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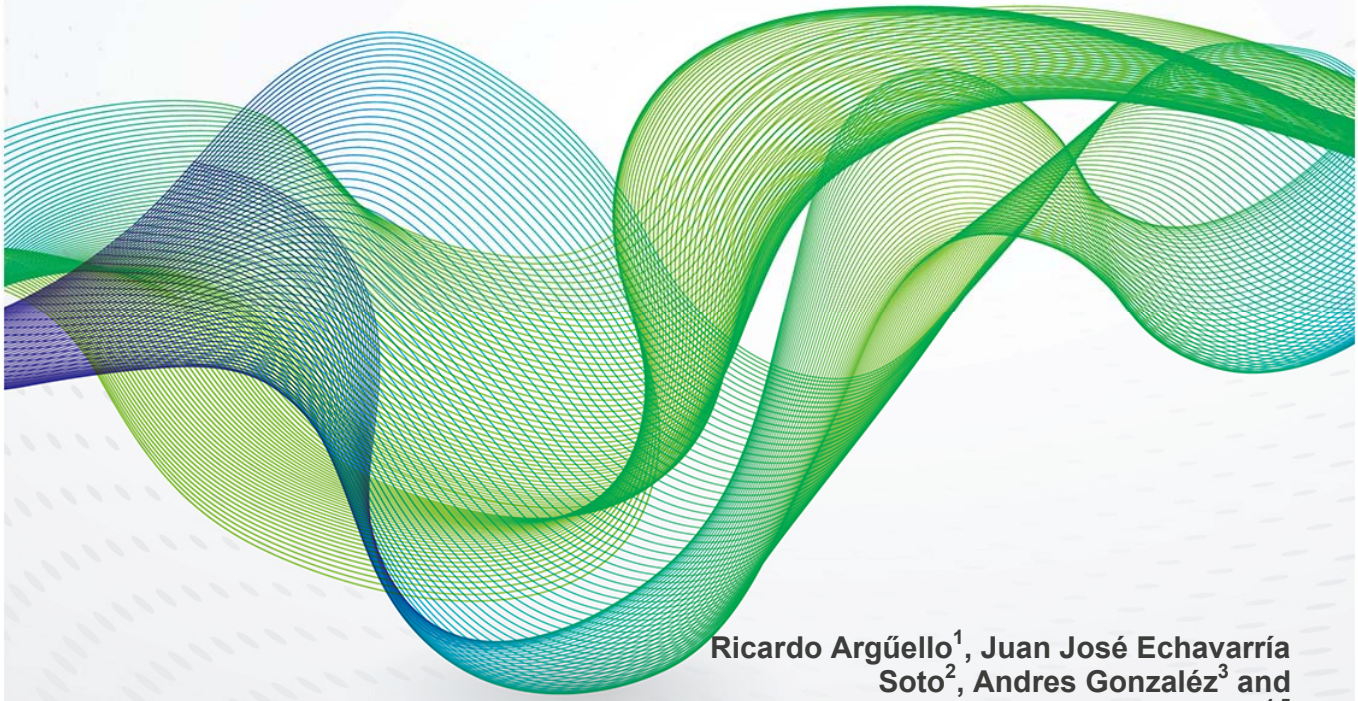
The Sectoral Effects of Exchange Rate Fluctuations in Fuel-Exporting Countries:

A Case Study of Colombia



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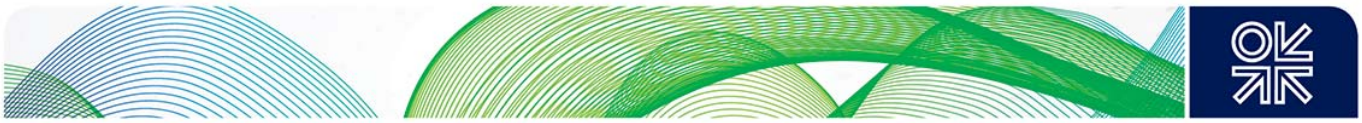

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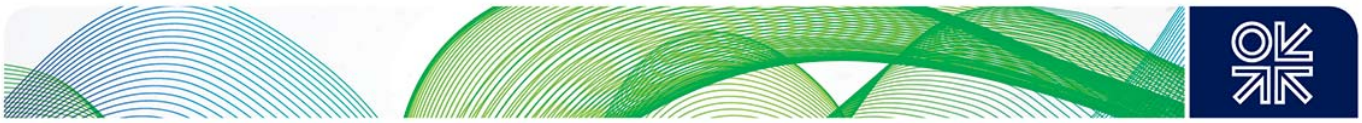


Summary

Nearly all countries whose exports are highly concentrated in fuel products fix their nominal exchange rate. This is to protect the livelihoods of vulnerable workers in other sectors from exchange rate changes that could be caused by variations in international fuel prices.

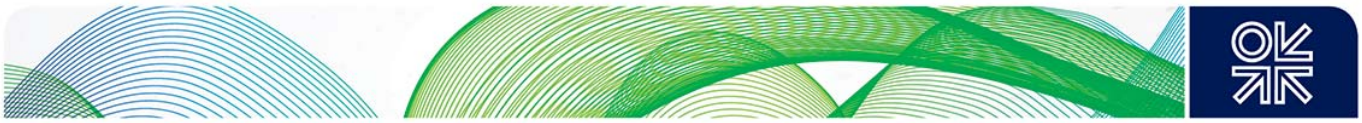
In this paper, we assess the impact that fuel price-induced exchange rate variability has on the different sectors of fuel-exporting countries. We focus on the labour incomes of those who are not employed in fuel extraction but instead in low-productive exporting or import-competing sectors. We ask what, if anything, should and can be done about the undesirable sectoral effects of being a fuel exporter. Some of our analysis is based on the international experience of fuel exporters since 1980. But making policy recommendations requires an understanding of the underlying frictions between sectors, which can only be achieved by an in-depth study of a particular country. Hence, for much of this paper, we take Colombia as a case study.

A study such as this requires a wide variety of methods, each of which has advantages and disadvantages, so that by combining them all we can develop a consistent diagnosis. We combine the following:

- Summaries of the relevant sectoral features in Colombia and a map of their interaction based on the 2011 Colombian National Accounts Supply and Use Tables.
- Simulations on a Computable General Equilibrium (CGE) model of Colombia.
- Estimations using a Factor Analysis Vector Autoregression (FAVAR) on recent data for Colombia.
- Simulations on a Dynamic Stochastic General Equilibrium (DSGE) Model of Colombia.
- Stylized facts and case studies of the international experiences of fuel exporters.
- A comparison of the agricultural performance of Colombia, Indonesia, and Malaysia and policy responses in these three countries.

Our analysis of the Colombian economy reveals that the agriculture and manufacturing sectors, in aggregate, combine both tradable and non-tradable elements, especially in that they serve both domestic and international markets. For example, manufacturers face competition from imports but they also import many inputs; in addition, much agricultural produce is processed domestically and sold in the domestic market. At least in aggregate, they cannot be called tradable sectors.

Coffee is the sector that is most clearly vulnerable to the exchange rate at this level of aggregation. Colombian coffee incomes are particularly vulnerable to exchange rate changes given the sector's overwhelming export orientation and the dominance of labour as an input. That said, it is likely that within the large aggregate sectors of agriculture and manufacturing, there might be smaller subsectors that are highly exposed to the exchange rate, either because of a marked export orientation or import substitution.



The simulations in a CGE model suggest that a 10 per cent oil price rise and a 10 per cent appreciation is expected to lead to a 0.7 per cent fall in the real value added of non-coffee agriculture, a 6.5 per cent fall in that of coffee cultivation, and a 2.3 per cent fall in manufacturing. In contrast, the real value-added level of the service sector and construction increase by 0.5 per cent and 4 per cent respectively.

The simulations in the estimated FAVAR model confirm that oil price-induced exchange rate appreciations have important and sectorally very different impacts on the Colombian economy. Non-tradable sectors are estimated to fare well, raising the aggregate level of GDP, even as exporting sectors such as coffee are worse off. A 15 per cent appreciation is estimated to raise the GDP growth rate by 0.1 to 0.9 pp and to raise service sector growth by 0.2pp while lowering agricultural and industrial growth by about 0.5pp.

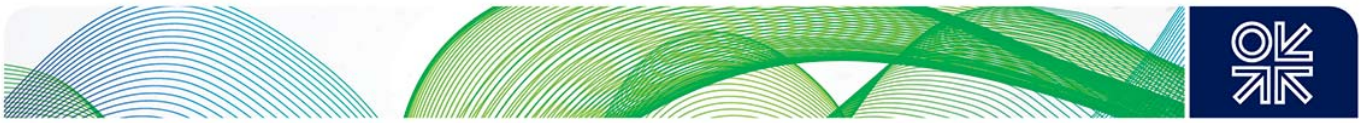
The DSGE model permits us to carry out counterfactual policy experiments based on a structure that reasonably approximates this understanding of Colombia's economy and its sectoral diversity. The results illustrate that the Central Bank should actively tighten policy to control inflation and stabilize credit in the face of oil price rises. As oil price rises can easily reverse, Central Bank policies need to take account not just of the effects of the oil price rise, but also of the fact that that the rise can reverse without the private sector having anticipated it. But sectorally undifferentiated monetary and macroprudential policies can themselves have sectorally different effects. In general, tighter policies tend to lean more heavily on tradable sectors in order to achieve a given aggregate adjustment, because of rigidities in transferring labour, capital, and collateral between sectors.

The survey of the international experience shows that fuel exporters with the greatest dominance of fuel in exports were also those countries that created less economic wealth. But there was no strong relationship between exchange rate changes and the rate at which national wealth accumulated or decumulated.

Many fuel exporters seek to stabilize nominal exchange rates, through fixing or intervening in foreign exchange markets. But the more successful wealth creators also maintain a degree of macroeconomic stability, which prevents the real exchange rate from appreciating during fuel booms.

As appreciations can be linked to rises in the service sector share and greater financial instability, it is important to consider the macroprudential responses of these countries. Interestingly, greater real or nominal appreciations are not in general associated with a shrinking share of the aggregate agricultural sector. Malaysia and Indonesia have supported their agricultural sectors during oil booms, with the purpose of improving competitiveness. In comparison to these countries, Colombia tends to support its export-orientated agriculture to a greater extent.

In formulating policy recommendations, it is important to a) establish an objective, b) link the policy actions to a market failure, and c) be conscious of political economy aspects in the design. On this basis, the objective of any policy intended to reduce exchange rate vulnerability should be to reduce the vulnerability of labour incomes of those currently working in sectors which are overwhelmingly export-orientated or import-competing. The market failure that policy needs to address is that there is insufficient scope for workers to access other productive activities when there is less demand from their main activity on a permanent



or temporary basis. The policy should not set off voracious demands for assistance from other less needy sectors.

Our results suggest that price support schemes should be thought of a temporary smoothing facility or risk management device, just as the use of market-based financial instruments to manage risk. Care should be taken to avoid existing price supports becoming a permanent support of the disparity with the world price. The main reason is that price support schemes are an imperfect way of addressing what our paper suggests is the underlying market failure afflicting vulnerable workers.

Our analysis reveals that in the case of Colombia, it is quite difficult to target the pockets of the most vulnerable workers by subsidizing the products of aggregate sectors. A very recent finding in the fiscal policy on oil exporting economies shows that in order to create favourable economic development without triggering voracious demands for state support, it is as important to be fair and transparent about how the money is spent as how it is earned.

Rather, we would favour policies that seek to reduce the vulnerability of incomes of workers in isolated regions. The policy is thus defined by location of the recipient and not by product (OECD, 2003).

One possible policy is the further development of the domestic market for the outputs of rural sectors. Whilst leaving aside the issue of whether or not this is feasible, we would expect that the side effect of a successful reorientation towards a domestic market would be that vulnerable incomes would be more sheltered from the impact of exchange rate movements. This should not be achieved through export taxes, which will lower producer incomes, or import tariffs, which affect poorer consumers.

In so far as the real exchange rate policy of Colombia itself is concerned, we see no reason to change the existing monetary and financial stability objectives in favour of more foreign exchange intervention. Our survey of the experience of Malaysia and Indonesia tells us that other policies were more important in promoting sustained development. Certainly, the ultimate objective of macroeconomic policies should be the pursuit of macroeconomic stability, in the face of fuel price shocks and the accompanying exchange rate changes that can trigger large sectoral divergences.

With that in mind, our analysis points to a greater need for sectoral countercyclical macroprudential tools in fuel-exporting countries – those that can be used to reduce lending only to the non-tradable sectors – in times of fuel price-induced exchange rate appreciation. This is to ensure that the non-tradable sector's finances are more resilient against a reversal of the oil price. Examples of these tools are discussed by the Committee on the Global Financial System (2012) and can take the form of: temporarily higher loan-to-value ratios and risk weights on mortgages, on the commercial retail sector, and on personal loans, together with regulatory capital ratios, sectoral liquidity buffers, or taxes on housing sales. A deeper investigation of the operationalization of these tools in fuel-exporting countries is required.

A final, but nonetheless important, message of this study is the urgent need for comparable data and analysis on the economic vulnerability of workers. Without nationally comparable data on workers' earnings, one is not able to quantify the extent of their economic isolation; without such data, it is difficult to estimate the consequences on the regions in which they

work. Such an economy-wide analysis is needed to justify a fair and properly prioritized policy of subsidizing or supporting the income of specific sectors.

