_{2t} + \varphi_3 + \varphi_{3a}$ ) is estimated at around 1.41, very close to the corresponding U.K. and Australian estimates. However, the net effect of income is zero, which is a surprising result. No doubt financial assets and housing wealth are themselves driven partly by income so that income has an indirect effect. Before liberalization the housing wealth effect was also zero, but becomes highly significant in interaction with CCI (t=5.3). The finding of no effect from directly-held financial assets, but a strong pension asset effect, makes good sense in the South African context, discussed above.

In the dynamics, the change in log employment is strongly significant, as in the consumption equation, and it has the same interpretation as a negative measure of increasing income uncertainty (or a positive one of confidence). Inflation has a negative effect as it does for consumption, with the same interpretation as an indicator of future rises in interest rates or signalling a short-term decline in real income, given sticky wages. But changes in income and interest rates are insignificant. Finally the population growth rate has a positive and strongly significant effect. Table 4 confirms that the parameter estimates are fairly stable over the different samples shown. LM tests for residual autocorrelation up to the fourth order are satisfactory.

As for the consumption equation, the omission of the credit conditions index produces a far worse fit, with serially correlated residuals, a far lower speed of adjustment and implausible wealth coefficients.

## 5. Conclusions

There is widespread disagreement about the role of housing wealth in explaining consumption. This paper has argued that much of the empirical literature is marred by poor controls for the common drivers both of house prices and consumption. In particular, the failure to control for the direct effect of credit liberalization in models of consumption can

over-estimate the effect of housing wealth or collateral on consumption in countries where easing of credit restrictions is correlated with rises in asset prices. The omission of income growth expectations can also bias estimates of the housing wealth or collateral effect, e.g. discussion by King and Pagano of Muellbauer and Murphy (1990).

This paper has proposed an empirical model, grounded in theory, to measure wealth effects on consumption. The model has more complete controls than hitherto used in the literature, including controls for shifts in credit conditions and the forecast growth rate of income to proxy expectations. The model is applied to quarterly data for South Africa from 1971 to 2005, and uses our own wealth estimates on a market value basis (Aron and Muellbauer, 2006a). The credit conditions index for South Africa is captured through a spline function that is common to jointly estimated consumption, household debt and income forecasting equations. The parameters of the spline function incorporate qualitative information on the timing of key institutional changes in credit markets. As in the U.K., U.S. and Australia, a major part of the rise of the consumption to income ratio from pre-1980 into the new millenium is explained by easier credit availability, even when offset<sup>27</sup> by rising real interest rates and by the increasing constraint of higher debt levels on spending.

Despite the very different macroeconomic histories, there are striking similarities in the consumptions functions found for South Africa and the above three Anglo-Saxon economies (Aron et al., 2011; Muellbauer and Williams, 2011). Credit market liberalization increases the average propensity to consume out of income in all four countries and its inclusion in the consumption models brings clear benefits in finding better determined long-run solutions including negative real interest rate effects on consumption and plausible wealth and collateral effects. The interaction effects found for the other economies, where credit market liberalization increases the roles of expected income growth and of housing wealth on consumption, are also confirmed for South Africa. The marginal propensities to spend out of net liquid assets and illiquid financial assets are broadly in line with those in the other economies, marginally higher for illiquid assets. This may reflect a slight underestimate of such wealth. The time variations in wealth appear to be relatively well-measured, judging by the stability and significance of the coefficients in the consumption and debt equations. Our evidence supports the claim by Case et al. (2005) that housing wealth or collateral effects

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<sup>27</sup> Aron and Muellbauer (2000a) discuss these and other general equilibrium effects, including a partial offset in higher corporate saving for lower household saving.

greatly exceed stock market wealth effects but with the qualification that this is only true after substantial credit market liberalization.

Attempts to estimate a conventional life-cycle consumption function for South Africa fail: only by controlling for the shifts in credit market architecture can a long-run relationship be found. The same credit market shifts also induce large and significant parameter shifts in the debt equation. These findings suggest that standard, constant parameter models such as VARs would be unlikely to be robust in the case of South Africa.

The estimated housing collateral effect after credit market liberalization for South Africa is estimated to be about twice as high as for the three Anglo-Saxon economies. The estimated effect is an average for a population with one of the highest levels on income inequality in the world and necessarily reflects a diverse set of micro-responses, zero for most households. It is plausible that the segments of the population where the responses are largest have been increasing their share of income and consumption. The growth of a Black South African middle-class, with low saving deposits but improving employment opportunities and confident expectations in future income, has likely led to an increase in spending linked to easier credit and higher collateral values, accounting for the large collateral effect.

The consumption model estimates also throw light on the monetary transmission mechanism in South Africa, showing that there are multiple channels for the effect of interest rates on consumption expenditure. This is highly relevant for policy making. A rise in short-term interest rates has negative direct effects on consumer spending, mainly through higher real rates, but there appear to be even larger *indirect* effects via asset prices and income expectations. In the absence of wealth stock data for South Africa, these large asset effects have not previously been measured. Given the multiple possible influences on asset prices in small open economies - including foreign interest rates, terms of trade and foreign equity prices - to quantify the marginal effect of domestic interest rate changes alone requires separate models for the main asset prices of equities, bonds and housing, in addition to the consumption function and income forecasts. This remains an important task for future work.