Introduction

Nearly all countries whose exports are highly concentrated in fuel exports fix their nominal exchange rate. This is to protect the livelihoods of that part of their workforce that is not employed in fuel extraction but which depends on low-productive exporting or import-competing sectors, from exchange rates changes that could be caused by variations in the international prices of fuel.

In this paper, we assess the impact that fuel price-induced exchange rate variability has on the different sectors of fuel-exporting countries. We ask what, if anything, should and can be done about the undesirable sectoral effects of being a fuel exporter. Some of our analysis is based on the international experience of fuel exporters since 1980. But making policy recommendations requires an understanding of the underlying frictions between sectors, which can only be achieved by an in-depth study of a particular country. Hence, for much of this paper, we take Colombia as a case study.

In the past, Colombia's exports have been dominated by coffee.[1] During the coffee years, Colombia's exchange rate would appreciate when its coffee earnings were buoyant. This ended in the late 1980s following a collapse of world coffee prices. For the next fifteen years or so, Colombia's exports could well have been described as diversified, combining manufactured goods, agricultural commodities, and energy and minerals in reasonably balanced proportions. Recently, Colombia's exports have, once more, become dominated by a single sector: the mantle of dominant export, formerly occupied by coffee, has now been assumed by the fuel sector, which was estimated to represent 68 per cent of merchandise exports in 2011.[2]

In contrast to coffee, petroleum extraction typically earns a high rent; most years are years of bumper harvest in petroleum extraction. Being a modern subsoil extractive industry, the petroleum sector is capital- rather than labour-intensive; few workers are employed relative to the income generated. Rather large inflows of imported capital, with its associated knowhow, are needed to extract oil. As energy-related trades dominate the current and capital account, Colombia's exchange rate has become sensitive to international energy prices.

In the first section, we highlight the distinctive economic features of some key sectors in Colombia that shape how their earnings respond to the exchange rate. We contrast coffee with other key sectors.

In the next section, we look at the effect of a combined higher oil price and exchange rate appreciation on other sectors in the Colombian economy. We follow that by estimating its effect on demand-side components of GDP. In a third section, we simulate the dynamic effect on the whole economy of an oil price-induced exchange rate change, taking the special role of the domestic banking sector into account. In this section also, we assess the sectoral side-effects of different macroeconomic policies and objectives. The last section compares the

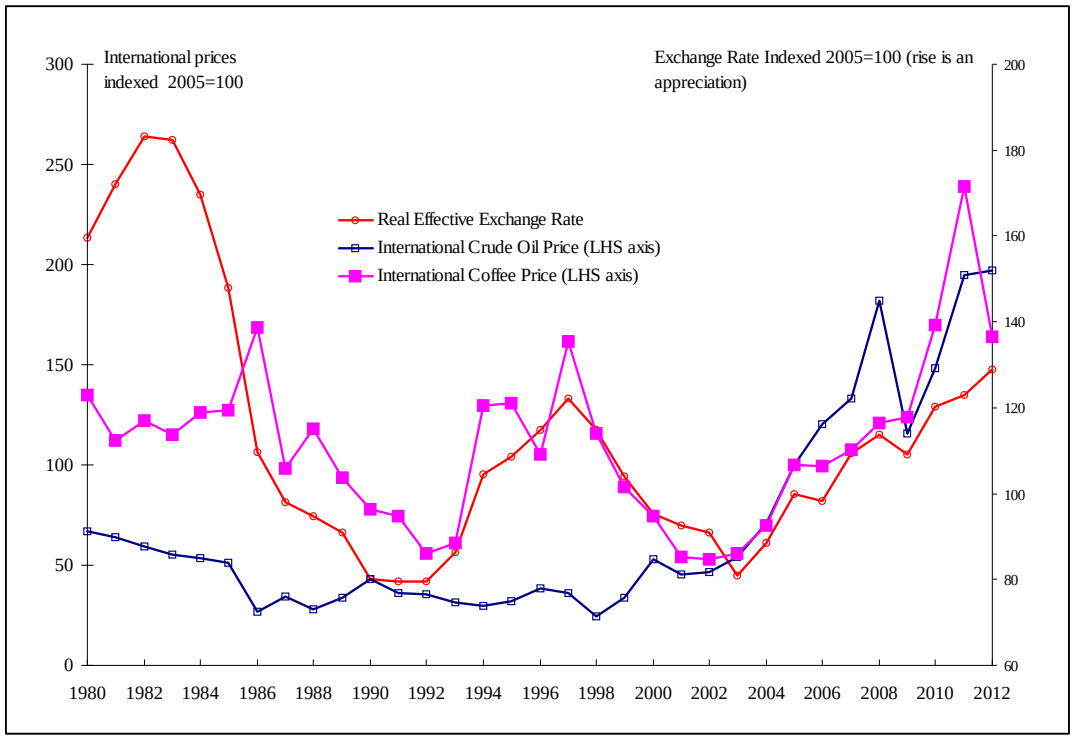
[1] In 1943, coffee was estimated to represent 80% of Colombia's export earnings and its share was still more than a half in 1986 (Ortiz, 1999).
[2] Source: IMF, April 2013 WEO database. Share of fuel in merchandise exports for Colombia.

international experience of successful diversification in energy-exporting countries. The final section concludes with some policy recommendations.

Setting the Scene

Chart 1 sets the scene for our analysis of the effect of oil price-induced exchange rate fluctuations on the income of coffee workers by plotting Colombia's real effective exchange rate against the international prices of oil and coffee.

Chart 1: International Prices of Crude Oil and Coffee and the Real Effective Exchange Rate in Colombia



Source: IMF April 2013 Database and IFS.

Notes: Crude oil (petroleum) in dollars, Simple average of three spot prices (APSP); Dated Brent, West Texas Intermediate, and the Dubai Fateh. Coffee, price index (in dollars): Other Mild Arabicas, International Coffee Organization New York cash price, ex-dock New York. Real effective exchange rate is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or index of costs.

The Colombian real exchange rate tracked the coffee price in the 1980s and 1990s, when that was still an important export. Since 2003, that role has been taken by oil and the real exchange rate has become more linked to the oil price.

The real exchange has been on an appreciating trend since 2003, when oil exports first rose over 3.5bn US dollars and Chart 1 shows that this has been also, in general, a period of high oil prices. But it is also notable that the steep but temporary oil price crash of summer 2008 to early 2009 was accompanied by a depreciation of Colombia's real exchange rate, and when the oil price recovered strongly thereafter, so did the real exchange rate.

Chart 1 also plots an index of the dollar price of coffee, which has risen from 2003 to 2011, but has fallen sharply since. We can see that though the oil and coffee price have risen together in recent times, historically this has been far from the case (Junguito Bonnet, 2007). Later we confirm this with estimates of cross correlations – that dollar commodity export prices are correlated with oil with varying degrees. Thus, in what follows, we adopt the prudent assumption that the coffee price will not rise with the oil price.

Table 1: Characteristics of Selected Sectors in Colombia (2011)

	Coffee cultivation and threshing	Agriculture, forestry and fishing excl. coffee[(a)]	Mining and Quarrying[(b)]	Manufacturing Industry[(c)]	Financial, Insurance, Real Estate and Business Services[(d)]
Share of exports (% total Colombian exports)	4.7	3.7	53.2	33.7	1.2
Share of GDP (% total Colombian GDP)	0.9	6.0	12.4	13.5	20.1
Share of employment (% total Colombian employment)[(e)]	2.8	18.7	1.0	13.4	8.5
Share of exports in sector's output (% net output)	77.8	7.1	74.4	10.7	1.2
Import competition (imports in main product market as % total supply at basic prices)	2.7	9.4	0.4	29.8	5.2
Share of costs (% net output)					
Share of remuneration	42.4	17.7	8.5	16.0	23.7
Share of mixed income	41.0	49.8	2.9	5.0	23.9
Share of capital	4.3	3.5	75.7	25.6	41.6
Share of taxes	0.3	0.2	0.8	1.5	1.6
Share of all intermediate inputs	12.1	28.7	12.0	51.9	9.3
Share of imported intermediate inputs[(f)]	2.7	5.2	1.1	18.0	2.2

Source: DANE, Colombian Coffee Federation and own calculations.
Notes: (a) Sectors 2–5 in the NIC classification.
(b) Sectors 6–9 in the NIC classification.
(c) Sectors 10–13 and 15–36 in the NIC classification.
(d) Sectors 51–53 in the NIC classification.
(e) Shares of employment calculated for 2005, using numbers of coffee workers in 2007.
(f) Calculated by multiplying the ratio of imports to total sales of the product by the amount of each input into the relevant sector, and then summing across products.

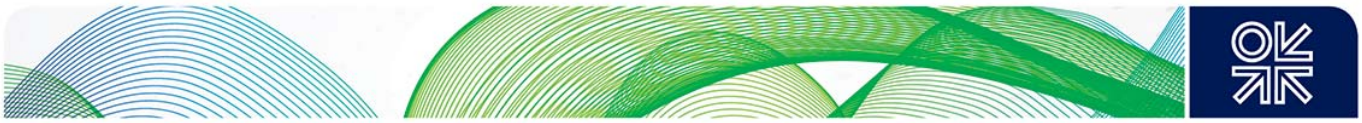
The importance of exchange rate fluctuations for labour incomes in each sector presumably arises from the characteristics of those sectors. To bring this out, Table 1 compares services to coffee (production and threshing) to four aggregate sectors: other agricultural sectors, mining and quarrying, manufacturing, and private (financial, real estate, and business).

a) Table 1 shows that the private financial and real estate services sector represents 20.1 per cent of value added and employs 8.5 per cent of the formal labour force but only earns 1.2 per cent of exports. Nearly the entire product of this very large sector goes to the domestic market. The 'other agricultural sectors' in aggregate, though they earn 3.7 per cent of export revenue, sell nearly 93 per cent of their product in domestic markets. Manufacturing in aggregate, often thought of as a tradable, actually dedicates only 10.7 per cent of its product for final export. In contrast, coffee represents only 0.9 per cent of Colombia's value added, though it earns 4.7 per cent of export revenues and employs 2.8 per cent of its formal labour force. A large share of coffee production (78 per cent) is destined for export. Only mining and quarrying is as export-orientated (at this level of sectoral detail). Thus coffee and crude petroleum extraction are the only two large sectors that produce a relatively homogenous and undiversified product for export.

b) Nearly 30 per cent of manufacturing products sold in Colombia are imported, compared to about 9 per cent of agricultural products. This could be because of import tariffs on some domestically produced food such as rice. Coffee stands out from other agricultural sectors in that there are few coffee imports for domestic producers to compete with: only 2.7 per cent of coffee sold in Colombia is imported. Thus in aggregate, manufacturing faces the most import competition, and is more exposed to the real exchange rate through this channel.

c) The total costs of production in the National Accounts can be split into those earned by the domestic value added factors employed in that sector (workers, capital, product taxes, and subsidies), and inputs purchased from other sectors or from abroad. Calculations presented in Table 1 reveal that 71 per cent of non-coffee agricultural net output is earned by agriculture's value-added factors. Labour incomes represent 67.5 per cent of total net output in agriculture, excluding coffee. An especially large share of value-added income earned in the production of Colombian coffee is down to wage remuneration or mixed income – 95 per cent (=(42.4+41)/(42.4+41+4.3+0.3)) – when compared with the shares of gross operating surplus or product taxes. In contrast, the manufacturing share going to labour as remuneration or mixed income is 21 per cent. In even sharper contrast, an 11.4 per cent share of Mining and Quarrying revenue goes to labour. Thus labour is an especially large share of agriculture; the vulnerability of labour income to the real exchange rate is through this sector. This is important because workers have less access to instruments that can help them cope with exchange rate fluctuations. For example, only about 40 per cent of the Colombian population has a bank account.

d) Input purchases represent 28.7 per cent of total net output in agriculture, excluding coffee. Also, only a small proportion of these products are imported: a simple approximation (in the absence of more information) is that imported inputs represent 5.2 per cent of net output. In the case of coffee, this share is estimated to be even lower at only 2.7 per cent. Thus, while the effects of an exchange rate appreciation on any sector's income would be mollified if production were of the type that involved a large cost share of imported inputs (whose price would then fall) this does not seem to be the case with agriculture, and certainly not coffee. Thus while, in general,



imported inputs might be expected to become cheaper as the exchange rate appreciates, this is unlikely to be of much relevance to agriculture. Manufacturing provides a sharp contrast, as a large share of costs (18 per cent) is down to imported inputs.

Summing up, at this level of aggregation, different sectors are vulnerable or resilient to a real exchange rate appreciation in different ways: the service sector looks likely to be little affected in inputs, exports, or import-competing terms; manufacturing import competition will rise, but its imports will become cheaper and workers earn a small share of income; agriculture faces some export competition but is vulnerable in that workers earn much of its income.

It is also important to acknowledge that these preliminary conclusions depend on the level of aggregation we have chosen; there may be other smaller sectors in the Colombian economy that display similar vulnerabilities to the exchange rate but which are hidden to us by aggregate data. In our suggestions for policy remedies, we will return to acknowledge this possibility. For example, coffee seems to be particular in the Colombian production system in that it produces mostly for export with mostly labour inputs. Its vulnerability does not lie in the threat faced by cheaper imports or that it is a very large sector, but in that the lower export price seems to impact the livelihood of coffee workers more directly.

In the first section we will use models to compare sectoral vulnerabilities more systematically.

The Sectoral Responses to an Oil price-Induced Exchange Rate Appreciation

A possible criticism of Table 1 is that once we look at the intermediate input trade between sectors, a different picture of sectoral exchange rate exposure would emerge. What is referred to as a domestic market for an intermediate product may only be a staging post for a final export destination.

In this section, we incorporate this intrasectoral interaction and find that other tradable sectors are quite interlinked with non-tradable sectors and hence more diversified to the exchange rate than might appear from Table 1. Nevertheless, coffee remains as it is shown above: an undiversified tradable sector.

Summarizing Sectoral Interactions

The key to analysing complex economic interactions is to use rules that summarize the messy raw data without distorting its information content. Our approach is to aggregate the 61 sectors in the Colombian National Accounts into nine sectors and cut off any interactions below a certain value.

Thus activities and products are classified into Coffee Production, Coffee Threshing, Other Agriculture (including live animals, forestry and fishing),[3] Mineral and Quarrying (including petroleum, gas and coal extraction),[4] Industry[5] (including the processing of agricultural products but not threshing), Utilities and Construction together,[6] Transport, Communications, and Hostelry,[7] Financial and Real Estate Services,[8] and other Services.[9] The sectors are as described in Table 1. All have a minimum level of exports of 3.5 bn pesos, with the exception of the three service sectors and coffee production, which has no exports in the National Accounts as these are passed through a separate coffee threshing sector.

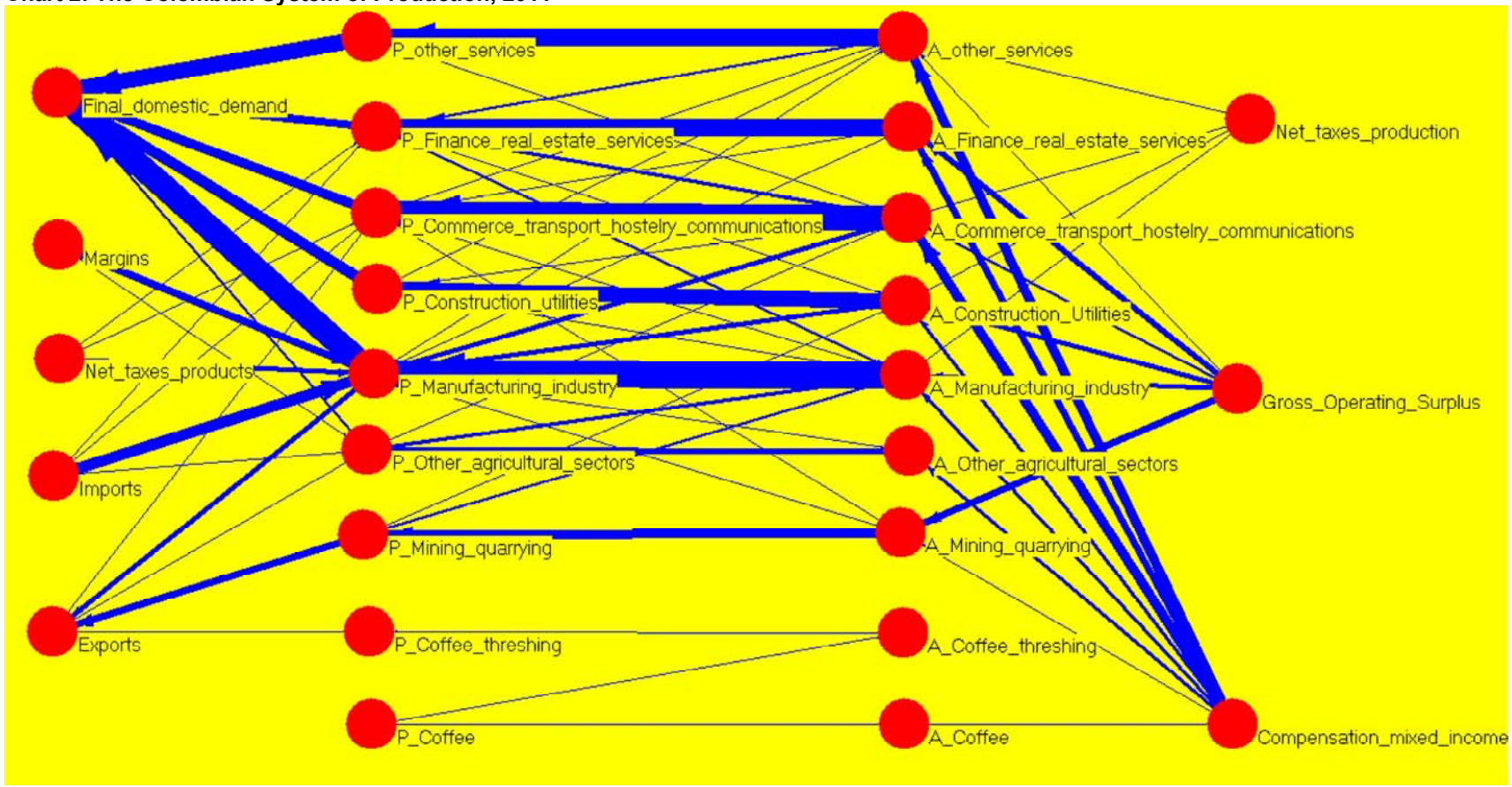
In Chart 2, we plot the links between these sectors, as well to final demand, from factor income sources, and from imports, margins, and product taxes, in one chart.

Links go from activity to product (reflecting production) and from product to activity (reflecting the use of intermediate inputs). Imports and margins matter to the value of the product. The value-added income earned goes to capital or labour (including mixed income).

There is a minimum of subjective manipulation in this depiction – the chart plots raw data from matrices of supply and use. In particular, we have not constructed an input–output table, which would involve reallocating secondary products (Hernandez, 2012).

[3] NIC classification sectors 2-5.
[4] NIC classification sectors 8-9.
[5] NIC classification sectors 10-13 and 15-36.
[6] NIC classification sectors 37-42.
[7] NIC classification sectors 43-51.
[8] NIC classification sectors 52-54.
[9] NIC classification sectors 55-61

Chart 2: The Colombian System of Production, 2011



To aid visualization all lines less than 2 trillion pesos are cut off. The widths of lines are linearly proportional to values. For example, exports of coffee are 5,326 bn pesos, compared to 60,399 for mining and quarrying.

The chart shows:

a) There is more of blurring between non-tradable and tradable sectors than one would expect from simple textbook models. The aggregates of the non-coffee agricultural and the manufacturing sectors import inputs from domestic inputs and sell to the domestic market. Hence they are, in some sense, shielded from the exchange rate.
b) Petrol and gas income is mostly in the form of rents and return to capital – this is a highly marginally productive sector with few employees. Its share of exports is large. Also noteworthy is that an important share of petrol is used as an input domestically.
c) Coffee is shown at this level of aggregation to be the most vulnerable sector. It does not sell much to domestic markets. All of coffee production goes to threshing and 95 per cent of threshing's production is for export. Coffee's value-added income is nearly all in the form of labour and mixed income. The effect of the exchange rate is consequently felt directly on coffee labour income.

Simulations of an Oil price-induced Exchange rate Appreciation in a CGE model

We now incorporate the linkages between sectors in estimating the effect of an oil price rise by simulating on a CGE model. Ardeni and Freebairn (2002) survey the use of CGE models for describing the responses of agriculture. The main advantage of CGE models for this purpose is that they allow for elasticities of demand and supply.

The CGE model we used is based upon the PEP Standard CGE model (single country, static; PEP-1-1).[10] It has a neoclassical structure with equations that describe producers' production and input decisions, households' behaviour, government demands, import demands, market-clearing conditions for commodities and factor markets, and numerous macroeconomic variables and price indices. Demand and supply equations for private-sector agents are derived from the solutions to optimization problems, in which it is assumed that agents are price-takers and markets competitive.

The structure of production represents value added as a constant elasticity of substitution relationship between composite labour and capital, while value added and composite intermediate consumption are linked through a Leontief function. On the other side, consumer preferences are derived from a linear expenditure system. The external sector is represented as a single region, and a 'mild' version of the small country assumption is used, in the sense that local producers can increase their share in international markets as long as they can offer a price that is advantageous with respect to the world price (and subject to a price elasticity of export demand). More detail on its structure is provided in the appendix, and a thorough documentation of the model is found in Decaluwé et al. (2009).

Minor changes were made to the model to adjust it to a 2005 Colombian Social Accounting Matrix (SAM). The model has two production factors: capital and labour. The latter is divided into four types: rural unskilled, rural skilled, urban unskilled, and urban skilled. Each activity in the model uses both production factors. The SAM was aggregated to 12 activities and 12 commodities (the original SAM

10 PEP stands for Partnership for Economic Policy, an international network of institutions, researchers, and experts involved in economic and development policy analysis in developing countries; it is based in Canada.

has 59 activities and 59 commodities) to emphasize the trade structure of the economy. Activities produce more than one commodity and several commodities are produced by more than one activity. Households are broken down into income deciles in order to obtain a deeper look at the distributional consequences of the shock simulated.

Table 2 shows the mapping between the activities in the SAM and national accounts sectors. As mentioned, the aggregation intends to reflect the basic structure of Colombian international trade. All activities other than infrastructure have characteristics that are both tradable and non-tradable. This heterogeneity has important implications for our simulation of the effects of an exchange rate appreciation.

Table 2: Mapping between Sectors in the CGE and National Accounts Sectors

Activity in the SAM	National Accounts Sector
Agriculture (agr)	Other agricultural products; live animals and animal products; forestry products; fish and fish products
Chemicals (che)	Basic and processed chemical products (except plastic and rubber)
Coal (coa)	Coal
Coffee (cof)	Coffee, not roasted, nor decaffeinated
Infrastructure (inf)	Construction works and buildings, civil engineering works
Machinery (mac)	General use machinery and specialized machinery; other machinery and electrical supplies
Manufactures (man)	Agroindustry; textiles and textile products; knitting products and apparel; leather, leather products, and shows; wood products; wood pulp, paper, and cardboard; printing material; plastic and rubber products; glass and glass products; furniture and other mobile products; scrap products; common metals and metallic products
Minerals (min)	Metallic minerals; other nonmetallic minerals
Oil (oil)	Crude oil, natural gas, and uranium
Refined oil (ref)	Refined oil products, nuclear fuel, and thermal coal
Services (ser)	Electricity and gas; water, sewerage, and garbage collection; commerce; repair services; hotels and restaurants; transport; mail and telecommunications; finance; real estate; firm services, domestic services; education; social services; recreation; public administration;
Transport equipment (teq)	Transport equipment

There are several advantages of using this type of model for our purposes. First, the model fits the National Accounts data; second, it considers first- and second-round effects arising from a shock; third, it provides convenient detail on the structure of the real economy and the relationships at its interior; fourth, it allows several ways for the economy to react to a shock (for instance, factor substitution in production, factor mobility between sectors, different ways to 'close' macroeconomic behaviour).

On the other hand the model, like any other, has limitations that we should also acknowledge. The model is static and permits no intertemporal optimization. Second, being a model based on micro

behaviour, there is a classic tension between this type of model's behavioural nature and the different notions of equilibrium coming from macro models (unemployment, the role of the financial sector, savings behaviour, and so forth). Third, although it models consumer behaviour, and therefore allows for the linking of income to demand for consumption, the way in which households are considered in the model precludes us from tracing the effects of the shock on coffee sector households specifically. In a later section, we will apply a dynamic general equilibrium model that will feature these properties.

Finally, the model assumes that workers do not move across the rural/urban and the qualified/unqualified divides; there are actually four separate labour markets. Labour is free to move between sub-sectors of these markets, equalising real consumer wages and thus revenue productivity levels within each labour market but not between sectors. Coffee is predominantly in the rural unqualified sector, and so the only alternatives to working in coffee are other very low productive agricultural jobs. The reader may prefer a more standard model where there is a formal sector with a barrier to entry such that its real wage is held high so as artificially restrict the demand for formal labour and push many workers into unemployment or low productive informal work. Later on, we discuss what the particular labour market assumption might affect our predictions.

As mentioned, our interest is in appraising the effects of an oil price-induced appreciation of the exchange rate on the economy and on the coffee sector in particular. We model the appreciation of the exchange rate by shocking all international prices except those of oil and refined oil products down by 10 per cent. This is akin to experiencing an exchange rate appreciation, lowering receipts from exports other than oil and refined oil, and lowering import prices, while relatively increasing the price of oil and refined oil.

Of course, an increase in the international price of petrol would have an upward effect not only on refined oil, but also on other products (either substitutes or those using oil as an input) like coal and chemicals. However, in order to keep our experiment transparent, we shock all other prices down in the simulation, and allow for this correlation in our interpretation of the results.

The Reactions of Value Added Across Sectors

Table 3 shows change in nominal value-added income in the first column. As value added is gross output minus intermediate consumption, the change in value added is broken down into the contribution of gross output of that sector and intermediate consumption by that sector in the other columns.