Finally, the empirical results underline the need to improve national wealth accounts and to track changes in financial architecture in other emerging and developing countries. Better modeling of consumption and debt should improve stabilisation policy and reduce risks of future financial crises.

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**Table 1: Variable Definitions**

<i>Variable</i>	<i>Definition</i>
<b><i>SA Debt Equation (1971Q2-2005Q4)</i></b>	
$\Delta \ln \text{debt}_t$	Log change of household debt (eocp)
real interest rate <sub>t-1</sub>	Real prime rate/100 (8 quart. MA), lagged one quarter
$\ln(\text{nominal interest rate}_t)$	The log of the prime rate/100
$(y^{\text{prop}} / y)_t$	Ratio of property income to non-property income
$\ln(\text{liquid financial assets}_{t-1} / y_t)$	Log ratio of liquid assets (eopp, 4 quart.MA) to annualised real income, y
$\ln(\text{directly held illiquid financial assets}_{t-1} / y_t)$	Log ratio of directly-held securities (eopp, 4-quart ma) to annualised real income, y
$\ln(\text{pension assets}_{t-1} / y_t)$	Log ratio of real pension assets (eopp) to annualised real income, y, 4-quarter ma
$\ln(\text{housing wealth}_{t-1} / y_t)$	Log ratio of real housing wealth (eopp) to annualised real income, y,
$CCI \times \ln(\text{housing wealth}_{t-1} / y_t)$	Log ratio of real housing wealth (eopp) to annualised real income, y, interacted with the credit conditions index
$\Delta_4 \ln \text{employment}_t$	Income uncertainty (or confidence) indicator: the annual change in the log of employment
$\Delta_3 \ln \text{pc}_t$	Inflation: the three-quarter change in the log of the implicit final consumption expenditure deflator
$\Delta_8 \ln \text{population}_{t-1}$	Two year log change in population (defined as a four quarter moving average)
Dummies	A seasonal dummy for quarter 4, indicating slightly higher end-of-year debt levels . D821 and D844 are temporary dummies taking values +1, -1 in successive quarters, reflecting shifting of debt between 1982Q1 and Q2, and between 1984Q4 and 1985Q1. D871 is an impulse dummy for an outlier in 1987Q1 and D023 an impulse dummy for a 2002Q3 outlier associated with the failure of Sambou Bank.
<b><i>SA Consumption Equation (1971Q2-2005Q4)</i></b>	
$\Delta \ln c_t$	Growth rate of real personal consumption (seas. adj.)
$CCI$	Credit conditions index (see text for definition)
real interest rate <sub>t</sub>	Real prime rate/100 (4 quart. MA); adjusted for inflation using the implicit final consumption expenditure deflator
$E \ln(y^{\text{perm}} / y)_t$	Forecast deviation between discounted present value of future log income and current log income (see text for definition of permanent income)
$(y^{\text{prop}} / y)_t$	Ratio of property income to non-property income
$\text{Net liquid assets}_{t-1} / y_t$	Ratio of real(liquid assets (eopp) – debt (eopp)) to annualised real income, y
$\text{Directly held illiquid financial assets}_{t-1} / y_t$	Ratio of real directly-held securities (eopp) to annualised real income, y, 4 quart. ma
$\text{Pension assets}_{t-1} / y_t$	Ratio of real pension assets (eopp) to annualised real income, y, 4 quart. ma
$\text{Housing wealth}_{t-1} / y_t$	Ratio of real housing wealth (eopp) to annualised real income, y
$CCI \times \text{housing wealth}_{t-1} / y_t$	The above interacted with the credit conditions index
$\Delta_4 \ln \text{employment}_t$	Uncertainty indicator: the annual change in the log of employment
$\Delta \ln c_{t-1}$	Growth rate of real personal consumption (seas. adj.), lagged one quarter
$\Delta_2 \ln \text{pc}_t$	Inflation: the two-quarter change in the log of the implicit final consumption expenditure deflator
$\Delta \ln y$	Real per capita income (nnpdi) growth (seas. adj.)
$\Delta \ln y \times CCI$	The above interacted with the credit conditions index