Table 3: Simulation of the Effect of a 10% Appreciation and a 10% Rise in Oil Price (CGE Model)

Sectors	% change in sector's value added		Contributions of gross output and intermediate consumption to % change in value added[a]		
	% change in value added	=	*Contribution of change in value of gross output*	+	*Contribution of change in value of intermediate consumption of sector*
Agriculture (agr)	–0.7		–3.6		2.9
Chemicals (che)	–7.6		–34.9		27.3
Coal (coa)	–10.0		–17.5		7.5
Coffee (cof)	–6.5		–10.2		3.7
Infrastructure (inf)	4.0		2.9		1.2
Machinery (mac)	–5.3		–29.4		24.1
Manufactures (man)	–2.3		–19.0		16.7
Minerals (min)	–2.3		–4.0		1.7
Oil (oil)	4.7		4.7		0.0
Refined oil (ref)	3.1		0.1		3.0
Services (ser)	0.5		–1.6		2.1
Transport equipment (teq)	–0.5		–45.6		45.1

Note: (a) The contributions sum to change in value added of that sector

The rationale for splitting the contributions is as follows: if the export price of that sector falls and there is no domestic production, then we might expect the value of gross output to fall. But if the sector also has large imports, then intermediate input cost might fall, implying an offsetting positive contribution to the proportional value added change. This is the case, for example, with transport equipment (teq), which imports a lot of cars, but also exports to neighbouring countries and faces competition from direct importers.

The results show that the other natural resource-exporting sectors such as mining, coal, and chemicals suffer a large proportionate loss in output. However, in reality, the effect of a higher oil price-driven exchange rate appreciation on mining and coal, and even on chemicals, is likely to be positive. This is simply because the international prices of these products tend to rise when the oil price rises. Table 4 below shows that oil price has been correlated with the prices of coal, minerals, fertilizers, and to a lesser extent with general agricultural products. The correlation with coal and metal and minerals has increased since the 1970s. The results for these two sectors should hence be ignored in what follows. The coffee price is, if anything, negatively correlated with oil price changes.[11]

[11] Claessens and Qian (1993) on data for 1965–89 and Hadri (2013) on more recent data also estimate that there is a negative correlation between real coffee prices and real crude oil prices. The increases in prices of fuels and minerals in the 2000s outstripped those of agricultural products, for which real prices have in general been below the levels of the 1960s and 1970s (Diaz-Bonilla and Robinson, 2010).

Table 4: Correlations between Annual Percentage Changes in the Dollar Price of Commodities and that of the Crude Oil Price

	1971–2012	1980–2012
Coal, Australia, $/mt, real 2005$	0.18	0.30
Coffee, Arabica, cents/kg, real 2005$	–0.10	–0.11
Fertilizers, 2005=100, real 2005$	0.67	0.35
Agriculture, 2005=100, real 2005$	0.27	0.23
Metals and minerals, 2005=100, real 2005$	0.22	0.35
Source: World Bank and own calculations. Crude oil price, average.		

Given that we can ignore impacts on the minerals and chemical sectors, the proportionate effect on value added-income for coffee is the largest among all sectors. The value added of coffee falls by 6.5 per cent, 0.65 percentage points for every percentage point of appreciation. But note also that manufacturing, machinery, and agriculture also suffer percentage losses in value added, although their losses are smaller as a proportion of their value-added level than for coffee.

One reason for the wide difference in reaction is that these tradable sectors are heterogeneous in the extent that they have diversified income through domestic markets. The sectors that have an important non-tradable side can switch production to domestic markets. For example, the value added of the 'other agriculture' sector falls by 0.7 per cent compared to the 6.5 per cent fall in that of coffee, because it produces more for domestic demand. In Chart 2, 85 per cent of its final demand goes to domestic demand rather than exports and the service sector's intermediate consumption of other agricultural output is about the same size as its exports.

Another reason for differences is that some sectors import a large value share of inputs, and thus can benefit from the higher exchange rate because import prices are cheaper. This lowering of costs can bring about an expansion in total supply, or at least some offset of the loss to exports.

A further source of variation is that sectors compete with imported products to a different extent. For example, judging from Table 1, industry faces more competition in home markets from producers abroad. However, none of these sectors suffers as much, proportionately, as coffee possibly because they also tend to be among the sectors that import many inputs.

Of course, we should remember that at a finer level of disaggregation there might be sectors with large losses, just as for coffee. These sectors are likely to be within agriculture or manufacturing.

It is important to recognize that the percentage loss of each sector is not an indication of its importance to the total losses suffered in the economy, as that depends also on the size of that sector. Table 5 shows contributions to value-added income losses of each sector to the total economy's value-added loss.

Table 5: Contributions to the % Loss in Total Value Added (percentage points)

Sector	Percentage points
Agriculture (agr)	–0.07
Chemicals (che)	–0.14
Coal (coa)	–0.14
Coffee (cof)	–0.09
Infrastructure (inf)	0.25
Machinery (mac)	–0.03
Manufactures (man)	–0.25
Minerals (min)	–0.04
Oil (oil)	0.15
Refined oil (ref)	0.06
Services (ser)	0.30
Transport equipment (teq)	0.00

Table 5 shows that, though we can expect its value added to be affected the most in proportionate terms, coffee is not the most important sector in terms of contribution to total value added loss. The larger contribution to the value-added loss is actually from manufacturing, which is a much larger sector. The negative contributions of agriculture and manufacturing are offset by powerful positive contributions from the oil sector itself, as well as services. While it is important to remember that the CGE model does not feature some key dynamic mechanisms (such as the decision to save or spend by consumers) it is reassuring that this pattern of responses to the oil price rise will be found in the more dynamic model we present later on.

Labour Market Dynamics

Our next set of results concerns the losses in employment generated by the appreciation. In the model there are four categories of worker: rural unqualified, rural qualified, urban unqualified, and urban qualified workers. Labour belonging to each of these four categories is employed in each of the activities of the economy, with sectoral shares of each type of labour being calculated using data from the 2003 Living Standards Measuring Survey.

In the simulation, we assume that salaries are completely flexible and there is no movement of workers between these four great categories of the labour market. There is no unemployment or informal sector. Instead, labour released from a higher productivity sector will have to seek employment in a lower productivity subsector, but not across the rural/urban or qualified/unqualified divide.

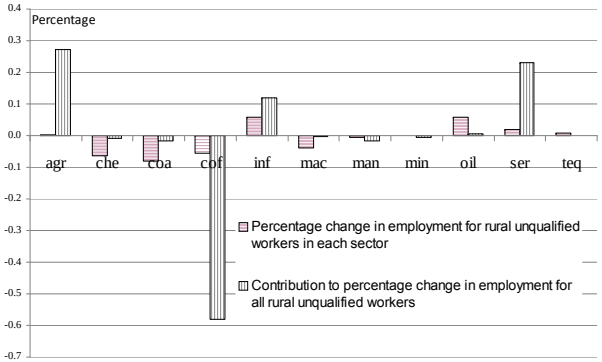
The simulation describes that as a result of the postulated 10 per cent oil price rise and appreciation, the real wages of workers in the rural unqualified sector fall by 10.9 per cent, while those workers in the rural qualified sector, in the urban unqualified sector, and in the urban qualified sector fall by 3.5, 3.6, and 2.3 per cent respectively. Hence there is an overall fall in the real marginal revenue of workers, and this is mostly concentrated within the ranks of unqualified rural workers. The reason is, as we shall see, because the most likely alternative employment for rural unqualified workers is in the

very low productive (low wage) activity of agricultural work. The massive increase in the supply of labour lowers wages for this subsector.

Charts 3 to 6 consider the changes in employment within each category, and each economic activity. The results are presented as contributions to the total change in employment for that category, as well as percentage changes to the employment in that activity for that type of worker. The sum of contributions across all economic activities is zero, as we do not allow for unemployment, inactivity, or exit or entry from each category of worker.

Chart 3–6: CGE Simulated Effect on Employment by Sector and Category of Worker of a 10% Oil Price Rise and Exchange Rate Appreciation

Chart 3: Rural Unqualified Sector (11.7% of all workers)



Note: For names of subsectors see Table 6.

Chart 4: Rural Qualified Sector (1.5% of all workers)

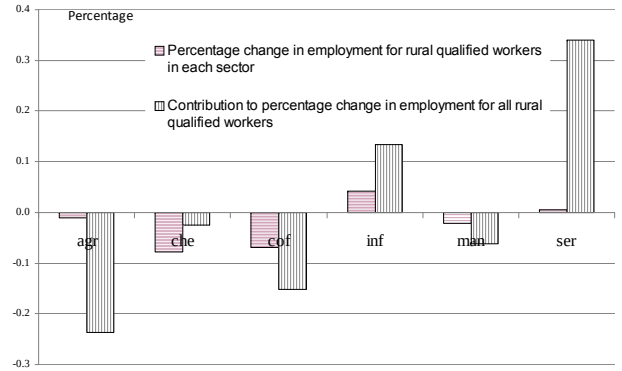


Chart 5: Urban Unqualified (43.7% of all workers)

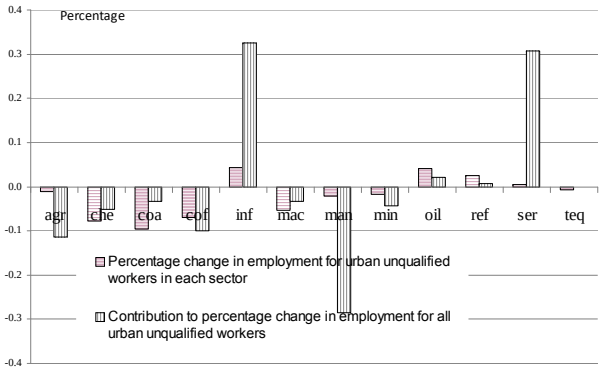
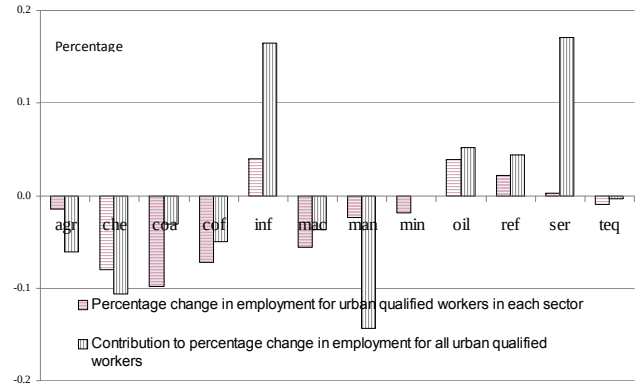
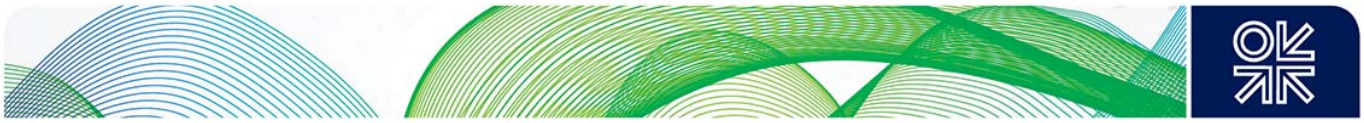


Chart 6: Urban Qualified (43.1% of all workers)





The simulation results highlight the importance of the coffee sector in explaining employment losses. In Chart 3, we see that the fall in demand for workers in coffee cultivation explains nearly all of the losses in unqualified rural labour demand. However, while the employment of agricultural workers rises (Chart 3), the ill consequences of the appreciation are felt in the form of lower salaries. Essentially agricultural work is the low productivity, last resort for the rural unqualified workers released from other sectors because of the exchange rate.

In the case of qualified rural workers, coffee workers along with other agricultural workers contribute most to the lower labour demand (Chart 4). In contrast, in urban areas, where 87 per cent of the workforce is to be found, the greatest contribution to the labour demand loss from the oil price rise and appreciation is from manufacturing (Charts 5 and 6). This is true in both qualified and unqualified worker groups. In urban areas, lower labour demand is more likely to be seen in the form of unemployment, rather than in lower salaries.

Across all categories of workers, the largest positive contributions to labour demand are from services, and in the case of urban workers, infrastructure construction (inf). This shows that the effect of an appreciation can be positive on employment, on wages, on non-tradable sectors, and is large enough to offset the deep losses in sectors such as coffee in the aggregate numbers.

In the introduction to this section, we compared this model to a more standard labour market description where the alternative to working in coffee is the lottery of a chance of either entering into formal work or more likely ending up in low productive informal work. The crucial difference between the two models is the outside option for coffee workers. In the CGE model in the paper this is other low productivity agricultural work. In the other, it is a great likelihood of unemployment (or low productivity informal work) combined with a small chance of well-remunerated formal work.

Our elasticity of interest is the response of employment in coffee to a rise in the exchange rate. The question is then, will the size of the fall in employment in coffee to a rise in the exchange rate be very different if we use the model in the paper compared to the rigid-wage model option? Under some settings, the magnitude of the effect could be different. Consider in particular if the formal sector is services, with a high labour share. If the wage in services is held artificially high and the service sector benefits from the appreciated exchange rate, there is a possibility that the fall in employment in coffee will be even larger than the CGE in the paper because coffee workers will exit coffee to gamble on getting a job in services. (That said, this depends on the extent of intersectoral labour immobility and emigration, both of which we have little data on.)

In conclusion, among all the categories of workers at this level of aggregation, the rural unqualified coffee workers suffer the largest percentage loss in employment as a result of an oil price-induced appreciation, as we would expect given our understanding of the structure of coffee production. However, rural unqualified workers in other agricultural activities suffer a large percentage loss in their salary, in part as a consequence of released workers being forced to enter this sector to work. This reinforces the point that the ability of workers in the rural unqualified labour market to access other productive activities is critical in determining the vulnerability to the exchange rate.

Reading from the literature on Colombian labour markets, we have good reasons to suspect that such frictions are present and important. Recent studies have looked at the migration between Colombian rural and urban labour markets. For example, Leibovich et al. (2005) found that there were great potential benefits for rural workers if they moved to urban areas, though naturally this would offset the

higher risk of unemployment in cities (Lopez, 2013). Lasso (2013) shows that there can be large movements between the states of being unemployed, employed, and inactive, but it is not straightforward to infer from this that workers in vulnerable sectors can temporarily access other productive employments if there is less demand in their main sector. Barón (2013) calculates that migration flows in Colombia seem relatively insensitive to wages, but he makes a point of emphasizing the inadequacy of the current available data to fully answer these important questions. Calderón-Mejia and Ibáñez Londoño (2008) estimate that much of rural urban migration has been as an escape from violence and has depressed urban salaries, and hindered the potential passage of economic migrants. Mondragon Velez et al. (2013) estimate that nonsalary costs play an important role in Colombian labour markets that may limit the ability of workers to diversify income.

Thus, from the CGE model simulations and studies on the Colombian labour market, we have some inkling as to the extent of diversification opportunities for vulnerable Colombian workers, but we have little idea how this depends on their rural urban location or degree of education. Perhaps, the safest conclusion to draw is that there is a lack of crucial data with which to calculate the extent of their economic isolation of Colombian labour markets.

Assessing the Importance of Sectoral Losses for Policy

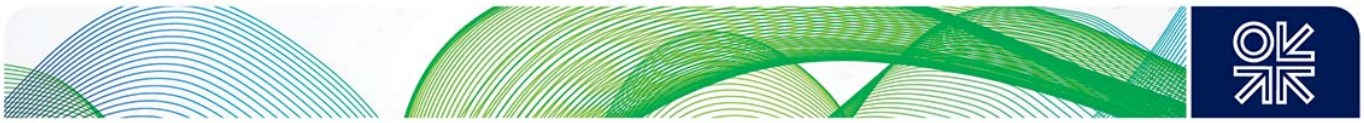
A common practice when assessing the impact of shocks like exchange rate appreciations or coffee price falls is to estimate the contribution of that sector to total losses in consumption and use that as an indicator of importance for policy. We now clarify that vulnerability, not contribution, seems more relevant from the point of view of impact assessment. The two can diverge across sectors.

Table 6 below shows the effect of the exchange rate appreciation on earned income, and thus consumption, in each decile according to our CGE model experiment.

Table 6: CGE Simulated Effect of the 10% Exchange Rate Appreciation on Income Deciles and their Consumption

Decile	Percentage effect on income of that decile	Absolute effect on income by decile	Marginal propensity to consume of decile	Absolute effect on consumption by decile	Contribution by decile to total loss in consumption
1	–8.0	–217	1.30	–282	3.6
2	–6.8	–348	1.19	–415	5.4
3	–6.1	–424	1.16	–493	6.4
4	–5.3	–499	1.11	–553	7.2
5	–4.8	–558	1.06	–590	7.6
6	–4.5	–646	0.96	–618	8.0
7	–4.2	–778	0.94	–727	9.4
8	–3.8	–1006	0.89	–898	11.6
9	–3.5	–1312	0.83	–1084	14.0
10	–3.0	–2979	0.70	–2071	26.8

The second column describes the proportionate effect of the appreciation on the income of that decile. Clearly, the oil price-induced exchange rate appreciation hurts poorer income earners



proportionately more, indeed much more, than richer workers. This is a consequence of the sectors in which the poorest income earners are to be found being those vulnerable to the exchange rate. As we saw earlier, the greatest fall in demand is for rural unqualified workers. Nevertheless, in the third column, we see that the effect of the exchange rate appreciation, in terms of nominal lost income, is higher for the richer deciles, simply because they earn vastly more.

The next column gives an estimate of the marginal propensity to consume from this income, which varies by income decile (Melo et al. 2006). This allows for the empirical observation that poorer workers have a greater propensity to consume from income. Multiplying this by the third column gives us the loss in consumption attributed to each decile, in the fifth column. The larger losses in consumption are from the richer deciles, even though it is the poorer deciles that are hurt most. Naturally their contribution to the total loss in consumption is greater (final column).

Therefore, in judging the extent of a sector's vulnerability to the appreciation, we should look at the percentage loss in income or percentage drop in consumption of that group. It is of less relevance to consider the contribution to the total economy-wide loss in income or consumption, because this might just reflect the greater spending power of relatively richer groups. We note that the contribution of even the second-lowest decile is greater than the lowest decile.

As 'contribution' is not the same thing as 'vulnerability', we should measure the policy concern over the vulnerability of workers to exchange rate appreciation by their percentage losses in consumption and not by their contribution to the responses of total consumption.

Empirical Estimates of the Effect of a Rise in the International Oil Price

In this section, we estimate the effects of a rise in the international price of crude oil on the different sectors of Colombian economy using recent data. To assess the impact of an increase in the oil price we use a Factor Augmented VAR model (FAVAR), a methodology proposed by Bernanke, Boivin, and Eliasz (2005). FAVAR models are VAR models with an emphasis on the ability to include a large number of macroeconomic variables. This is useful in the case of an oil price shock, when useful information on the underlying phenomenon could well be dispersed over many series. The inclusion of more variables also represents an advantage over traditional VAR analysis because the potential for bias in the estimated dynamic effect of a shock is reduced, and the effect of a shock can be analysed on a much larger number of macroeconomic variables.

In keeping with the tradition of VAR models (Sims, 1980), our aim is to impose the minimum of assumptions that are needed to identify the feature of interest. In the particular case of the price of oil, we assume that the international oil price is exogenous to the Colombian economy. Since oil production in Colombia represents less than one per cent of world oil production, we can very plausibly consider Colombia to be a price taker in international oil markets.

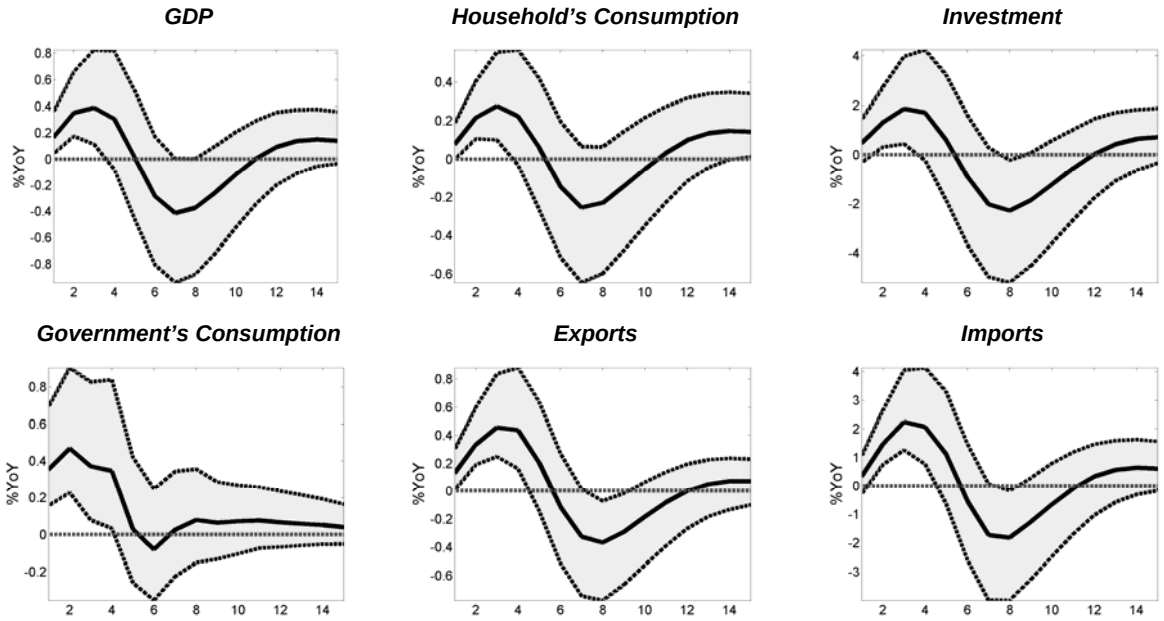
The FAVAR model was estimated using quarterly data from 1998–2012 for 87 macroeconomic variables. The sample includes the period in which oil has played an important role in the Colombian economy. Technical details about the FAVAR model and its specification can be found in Appendix 2 and in Echavarría, González, and Gutierrez (2013).

Chart 7 describes the effect of an oil shock on the components of the aggregate demand in the model. The size of the shock is one standard deviation of the oil price, which, as oil prices are volatile, roughly translates to an increase of about 15 per cent on the quarter. At an aggregate level, an increase of this magnitude in the price of oil causes the annual growth of Colombian GDP to rise between 10 and 90 basis points above its long-run average rate (which is around 4.0 per cent) with the maximum effect attained approximately one year after the shock. This boost in economic activity is rooted in an expansion of consumption and investment. The average annual growth rate in consumption increases between 20bp and 40bp while the growth rate of investment is boosted by a much larger 200bp. The positive effect on the growth rate of GDP is reversed in the second year, though this is more uncertain.

Chart 8 illustrates the responses on other variables:

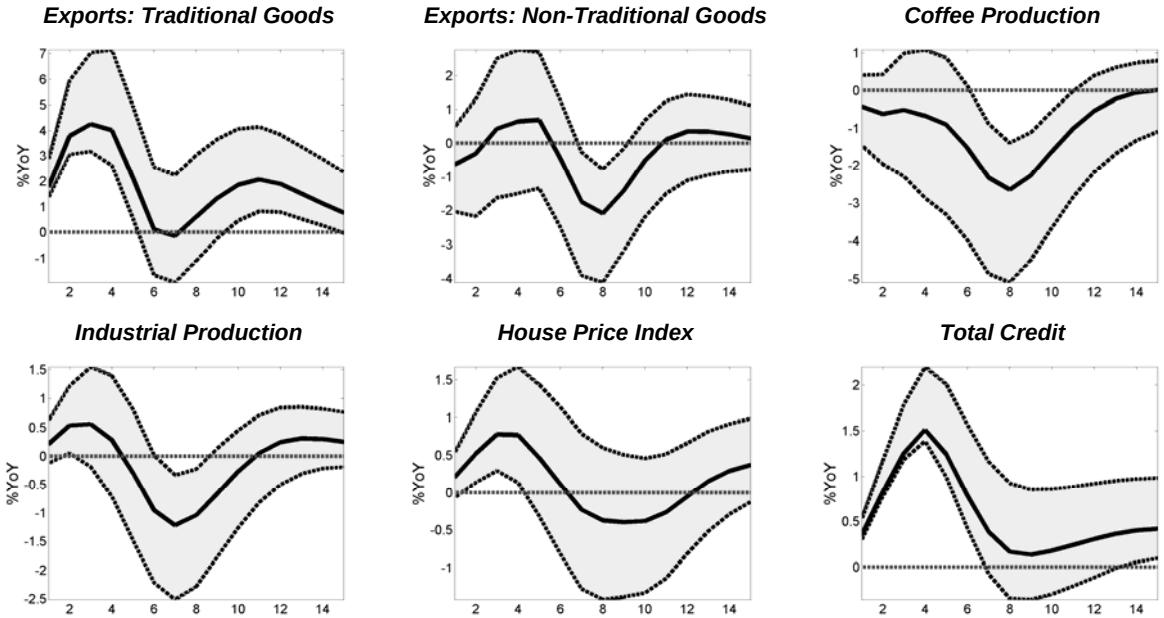
- There is a pick up in the real exports of traditional goods, but only in aggregate.
- This movement in the total disguises large differences between the components of traditional exports, especially between coffee and fuel exports. Chart 8 also shows that there is a sharp slowdown in the growth of the export volume of coffee that gradually intensifies, such that, after a year, exports of coffee have slowed down by 300 basis points. Hence the higher growth in oil exports offsets the slower growth in coffee.
- The growth rate of exports of nontraditional goods also falls slightly, one year after the shock.
- Most analyses of the effects of the oil price shock do not consider its effect on domestic credit and domestic house prices. However these variables are crucial indicators of both economic health and risk in economies like Colombia. In Chart 8, we can see that the higher oil price raises the growth rate of credit for nearly a year and a half. The rise is about 150 basis points at its peak. House prices rise also, but by less than credit, and with much uncertainty surrounding the estimate. These results point to the stimulating effect that an oil price rise can have on the non-tradable sectors, in particular on financial intermediaries.

Chart 7: Response of the Annual Growth rate of GDP and its Components after a One Standard Deviation Shock to Price of Oil.