<i>Variable</i>	<i>Definition</i>
Dummies	Q1DU75 is a pre-1976 seasonal to reflect mis-measured seasonal correction in the data before that date. D751 is an impulse dummy for an outlier in 1975Q1. GST78 and GST84 are temporary dummies taking values +1, -1 in successive quarters, reflecting shifting of expenditure in anticipation of increases in sales tax in 1978 and in 1984.
<b><i>SA Income Forecasting Equation (1971Q2-2005Q4)</i></b>	
$E \ln(y_{perm} / y)_t$	Forecast deviation between discounted present value of future log income and current log income (see text for definition of permanent income)
$\ln y_t$	Log of real income (nppdi) per capita (seas. adj.); adjusted for inflation using the implicit final consumption expenditure deflator
$\Delta_4 \ln y_t$	Annual change in the above
Trend	Trend
split trend 1984 <sub>t+2</sub>	split trend, zero before 1984 and 1 thereafter, leading by two quarters
split trend 1990 <sub>t-1</sub>	split trend, zero before 1990 and 1 thereafter, lagged by one quarter
split trend 1994 <sub>t-1</sub>	split trend, zero before 1994 and 1 thereafter, lagged by one quarter
$\ln(\text{real \$ gold price})_t$	the log of the real gold price in dollars, deflated by the US WPI
$\text{CCI} \times \ln(\text{housing wealth}_{t-1}/y)$	Ratio of housing wealth (eopp) to annualised real income, y, interacted with the credit conditions index
real interest rate <sub>t-1</sub>	real prime rate/100 (4 quart. MA) and lagged one quarter; adjusted for inflation using the implicit final consumption expenditure deflator
real interest rate <sub>t-5</sub>	as above, lagged five quarters
$\Delta_4$ nominal interest rate <sub>t</sub>	annual change in the nominal prime rate/100
$\Delta_4$ nominal interest rate <sub>t-4</sub>	as above, lagged four quarters
liquidity ratio dummy, LRD	liquidity ratio dummy based on actual liquidity ratios defined as follows: 1960:1 1983:2; LRD=0; 1983:3 1983:3; LRD =0.18; 1983:4 1983:4; LRD =0.42; 1984:1 1984:1; LRD =0.72; 1984:2 1985:1; LRD =0.87; 1985:2 1985:3; LRD =0.94; 1985:4 2006:2; LRD =1;
$\text{LRD} \times \Delta_4 \text{ nominal interest rate}_t$	LRD interacted with the annual change in the nominal prime rate/100
$\text{LRD} \times \Delta_4 \text{ nominal interest rate}_{t-4}$	as above, lagged four quarters

*Notes:* eopp is “end of previous period”, eocp is “end of current period”, ma is “moving average”, nppdi is “non-property personal disposable income”. Constructed asset data are not seasonally-adjusted. All variables potentially entering with CCI interaction effects have their end of 1980 values subtracted as denoted by the  $x_t^*$  notation in equations (10) and (11); thus,  $x_t^* = (x_t - x_{1980Q4})$ . All income and wealth data are on a per capita basis.



**Table 2: Income Forecasting Equation Estimates**

<i>Dependent Variable =</i> $E \ln(y_{perm} / y)_t$	(1) 1971Q2-2005Q4		(2) 1971Q2-2005Q4		(3) 1971Q2-1994Q1		(4) 1974Q1-2005Q4	
	<i>coefficient</i>	<i>t- ratio</i>	<i>coefficient</i>	<i>t- ratio</i>	<i>Coefficient</i>	<i>t- ratio</i>	<i>coefficient</i>	<i>t- ratio</i>
constant	8.675	22.47	8.843	22.59	10.807	26.72	9.221	22.14
current income growth: $\Delta_4 \ln y_t$	-0.110	-2.21	-0.104	-2.10	0.0197	0.41	-0.0260	-0.46
$\ln y_t$	-0.952	-21.95	-0.970	-22.08	-1.194	-26.17	-1.010	-21.71
Trend	0.000411	1.87	0.000468	2.13	1.94E-03	8.14	0.000360	1.59
split trend 1984 <sub>t+2</sub>	-0.00425	-10.79	-0.00436	-11.09	-7.30E-03	-16.96	-0.00407	-10.17
split trend 1990 <sub>t-1</sub>	0.00626	12.15	0.00628	12.37	6.02E-03	13.75	0.00596	11.67
split trend 1994 <sub>t-1</sub>	0.00368	6.84	0.00373	7.13	3.65E-03	0.00	0.00365	6.84
$\ln(\text{real \$ gold price})_t$	0.0352	5.80	0.0355	5.92	0.0203	3.86	0.0301	4.59
CCI x $\ln(\text{housing wealth}_{t-1}/y)$	0.152	5.18	0.138	5.27	0	0	0.207	5.58
real interest rate <sub>t-1</sub>	-0.166	-3.29	-0.171	-3.43	-0.168	-3.21	-0.163	-3.26
real interest rate <sub>t-5</sub>	-0.287	-6.30	-0.282	-6.27	-0.288	-5.18	-0.243	-5.25
$\Delta_4$ nominal interest rate <sub>t</sub>	-0.223	-3.28	-0.203	-3.01	-0.0884	-1.45	-0.198	-2.96
$\Delta_4$ nominal interest rate <sub>t-4</sub>	-0.325	-4.39	-0.313	-4.26	-0.276	-4.13	-0.243	-3.19
liquidity ratio dummy x $\Delta_4$ nominal interest rate <sub>t</sub>	0.0968	1.38	0.0810	1.17	-0.0173	-0.27	0.0929	1.35
liquidity ratio dummy x $\Delta_4$ nominal interest rate <sub>t-4</sub>	0.416	5.54	0.408	5.49	0.491	7.37	0.350	4.66
<b>Diagnostics</b>								
Standard error	8.87E-03		8.78E-03		6.77E-03		8.65E-03	
Adjusted R <sup>2</sup>	0.984		0.984		0.984		0.985	
LM het. Test	2.61 [.106]		2.67[.102]		.290 [.590]		4.19 [.041]	
Durbin Watson	0.286		0.281		0.379		0.232	
Log likelihood	1349.2		1347.89		880.245		1239.81	
Number of observations	130		130		83		119	

Notes: The results for column 2 impose a peak coefficient in the consumption function of 0.75 on log permanent income at t+1, and 0.95 in the remaining columns.

**Table 3: Consumption Function Estimates**

<b>Dependent Variable =</b> $\Delta \ln c_t$	<b>Symbol</b>	<b>(1)</b> 1971Q2-2005Q4		<b>(2)</b> 1971Q2-2005Q4		<b>(3)</b> 1971Q2-1994Q1		<b>(4)</b> 1974Q1-2005Q4	
		<i>coefficient</i>	<i>t- ratio</i>	<i>coefficient</i>	<i>t- ratio</i>	<i>coefficient</i>	<i>t- ratio</i>	<i>coefficient</i>	<i>t- ratio</i>
<b>Long-run coefficients</b>									
speed of adjustment	$\lambda$	0.453	10.92	0.442	10.55	0.493	9.15	0.442	10.34
Constant	$\alpha_0$	0.0269	0.79	0.0382	1.11	0.0167	0.317	0.0498	1.40
credit conditions index: <i>CCI</i>	$\alpha_{0c}$	0.553	9.04	0.482	7.76	0.654	6.07	0.546	7.94
real interest rate $r_t$	$\alpha_1$	-0.473	-4.23	-0.487	-4.18	-0.550	-3.55	-0.431	-3.71
forecast future income growth: $E \ln(y^{perm} / y)_t$	$\alpha_{3c}$	1.112	7.85	0.657	4.97	1.021	6.07	1.060	6.81
$(y^{prop} / y)_t$	$\alpha_4$	0.136	3.82	0.140	3.81	0.129	3.22	0.110	2.96
net liquid assets $_{t-1} / y_t$	$\gamma_1$	0.167	3.43	0.155	3.19	0.193	2.60	0.127	2.55
directly held illiquid financial+pension assets $_{t-1} / y_t$	$\gamma_2$	0.0250	3.24	0.0226	2.86	0.0283	2.63	0.0222	2.54
<i>CCI</i> x housing wealth $_{t-1} / y_t$	$\gamma_{3c}$	0.248	3.52	0.158	2.60	0.222	1.39	0.296	3.25
<b>Short-run coefficients</b>									
uncertainty: $\Delta_4 \ln employment_t$	$\beta_3$	0.204	4.42	0.210	4.55	0.216	2.94	0.204	4.30
inflation: $\Delta_2 \ln pc_t$	$\beta_4$	-0.154	-3.33	-0.156	-3.31	-0.177	-3.14	-0.145	-3.07
$\Delta \ln c_{t-1}$	$\beta_5$	-0.283	-6.19	-0.287	-6.21	-0.352	-5.79	-0.230	-4.77
<b>Diagnostics</b>									
Standard error		6.03E-03		6.14E-03		6.92E-03		5.83E-03	
Adjusted R <sup>2</sup>		0.839		0.833		0.855		0.846	
LM het. Test		.503 [.478]		.468 [.494]		.845 [.358]		.309E-03 [.986]	

Durbin Watson		2.34		2.28		2.40		2.33	
LM AR4, MA4 Test (p-value)		0.83		0.90		0.55		0.60	
Log likelihood		1349.2		1347.89		880.25		1239.81	
Number of observations		130		130		83		119	

Notes:

- i. The results for column 2 impose a peak coefficient in the consumption function of 0.75 on log permanent income at t+1, and 0.95 in the remaining columns.
- ii. Estimates for the dummies are not reported. Coefficients correspond to the equation below which is based on the theory equation (10). All interaction terms are in the form of  $CCI_t \times (x_t^*)$  where  $x_t^* = x_t - x_{1980Q4}$ .

iii. The form of the equation is:

$$\begin{aligned} \Delta \ln c_t = & \lambda[(\alpha_0 + \alpha_{0c} CCI_t) + (\alpha_1 + \alpha_{1c} \times CCI_t) rma_t^* \\ & + (\alpha_3 + \alpha_{3c} \times CCI_t) E_t \ln(yperm_t / y_t)^* + \alpha_4 (y^{prop} / y)_t \\ & + \gamma_1 NLA_{t-1} / y_t + \gamma_2 DHIFAma_{t-1} / y_t + \gamma_3 P Ama_{t-1} / y_t \\ & + (\gamma_3 + \gamma_{3c} \times CCI_t)(HA_{t-1} / y_t)^* \\ & + \ln y_t - \ln c_{t-1}] \\ & + (\beta_1 + \beta_{1c} \times CCI_t)(\Delta \ln y_t)^* + (\beta_2 + \beta_{2c} \times CCI_t)(\Delta_4 nr_t \times debt_{t-1} / y_t)^* \\ & + (\beta_3 + \beta_{3c} \times CCI_t)(\Delta_4 \ln empl_t)^* \\ & + \beta_4 \Delta_2 \ln pc_t + \beta_5 \Delta \ln c_{t-1} + dummies + \varepsilon_{it} \end{aligned}$$