Source: Echavarria, Gonzalez and Gutierrez (2013). %YoY is percentage change on a year earlier.

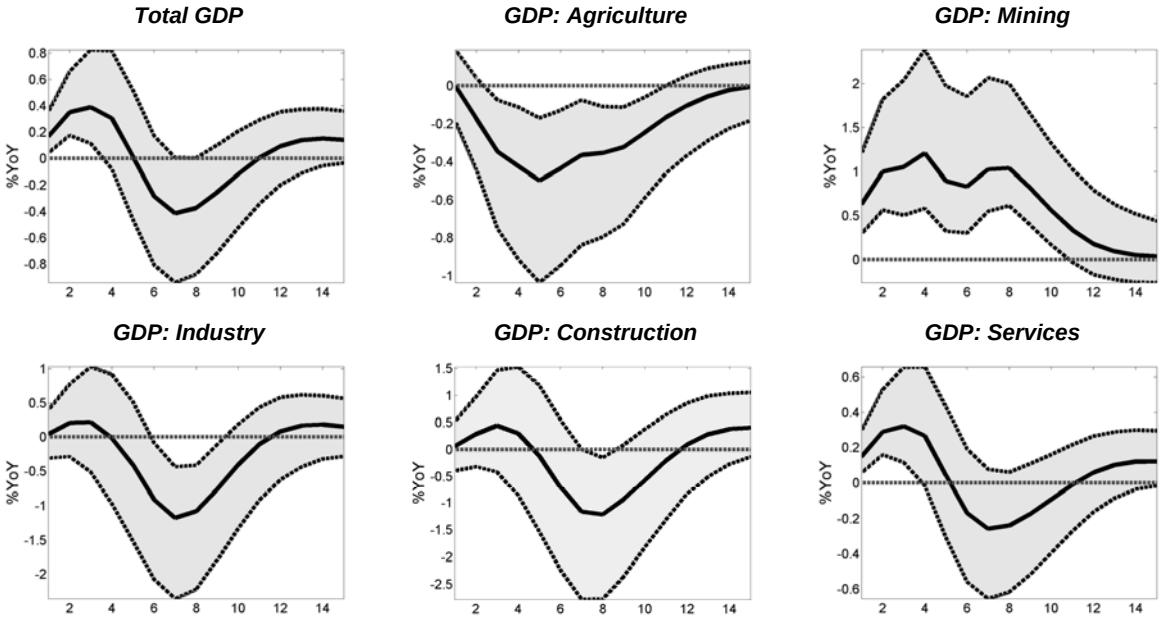
Chart 8: Effects of a One Standard Deviation Shock to Price of Oil on the Annual Growth Rate of Macroeconomic Variables



Source: Echavarría, González and Gutierrez (2013).

Finally, Chart 9 shows the effect of the oil shock in the production of the various sectors of the economy, highlighting the variety of responses. As can be seen, the service industries and mining and extraction grow at higher rates after the shock, while industry and agriculture slow down. In particular, the mining and energy sector experiences the largest pickup in growth after the shock, reaching an annual growth rate of 1 pp above its long term. But it is also noteworthy that the service sector grows faster (by 20 basis points) soon after the crude oil price rise. In contrast, the annual growth rates of agriculture and industry both fall by about 50bp.

Chart 9: Response of the Annual Growth of Real GDP (output measure) in Aggregate and of Selected Sectors after a One Standard Deviation Shock to Price of Oil.



Source Echavarría, González y Gutiérrez (2013).

Channels by Which an Oil Price-Induced Exchange Rate Appreciation Affects Sectors

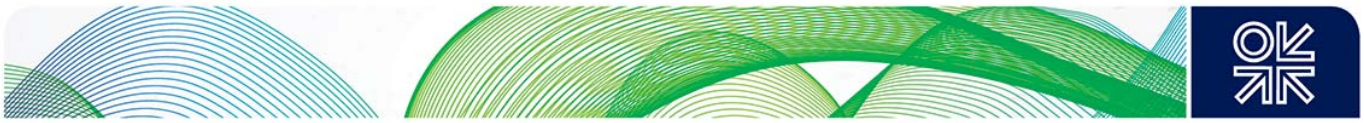
The Relevance of Economic Theories on Natural Resource Appreciations for Fuel Exporters, such as Colombia

In this section, we consider the effect of exchange rate appreciations that are due to oil price rises, which draw in foreign capital. We will show that the oil price rise boosts non-tradable sector output, credit to that sector, and inflation. Our main aim is to describe the sectoral implications of the various ways in which this inflationary impulse (a threat to monetary stability) and the credit build up (a threat to financial stability) can be averted. As we shall see, the oil price shock itself, as well as any offsetting policy action, will inevitably have sectoral implications. Any exchange rate appreciation will lower the labour earnings of other tradable sectors, such as coffee.

Historically the models used to answer this question have been of different sectors with different productivities and prices, but free movement of labour (and sometimes capital) between the sectors (Magud and Sosa, 2010). The classic model of the Booming Sector, or Dutch Disease effect, involves three sectors: a very productive and a less productive tradable sector and a non-tradable sector. There is indeed a large productivity differential between the Colombian mining and quarrying and coffee sectors: subsoil extraction earns high rents while coffee is labour intensive. But the other key assumption of the Dutch disease model (Corden, 1984) – that labour is mobile between sectors – is not applicable to Colombia's current situation. This assumption is highly unrealistic in the case of the oil sector where, as we have seen, most revenue is earned as rent and there is limited scope for employment. As further evidence, we can cite Buitrago (2007)'s calculations of the employment coefficients of Colombian sectors in 2004. She finds that petroleum extraction employment is 2.7 per cent of agricultural employment, but while 69 per cent of petroleum labour has had at least 12 years of education, the corresponding proportion for agriculture is only 1.8 per cent. Eighty-five per cent of agricultural workers have had no more than seven years of education, a far higher proportion than any other major employing sector. In the absence of more formal evidence, this gives us good reasons to suspect that labour cannot move out of agricultural sectors into other productive employment, as decent alternative employments seem limited for rural workers. This does not, however, preclude the possibility that labour might be mobile within and between the services and manufacturing conglomerate, as shown in Chart 2.

Furthermore, our analysis in the first two sections of this paper shows that there is no perfect match between the third sector in this model – the non-tradable sector – and the reality of most of Colombian production. Industry and other agriculture sectors have both tradable and non-tradable aspects and the service sector, in aggregate, exports and imports significant quantities.

Yet another concern with the standard Dutch Disease model is that as it does not allow for the choice of how much to save and borrow and in what form, it cannot explain the crucial financial stability impact of oil incomes that are associated with appreciation. Collier and Gunning (1999) criticized the standard model, arguing that what was needed was a model that emphasizes the incentive to save (through physical capital building as well as financial assets) from oil windfalls, as only that could capture the possibility of triggering a construction boom. Colombia's own historical experience reveals



the crucial role of private saving in shielding the economy from coffee price-induced exchange rate fluctuations (Montenegro, 1999).

In conclusion, to explore the consequences of an oil price-induced appreciation in a fuel-exporting country such as Colombia, the standard Dutch Disease model is inappropriate. We need a model that allows for labour immobility, consumption, and saving – one that also includes the banking sector in order to explain the cost of intervention in terms of insufficient private savings. We now describe a model that fulfils these needs.[12]

Simulations of an Oil Price-induced Exchange Rate Appreciation in a DSGE Model

In this section of the paper, we use a Dynamic Stochastic General Equilibrium (DSGE) model to evaluate the consequences of alternative monetary and exchange rate policies on the tradable sector and, potentially, on the coffee sector. The evaluation of these policies is conditional on oil shock. That is, the evaluation of different policies is done assuming an oil price increase.

The evaluated alternative monetary policies are:

1. A traditional monetary policy in which the short-term interest rate is set by the Central Bank following a Taylor rule that responds to non-tradable inflation.
2. A macroprudential policy that affects the cost of credit to the private sector. The potential instruments of macroprudential policy are the statutory reserves and capital requirements of commercial banks. The macroprudential policy makes no conscious distinction between the tradable and non-tradable sector.

For the evaluation of these policies, we use the model developed by González, Hamann, and Rodríguez (2013), which replicates the most important stylized facts of oil shocks in Colombia. From the results of the first section of this paper and the work by González, Hamann, and Rodríguez (2013), one can conclude that the main stylized facts of an oil shock are:[13]

1. A decrease in the external risk premium measured by the J P Morgan Emerging Market Bond Index for Colombia. González, Hamann, and Rodriguez (2013) describe the effect of oil prices on the risk premium (See Figure 2 in their paper). Additional support can be found in the studies on corporate bond spreads in emerging markets. For example, it has been estimated that in emerging markets there are typically no or few firms with less risk than the government.[14]
2. A general increase in aggregate demand (Chart 7).
3. An expansion of private sector credit (Chart 8).
4. An appreciation of the peso in real terms (Chart 1).
5. A fall in the growth rate of the tradable sectors (manufacturing and agriculture) accompanied by an increase in the growth rate of non-tradable sectors (services and construction) (Chart 9).

12 Static models such as the CGE do not allow a role for saving. The FAVAR model in the previous section does not allow for counterfactual policy experiments.

13 Earlier work by Mahadeva and Gómez (2009) found similar stylized facts.

14 Durbin and Ng (2005) find strong evidence for this sovereign risk ceiling, with only a few exceptions. Recently, an article by Longstaff et al. (2011) found that most sovereign credit risk is linked to global factors, including the prices of commodities. Edwards (1984) found that coffee price booms were associated with an increase in money supply in Colombia. Perhaps to the contrary, Beck (2013) estimates that natural resource economies have less developed domestic financial sectors, adjusting for other factors, but outliers may dominate this.

The model presented in González, Hamann, and Rodríguez (2013) has three sectors: a tradable sector (coffee), a non-tradable sector (services), and the oil sector. The production of the first two sectors uses domestic inputs (capital and labour) while the production of oil does not require capital and, most importantly, does not use significant quantities of labour. However, export revenues from the oil sector enter the economy as income to households.

The model includes commercial banks whose main business is intermediating financial resources in the economy. Households deposit their savings in banks, which are responsible for providing these resources to firms in the tradable and non-tradable sectors. Firms require these funds to finance their investment plans. We assumed that there are information frictions between commercial banks and entrepreneurs (Bernanke, Gertler, and Gilchrist, 1999) and so there is an external financing premium that an entrepreneur must pay to the commercial bank to obtain a credit. This premium depends on the value of the collateral of the entrepreneur (or their level of leverage). Thus, for a given debt stock, if the value of collateral increases, the premium is lower and the entrepreneur can get credit at a lower interest rate.

Commercial banks also interact with the Central Bank (CB) and the international financial system. In particular, the CB issues sterilization bonds that are purchased by commercial banks at a risk-free rate. This risk-free rate is assumed to be the reference rate for monetary policy. Thus, the asset side of the commercial bank balance consists of loans to entrepreneurs and sterilization bonds from the Central Bank. To finance its portfolio, a commercial bank uses deposits from households and borrows from the international financial system. The commercial bank loans from the international financial system are traded at an interest rate that equals an external risk-free interest rate plus a country risk-premium that depends on both the aggregate indebtedness of the economy and the oil wealth of the country (Longstaff, et al., 2011). Consequently, when there is an increase in the oil price, the external risk premium to be paid by commercial banks decreases.

The aforementioned elements of model play an important role in explaining the behaviour of the economy after an oil price shock. Indeed, when there is a positive shock to the oil price, households (and government) experience an increase in their income, and therefore in their spending. This implies a greater demand for both tradable and non-tradable goods. However, the fall in the external risk premium associated with a higher oil price generates an appreciation of the real exchange rate. Therefore, the increased demand for tradable goods is met by a greater share of imported goods. The demand surge after the oil price shock also drives entrepreneurs to increase their demand for loans.

The appreciation of the exchange rate leads to a fall in the value of the assets of the tradable sector and lowers the value of its collateral; consequently, the external financing premium that tradable firms pay to commercial banks increases. This increase in financing costs, coupled with the lower demand of domestically produced tradable goods, drives down employment in this sector.

In contrast, the non-tradable sectors benefit from an exchange rate appreciation. There are three reasons for this. First, while in Colombia there might be many small non-tradable sectors facing import competition, we assume that the sector in aggregate operates in domestically shielded final output markets and faces little direct competition from abroad (see Table 1). Second, it is also an aggregate feature of the Colombian economy that non-tradable sectors import an important share of their inputs, as shown in Chart 2. For example, many retail products are originally produced abroad. Given the relative shelter from foreign competition and the importance of imported inputs for non-tradable sectors, the exchange rate appreciation lowers the cost of non-tradable sectors' inputs without lowering their domestic output price. This boosts the non-tradable sectors' value-added

incomes and permits an expansion in the scale of production, just as in the CGE model simulation in the previous section.