**Table 4: Household Debt Equation Estimates**

<i>Dependent Variable =</i> $\Delta \ln \text{debt}_t$	<i>Symbol</i>	(1) 1971Q2-2005Q4		(2) 1971Q2-2005Q4		(3) 1971Q2-1994Q1		(4) 1974Q1-2005Q4	
		<i>coefficient</i>	<i>t- ratio</i>	<i>coefficient</i>	<i>t- ratio</i>	<i>coefficient</i>	<i>t- ratio</i>	<i>coefficient</i>	<i>t- ratio</i>
Speed of adjustment	$\delta$	0.217	7.43	0.213	7.07	0.229	6.08	0.198	6.49
Constant	$\delta_0$	-4.444	-3.16	-4.443	-2.94	-2.811	-1.76	-6.232	-3.37
real interest rate <sub>t-1</sub>	$\delta_1$	-0.735	-2.84	-0.915	-3.18	-0.631	-2.20	-0.876	-2.85
Nominal interest rate <sub>t</sub>	$\delta_2$	-0.105	-3.21	-0.122	-3.33	-0.058	-1.21	-0.0949	-2.54
ln (liquid financial assets <sub>t-1</sub> / y <sub>t</sub> )	$\theta_2$	0.359	6.77	0.344	6.15	0.348	5.82	0.440	6.16
ln (pension assets <sub>t-1</sub> / y <sub>t</sub> )	$\theta_{3a}$	1.049	9.83	1.056	9.05	0.900	6.84	1.157	8.51
(y <sup>prop</sup> / y) <sub>t</sub>	$\delta_6$	0.184	1.97	0.200	2.06	0.182	2.02	0.251	2.20
CCI x ln (housing wealth <sub>t-1</sub> / y <sub>t</sub> )	$\theta_{1c}$	1.432	5.31	1.166	4.68	0.812	1.13	1.625	4.51
uncertainty: $\Delta_4 \ln \text{employment}_t$	$\eta_3$	0.879	2.89	0.842	2.86	0.915	2.49	0.703	2.30
inflation: $\Delta_3 \ln \text{pc}_t$	$\eta_5$	-0.119	-2.44	-0.106	-2.13	-0.169	-2.59	-0.117	-2.25
$\Delta_8 \ln \text{population}_{t-1}$	$\eta_6$	1.166	5.04	1.401	5.81	0.661	1.18	1.393	5.66
<b>Diagnostics</b>									
Standard error		8.37E-03		8.41E-03		8.39E-03		8.56E-03	
Adjusted R <sup>2</sup>		0.823		0.822		0.828		0.823	
LM het. Test		.018052 [.893]		.130805 [.718]		.055431 [.814]		.081056 [.776]	
Durbin Watson		2.20		2.19		1.92		2.23	
LM AR4, MA4 Test (p-value)		0.14		0.24		0.35		0.14	
Log likelihood		1349.2		1347.89		880.25		1239.81	

Number of observations		130		130		83		119	
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Notes:

- i. The results for column 2 impose a peak coefficient in the consumption function of 0.75 on log permanent income at t+1, and 0.95 in the remaining columns.
- ii. Estimates for the dummies are not reported. Coefficients correspond to the equation below which is based on the theory equation (11). All interaction terms are in the form of  $CCI_t \times (x_t^*)$  where  $x_t^* = x_t - x_{1980Q4}$ .
- iii. The form of the equation is:

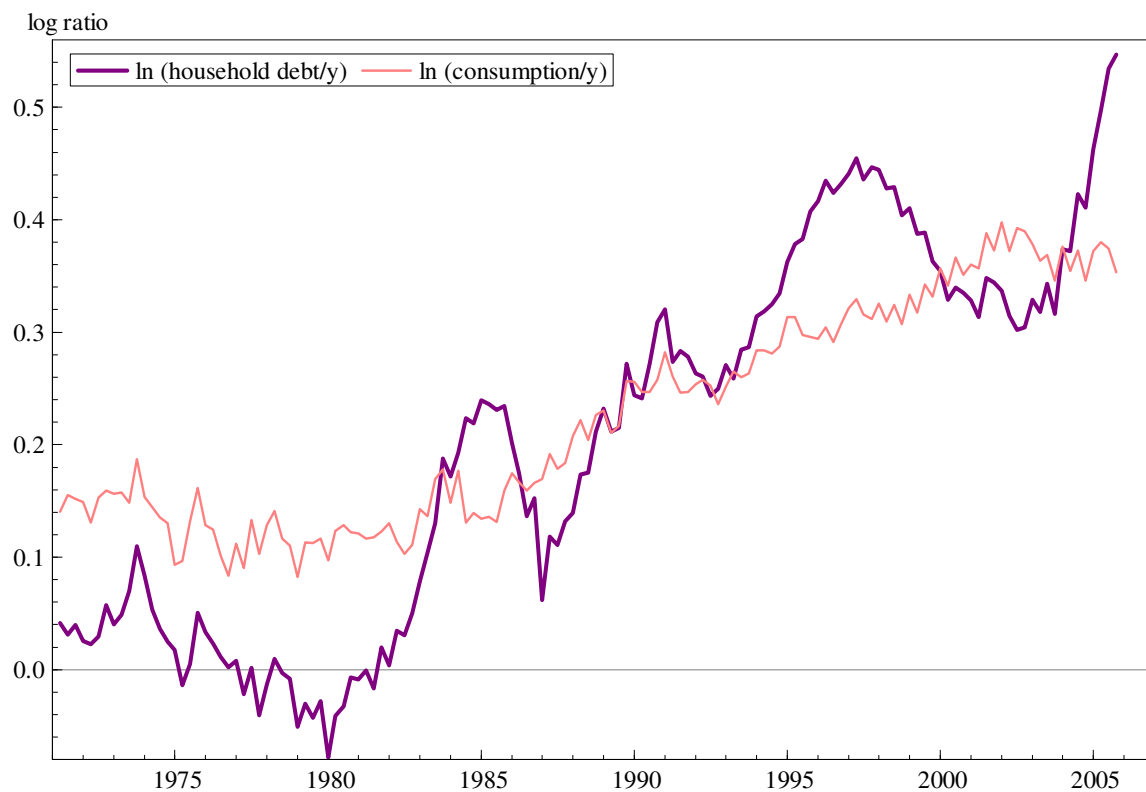
$$\begin{aligned}
\Delta \ln debt_t = & \delta[(\delta_0 + \delta_{0c} \times CCI_t) + (\delta_1 + \delta_{1c} \times CCI_t)(rma8_{t-1})^* \\
& (\delta_2 + \delta_{2c} \times CCI_t)(\ln nr_t)^* + (\delta_4 + \delta_{4c} \times CCI_t)E_t \ln(yperm_t / y_t)^* \\
& + \delta_5 \ln y_t + \delta_6 (y^{prop} / y)_t + \varphi_1 \ln(HA_{t-1} / y_t) + \varphi_2 \ln(LA_{t-1} / y_t) \\
& + (\varphi_{1c} \times CCI_t)(\ln(HA_{t-1} / y_t)^* - \ln(LA_{t-1} / y_t)^*) \\
& + \varphi_3 \ln(DIFama_{t-1} / y_t) + \varphi_{3a} \ln(PAma_{t-1} / y_t) - \ln rdebt_{t-1}] \\
& + (\eta_1 + \eta_{1c} \times CCI_t)(\Delta \ln y_t)^* + (\eta_2 + \eta_{2c} \times CCI_t)(\Delta \ln nr_t)^* \\
& + (\eta_3 + \eta_{3c} \times CCI_t)(\Delta_4 \ln empl_t)^* \\
& + \eta_4 \Delta \ln debt_{t-1} + \eta_5 \Delta_3 \ln pc_t \\
& + \eta_6 \Delta_8 \ln(popma_t) + dummies + \varepsilon_{2t}
\end{aligned}$$

**Table 5: Estimates of the smoothed year dummies for the Credit Conditions Index (CCI), corresponding to Tables 2 to 4**

<i>Spline dummies</i>	<i>coefficient</i>	<i>t- ratio</i>
D73	-0.0184	-1.81
D81	0.1433	7.52
D83	0.0775	4.09
D85	-0.0469	-1.56
D87	0.1050	3.74
D88	0.1604	5.42
D94	0.0842	4.06
D95	0.0939	3.99
D97	-0.0722	-3.83
D99	-0.0639	-2.68
D100	-0.0901	-4.01
D102	-0.0361	-2.53
D104	0.0267	1.22

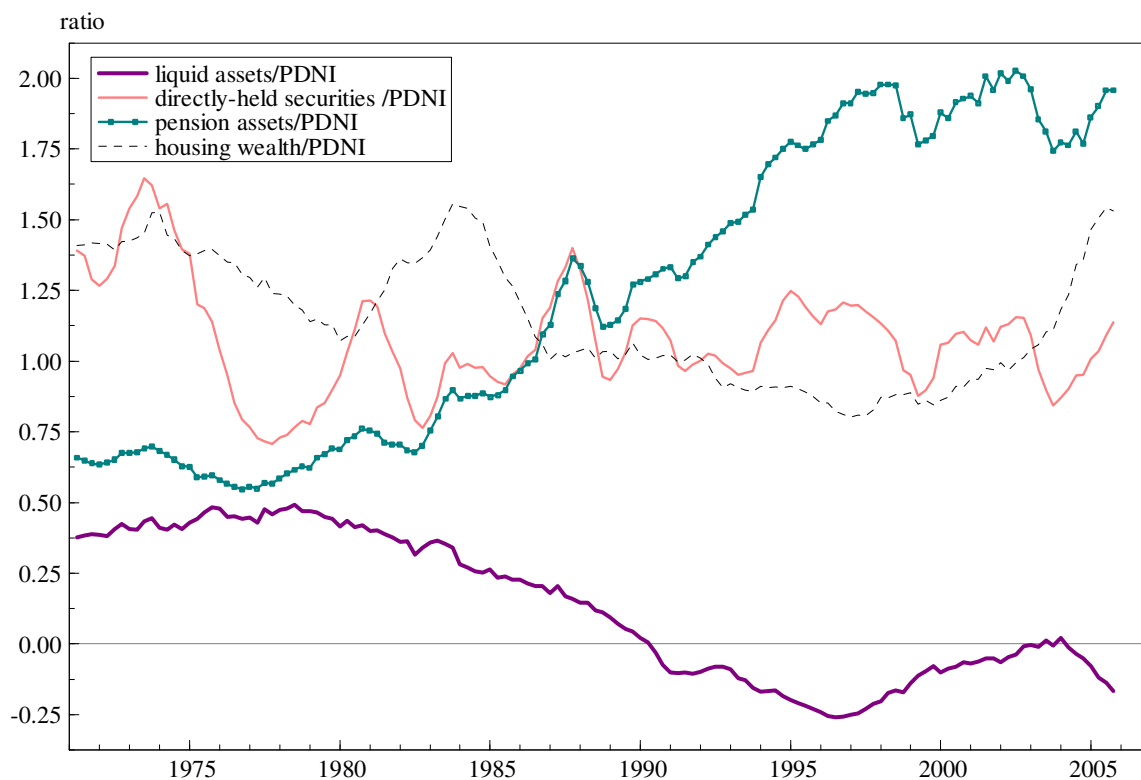
*Notes:* These values stem from the consumption-debt-income forecast system with regressions as reported in Column 1 of Tables 2, 3 and 4.