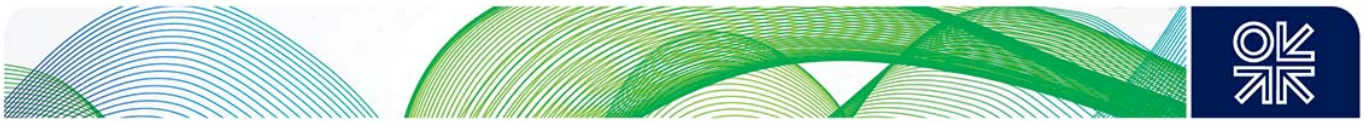
Finally, another favourable boost to the non-tradable sector arises through the reaction of the consumer to the lower exchange rate. In the Dutch Disease literature, this was called the spending effect. In Colombia, an important share of imported goods goes into household consumption. Thus, the real exchange rate appreciation raises the real value of household income. In aggregate, this offsets the loss of income from those consumers who work in the tradable sectors. The rise in consumers' income leads them to demand more. As most of domestic demand is supplied by the non-tradable sector, this represents a fourth channel through which the oil price rise benefits the non-tradable sectors. Experience shows that the combination of all these effects can be powerful, but especially when a boom in bank credit is also triggered by the appreciation.

In contrast to most of the earlier literature on the Dutch Disease, we do not expect that the non tradable sector will be stimulated because the expansion in oil threatens to draw in workers to oil from the service sector or domestically orientated manufacturing and boost their wages. As we have emphasized, a crucial feature of the oil sector is that it is not labour intensive and requires a few specialized workers, a relatively greater percentage of whom are foreigners. Thus this resource-switching effect identified in the Dutch Disease literature is, we think, unlikely to take place in this case and is not a feature of the model.

The adjustment of the economy described above reflects the best reactions of economic actors, given the financial restrictions they face, and, also crucially, under the assumption that they expect that the oil price rise will not be reversed. However, oil prices are notoriously volatile and a complete policy analysis should also consider any vulnerability to a sudden reversal in the oil price. The vulnerability arises because: first, the economy's aggregate debt is higher, and second, the 'size' of the tradable sector is lower and its ability to absorb non-tradable sector employees is limited by its capital stock. Given these macroeconomic vulnerabilities, a Central Bank could act using different instruments and reduce the size of the necessary adjustments if a sudden reversal of the oil price happens. The fundamental question is to determine if alternative monetary policies have different effects at the macro level and/or at the sectoral level.

One policy option is to increase the Central Bank (CB) reference rate. With this policy, the CB controls both the expansion of aggregate demand and credit. A second policy option is to combine the movement of the policy rate with a macroprudential policy that aims to increase the interest rates on commercial loans. The first policy is modelled in González, Hamann, and Rodriguez (2013) through a Taylor rule in which the reference interest rate is set by the Central Bank following the behaviour of non-tradable inflation, and there is also consideration for variations in output. Thus, the rule is considered to be an approximation to an optimal rule where anti-inflationary concerns are weighed against losses in aggregate output. To model the addition of a macroprudential policy, we added to a regulation premium that increases when domestic credit exceeds its steady state value to the lending rate of the economy. As this premium can be set independently of the rate, this represents two instruments. For further details on this policy rule, see Unsal (2013) and González, Hamann, and Rodriguez (2013).

Charts 10 and 11 plot the responses of the economy after an oil price shock under three scenarios (shown by solid, dashed and dash-dot lines on these charts). To mimic the dynamic pattern of a typical oil price shock, we simulate it as an AR(2) process. The parameters of an AR(2) model are configured in such a way that after an initial increase in the price of oil, agents can expect additional



increases in the future (tracing a hump shape). In a second experiment, to capture the idea of a sudden reversal in the oil price, an unexpected negative shock is added six quarters after the initial price hike. The solid line in these charts shows the path followed by the variables in absence of the price reversal, while the dashed and dash-dot lines show the behaviour of the variables when there is the reversal. Central Bank actions in the solid line scenario comprise only of monetary policy actions (according to the standard Taylor rule). In the dashed line also, only monetary policy is implemented but this time in the presence of the oil price reversal. In the dash-dot line, this traditional monetary policy is complemented with a macroprudential policy.

We can begin by considering the solid line only, which describes the scenario of a long-lasting rise in the oil price of 15 bps that is not reversed. The real exchange rate is shown as dollars per peso so that a fall is an appreciation. Thus the rise in the oil price leads to an immediate sharp appreciation of the exchange rate of 25 bps, which is unwound slowly thereafter. The appreciation has the effect of lowering tradable sector output initially by 50 bps. The level of tradable sector output very gradually returns to its former level, as the exchange rate depreciates slowly. As we have argued, appreciations favour the non-tradable sector; non-tradable sector output increases immediately and enjoys a higher level of activity over the period of higher oil prices. As the non-tradable sector is larger, the net effect is a higher level of GDP.

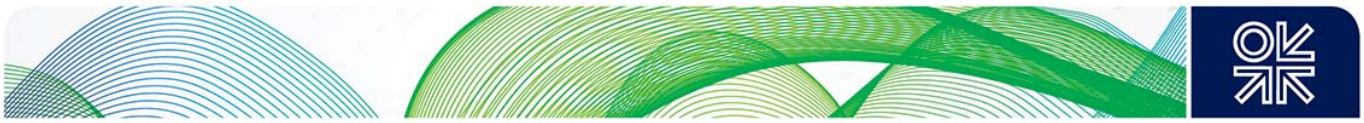
During the course of the process, monetary policy is tightened to keep non-tradable inflation under control. Without it, the inflation objective would be compromised. But as there is no macroprudential objective or instrument, private credit is allowed to increase, and, indeed, its level rises by 5 bps.

Thus, if the oil price rises and is not expected to be reversed, monetary policy would have to be tightened to deal with non-tradable inflation. The model illustrates that we should expect the standard development following the oil price rise-induced appreciation to be a rise in non-tradable output and a fall in the tradable sector, with the former offsetting the other in GDP. Hence, under a long-lasting oil price rise, the dilemma is that tradable sector output has to be sacrificed for lower inflation and for higher non-tradable output. The coffee sector is a tradable sector, and the results of the previous section indicate that even among the tradable sectors, it is likely to be among the worst affected.

In reality, there is not much certainty that any oil price rise will be sustained. Oil prices are affected by supply and demand shocks and the possibility of storage implies that the price is very sensitive to future prospects. Policy makers would do well to incorporate the risk that the oil price rise will reverse in their actions. In what follows, we consider different policies, under the assumption that the oil price rise unexpectedly reverses. Our focus is again on the impact across the different sectors.

By comparing the solid and the dashed line one can see the necessary adjustment of the economy after a sudden reversal in oil price. As before, only monetary policy is active. Chart 10 reveals that at the time of the reversal there is a sharp depreciation of the exchange rate together with a fall in aggregate consumption and investment. In Chart 11, we see that non-tradable sector debt has to be drastically reduced on news of the oil price reversal. This reflects the sudden realization that past investments in the sector will not be justified.

Moreover, turning back to Chart 10, non-tradable inflation declines strongly at the time of the reversal. The fall of inflation is explained by the adjustment of the labour market. In particular, real wages have to fall.



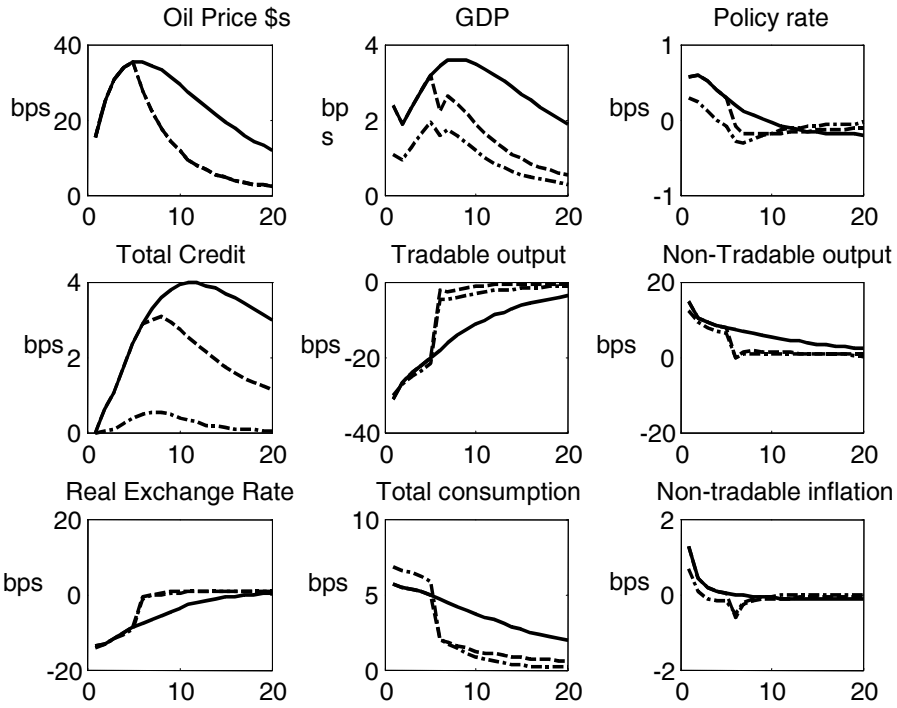
This fall in real wages is due to several factors. First, the policy-induced depreciation of exchange rate triggers a flow of employment from the non-tradable to the tradable sector, causing an excess supply in the tradable sector. Second, labour demand in the tradable sector is lowered because there is a shortage of domestic demand for these goods. Third, the tradable sector's ability to 'absorb' the greater labour supply at any given wage is limited by its capital stock, which had decreased in the first phase of the oil shock.

Note, however, that investment in the tradable sector increases upon the reversal of the oil price and the consequent depreciation. To some extent, credit is diverted back to this sector (Chart 11) and output recovers closely back to its level at the oil price before any movement (Chart 10). Thus, the sectoral asymmetries linked to the exchange rate movement are also present in the case of a reversal.

The behaviour of the economy after the oil price rise and unexpected reversal differs between the scenarios where monetary policy is conducted only with interest rate, and where monetary policy works in conjunction with a macroprudential instrument. As one see in Chart 10, when monetary policy is complemented by a macroprudential policy, less of a rise in interest rate is needed to offset the initial expansion of the economy; when the CB uses a complementary macroprudential policy it may need to raise interest rates less to control the aggregate demand. Second, with an active macroprudential policy, the total credit expansion is much lower. Consequently, once the oil price reverses, there is less need to sharply reduce non-tradable sector debt: a financial crisis is staved off. In this sense, the macroprudential policy achieves its primary objective of eliminating a key source of vulnerability in the economy (one that could be created following an oil boom, allowing it to be brutally exposed if the oil price rise were reversed). Finally, the macroprudential policy does not lead to a different exchange rate path compared to the situation when only monetary policy is in operation. The appreciation (which leads to sectoral differences) remains as it was. Consequently, we may consider this macroprudential instrument to be an additional and complementary tool for monetary policy, but with little extra implication for the exchange rate.

These results illustrate that macroprudential policy can be an effective complementary tool in achieving the goal of overall macroeconomic stability; it keeps overall credit in check. However, it is also true that the use of these instruments can produce further differential effects at the sectoral level. Chart 10 describes how, as a result of the combined policy stance, credit to the tradable sector is lowered in comparison to the situation when only monetary policy is in operation. This happens throughout the episode, even before the oil price reversal. This sector faces both a higher interest rate as a result of counter-cyclical policy (like the non-tradable sector) and, additionally, suffers from the devaluation of its collateral as a result of the appreciation of the exchange rate, which leads to a higher external finance premium for companies in the tradable sector. As a result, investment in the tradable sector falls to a greater extent when macroprudential policy is employed than when it is not. Consequently, the adjustment of this sector after the oil price reversal takes longer. Thus, while the macroprudential policy limits the build up of debt, the simulations illustrate that it also is likely to have unintended consequences at the sectoral level.

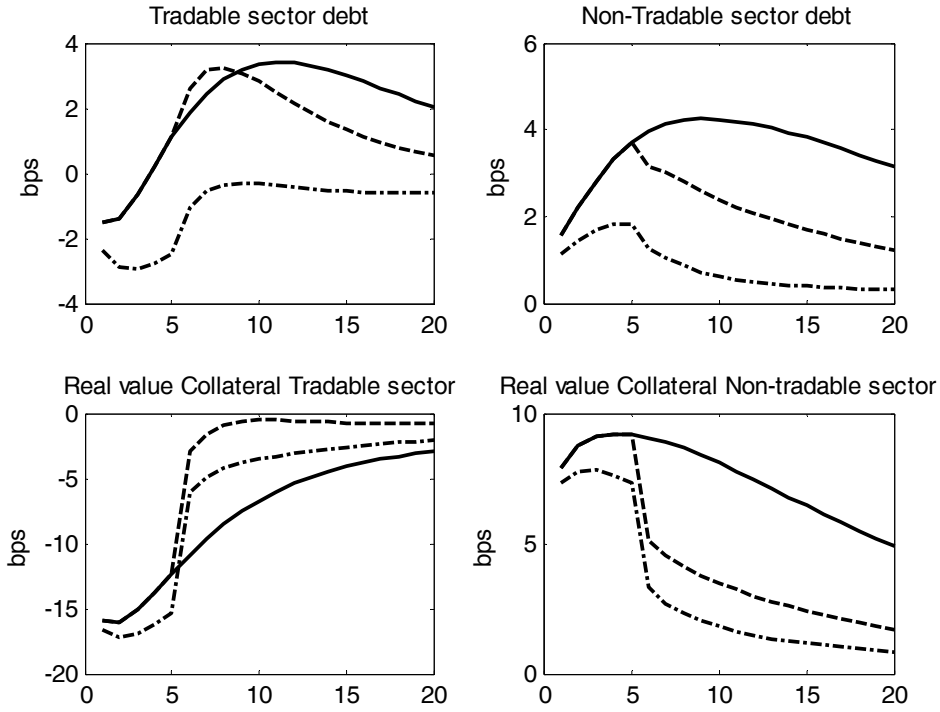
Chart 10: Simulated Response of the Economy to an Oil Shock Under Alternative Policy Settings



Source: González, Hamann and Rodriguez (2013)

Notes: The solid line shows the path followed by the variables in absence of the price reversal, while the dashed and dash-dot lines show the behaviour of the variables when there is the reversal. Central Bank actions in the solid line scenario comprise only of monetary policy actions (according to the standard Taylor rule). In the dashed line also, only monetary policy is implemented but this time in the presence of the oil price reversal. In the dash-dot line, this traditional monetary policy is complemented with a macroprudential policy.