**Figure 1: South African personal consumption and household debt relative to personal disposable non-property income**

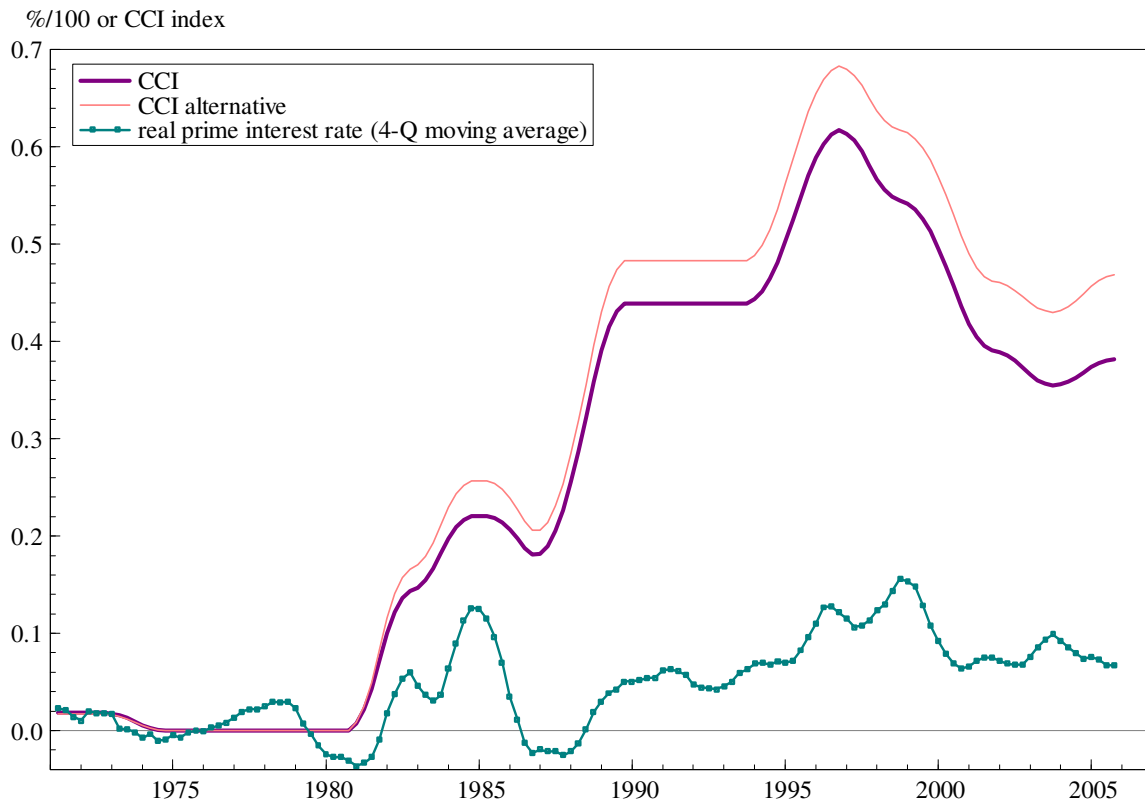


Note: 0.6 is added to the debt ratio for scaling purposes.

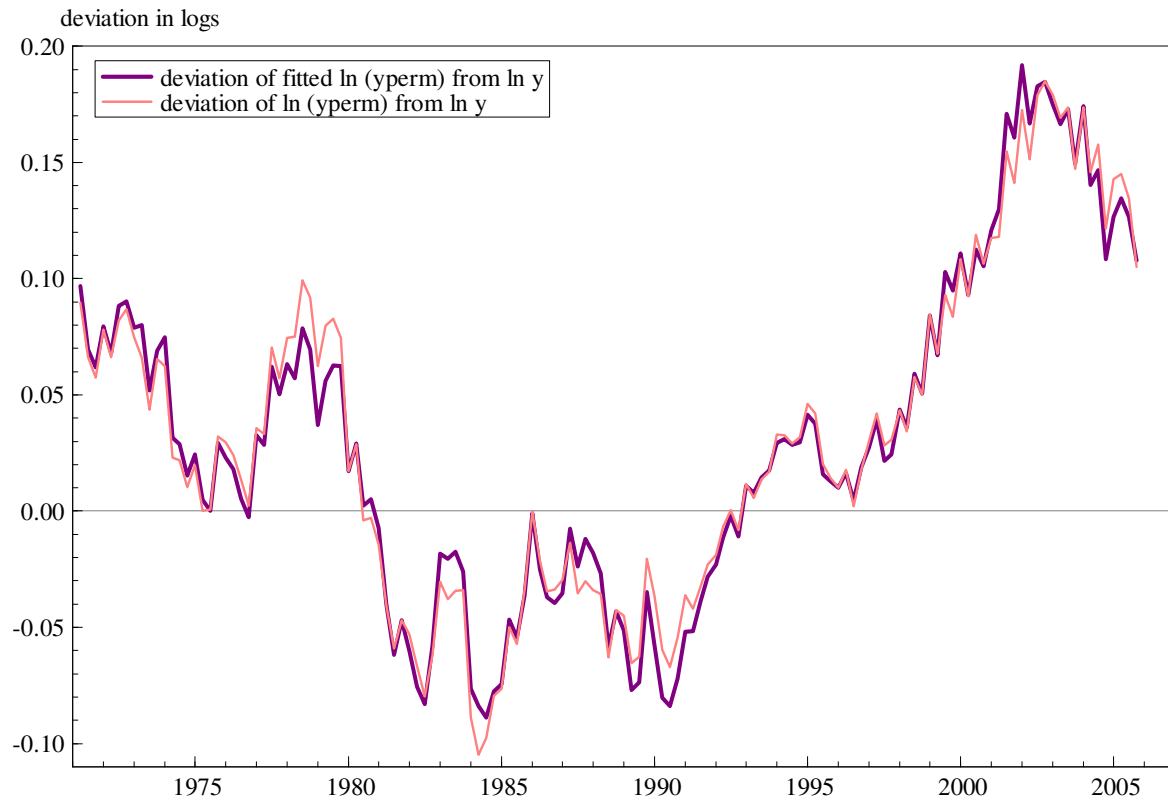
**Figure 2: South African debt, liquid and illiquid assets relative to personal disposable non-property income**



**Figure 3: Credit conditions index for South Africa and the real interest rate**

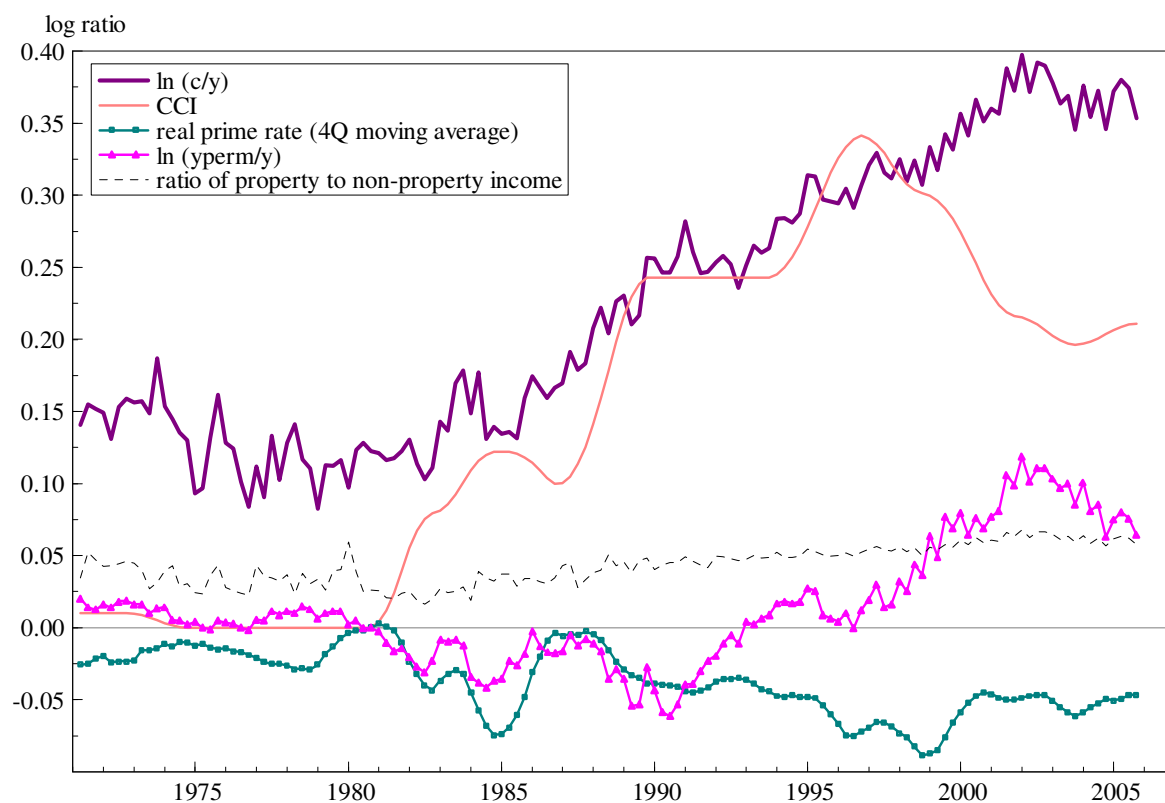


**Figure 4: Forecast and actual log “permanent” income/current income**





**Figure 5a: Contribution of regressors to explaining the consumption to income ratio**



**Figure 5b: Contribution of further regressors to explaining the consumption to income ratio**