Chart 11: Simulated Response of the Economy to an Oil Shock Under Alternative Policy Settings



Source: González, Hamann and Rodriguez (2013)
Notes: The solid line shows the path followed by the variables in absence of the price reversal while the dashed and dash-dot lines show the behaviour of the variables when there is the reversal. Central Bank actions in the solid line scenario comprise only of monetary policy actions (according to the standard Taylor rule). In the dashed line also, only monetary policy is implemented but this time in the presence of the oil price reversal. In the dash-dot line, this traditional monetary policy is complemented with a macroprudential policy.

Summing up, the model describes that the oil price will result in a non-tradable boom which leads to a rise in GDP and inflation, and that has to be dealt with somehow. We have also shown that both the oil price shock itself and mitigating actions have sectoral consequences.

The standard solution to this dilemma is to operate a policy of sterilized interventions in the exchange rate. In principle, this would inhibit the appreciation while controlling inflation and limiting the boom in the non-tradable sector output. The literature has thoroughly discussed the efficacy of sterilized interventions in general, and in the Colombian context (Vargas et al., 2013). We shall summarize this debate in the next section and draw some conclusions.

There we will also consider if these sectoral effects could be mitigated within the macroprudential framework by using macroprudential instruments that are skewed against lending to borrowers in the non-tradable sector. Examples would be: higher risk weights on lending for mortgages or for consumer credit in statutory capital ratios, or tighter loan-to-value ratios on these products.

The International Experience of Fuel Exporters

Up until now our analysis has been restricted to Colombia. In this section, we compare the exchange rate experiences of a number of fuel-exporting countries. The question we ask is: are real exchange rate appreciations associated with unfavourable developments for oil exporters?

Cross Country Experiences

Table 7 summarizes the experiences of all fuel exporters from 1980 to 2011. Fuel exporters are those countries for which fuel products represent at least 15 per cent of merchandise exports. In many cases, a country had its exports dominated by fuel for only a few years. Hence, in calculating our statistics, we only consider the years when fuel attained at least the 15 per cent share. We also drop any countries that have not attained the 15 per cent share for at least ten years.

The share of fuel in exports is the most appropriate metric when the purpose is to consider the effect of fuel price-induced changes on the economy. We exclude countries such as Brazil, China, the USA, and Canada which, though they contribute a large share to global oil supply, either consume much of their own oil or have diversified exports, such that their exchange rate is less likely to be dominated by oil. Conversely, Colombia is included; though it is not a major oil producer, its exports are dominated by oil. Vietnam and Indonesia, being the second and fourth largest producers of coffee, are also included, but by virtue of their oil exports.

The first column of Table 7 reports the average fuel share in exports, calculated for those years where the share was greater than 15 per cent.

We can see that there is a wide range of countries in Table 7. Most of the countries with more than 70 per cent of their exports in the form of fuel are in the Middle East. And in the second column, we see that most of these fix their exchange rate to the dollar. But in general, the higher the share of fuel in exports the more countries tend to intervene in their exchange rate. In fact only three of these 42 countries, Norway, Mexico and, Australia, or 6 per cent, have been designated as completely free-floating by the IMF. This compares to 13 per cent of all countries.

In Tables 11, 12 and 13 in Appendix 3, we report other characteristics of these countries during their fuel exporting episodes. These statistics are calculated only for those years where the fuel share in exports was greater than 15 per cent.

Table 7: Fuel exporters and their exchange rate arrangements

	average share of fuels in exports (% of merchandise exports)	IMF de facto classification of exchange rate arrangements, 2006.
Brunei Darussalam	97.5	Currency board arrangement
Libya	97.0	Other conventional fixed peg arrangement
Algeria	96.8	Managed floating with no pre-determined path for the exchange rate
Yemen, Rep.	93.5	Other conventional fixed peg arrangement
Nigeria	95.6	Managed floating with no pre-determined path for the exchange rate
Saudi Arabia	90.8	Other conventional fixed peg arrangement
Kuwait	90.0	Other conventional fixed peg arrangement
Iraq	87.2	Crawling peg
Congo, Rep.	85.5	Other conventional fixed peg arrangement
Venezuela, RB	85.2	Other conventional fixed peg arrangement
Oman	84.7	Other conventional fixed peg arrangement
Qatar	84.5	Other conventional fixed peg arrangement
Sudan	83.9	Managed floating with no pre-determined path for the exchange rate
Azerbaijan	83.2	Crawling band
Gabon	80.1	Other conventional fixed peg arrangement
Iran, Islamic Rep.	79.2	Crawling peg
Bahrain	70.7	Other conventional fixed peg arrangement
United Arab Emirates	69.7	Other conventional fixed peg arrangement
Trinidad and Tobago	66.3	Other conventional fixed peg arrangement
Syrian Arab Republic	61.0	Pegged exchange rate within horizontal bands
Kazakhstan	56.7	Other conventional fixed peg arrangement
Norway	55.4	Independently floating
Russian Federation	55.3	Other conventional fixed peg arrangement
Ecuador	49.0	Exchange arrangement with no separate legal tender
Egypt, Arab Rep.	45.0	Managed floating with no pre-determined path for the exchange rate
Cameroon	43.0	Other conventional fixed peg arrangement
Mexico	40.7	Independently floating
Bolivia	39.1	Crawling peg
Indonesia	39.0	Managed floating with no pre-determined path for the exchange rate
Colombia	36.6	Managed floating with no pre-determined path for the exchange rate
Bhutan	33.0	Other conventional fixed peg arrangement
Tunisia	31.0	Other conventional fixed peg arrangement
Belarus	29.3	Other conventional fixed peg arrangement
Cote d'Ivoire	27.0	Other conventional fixed peg arrangement
Kenya	23.4	Managed floating with no pre-determined path for the exchange rate
Australia	22.6	Independently floating
Malaysia	22.1	Managed floating with no pre-determined path for the exchange rate
Lithuania	21.7	Currency board arrangement
Senegal	21.6	Other conventional fixed peg arrangement
Vietnam	21.2	Other conventional fixed peg arrangement
Singapore	21.1	Managed floating with no pre-determined path for the exchange rate
Kyrgyz Republic	19.4	Managed floating with no pre-determined path for the exchange rate
Source: IMF (2013), WEO data base		

Table 8 reports the correlations between the share of fuel exports on one hand, and on the measures of economic success and qualifiers on the other.

Table 8: Correlations between Fuel Export Share and Wealth Creation

	annual average adjusted net savings (incl emissions) (% GNI)	Gross National Savings (% GNI)
Average share of fuels in merchandise exports	–0.53	0.54

Our preferred measure of the economic success of fuel exporters is adjusted net savings. This is calculated by the World Bank and captures the change in the total wealth of each country, considering a wide range of productive assets and liabilities. Formally, adjusted net saving is equal to net national savings plus education expenditure and minus energy depletion, mineral depletion, net forest depletion, and carbon dioxide and particulate emissions damages. This is relevant for fuel exporters because it captures the extent to which extracted energy and mineral assets are converted in productive assets, such as human capital. GDP, on the other hand, would only measure the revenue from fuel exports. Furthermore, an optimal diversification strategy should involve a higher level of saving (Matsen and Torvik, 2005). A successful outcome would be measured by a high positive adjusted net savings rate.

The measure of economic success is qualified, or informed, by considering the more familiar, gross savings, defined as the difference between gross national income and public and private consumption, plus net current transfers. This is but one component of adjusted net savings, and so it helps us judge whether the fuel exporter is accumulating standard assets but failing to convert those into broader measures of wealth.

Table 8 reveals that the higher the share of fuel in exports, the lower the adjusted net saving, with a correlation of –0.53. Thus the more important fuel exporters have not been able to convert their subsoil assets into total wealth. The data on each country's savings is in Table 11 (Appendix 3). We can see that many fuel-dominated exporters, such as Saudi Arabia, have a negative adjusted net savings rate. Looking lower down the table, towards those with a smaller share of fuel exports, positive savings rates emerge. Colombia's average adjusted net savings rate is positive, but meagre, at 4.2 per cent of GNI. The healthiest average wealth creation rates have been achieved by the south Asian countries – Indonesia (12.5), Malaysia (15.6), Singapore (34.9), and Vietnam (15.0) – as well as by Algeria (19.6), Belarus (16.3), and Norway (11.6).

Interestingly, the lower share of adjusted net savings of fuel exporters is not due to the fact that these countries save less in gross terms: the gross national savings correlation with fuel exports is reported to be positive and significant at 0.54. Thus the difficulty does not seem to be that countries with more fuel-dominated exports have insufficient saving, but rather that they are not converting these savings into productive assets, such as human capital. It could also be that these assets are of poor quality: their depreciation is high, or the type of economic activity that takes place is generating many negative externalities such as pollution or environmental degradation.

Table 9 reports the correlations between exchange rate movements and the share of fuel exports and the measures of economic success and qualifiers.

We compare the real and nominal changes and also the maximum nominal appreciation in any one year. Our data on effective exchange rates comes from Darvas (2012) who, using a consistent methodology, calculated annual CPI-based Real Effective Exchange Rates for 178 countries (plus the euro area) for annual data.

Table 9: Correlations between Exchange Rate Changes and Wealth Creation

	Average share of fuels in merchandise exports (%)	Annual Average Adjusted Net Savings (excluding emissions) (% GNI)	Gross National Savings (% GNI)
Average Real Exchange Rate Annual Change (positive is an appreciation)	0.13	0.06	0.04
Average Nominal Exchange Rate Annual Change (%)	0.10	–0.10	0.23
Maximum Nominal Annual Change	0.09	–0.17	–0.04

The first result is that there is no significant correlation between any measure of exchange rate changes and the share of fuel exports. The extent of real exchange rate appreciation does not seem to be systematically related to the degree to which exports are concentrated in fuel.

Nor is there any strong association between exchange rate appreciations and wealth creation. The most we can say is that the greater the maximum nominal appreciation, the lower the adjusted net savings rate, although the correlation (–0.17) is not strong. Thus there is insufficiently clear evidence that real exchange rate appreciations and large nominal appreciations are associated with lower wealth creation of fuel exporters.

The only significant relationship we identify is between gross savings and nominal appreciations. If this were net foreign savings, we would expect this to be negative, with countries that save more abroad having a more depreciated exchange rate. Countries that invest more in physical capital have to import more of that capital, causing a nominal appreciation. As can be judged from the previous table, that investment could be related to fuel extraction. The important point is that this greater gross saving does not translate into a clear relationship with wealth creation.

Table 10 reports the correlations between exchange rate movements and the changes in the shares of value added in the agricultural, services, and manufacturing sectors.

Table 10: Correlations between Exchange Rate Changes and Sectoral Shifts

	Average annual change in agriculture value-added share (pp of GDP)	Average annual change in services value-added share (pp of GDP)	Average annual change in manufacturing value-added share (pp of GDP)
Average real exchange rate change (positive is an appreciation)	0.22	0.55	–0.20
Average nominal exchange rate change	0.19	0.12	–0.03
Maximum nominal appreciation	0.02	0.11	–0.11

Table 10 shows that real appreciations are significantly correlated with increases in the value-added share of services across fuel-exporting countries, with a correlation of 0.55. The positive relationship with the service share is most likely because service value-added is boosted by the cheaper price of imported inputs. This is the spending effect of resource booms, as explained in the previous section.

The importance of this correlation for our study is twofold. First, because service sectors tend to be large, real exchange rate appreciations can be associated with a rise in aggregate real GDP, possibly masking a range of distributional impacts. Thus, insofar as distribution matters, real GDP is not necessarily the best – or not the only – metric with which to assess the policy implications.

Second, as on one hand, the financial sector is often central to the service sector and, on the other, the real exchange rate change can reverse;[15] this correlation warns of the risk that the real exchange rate boom is related to worsening financial vulnerability. Mahadeva and Gómez (2009) show how the cycle in the real value added of the real estate and financial sector has been correlated with that of Colombia's real dollar export prices.

There is a no correlation with the changes in the service share against the average or the largest nominal appreciation. Hence the problem would seem to be at least as much one of accumulated exchange rate change rather than a change in the real exchange rate. On these grounds, the common advice to fuel exporters – to resist any large nominal exchange rate change – seems to be unsupported.

The correlation between both real and nominal exchange rate changes, against changes in the value-added share of agriculture is, if anything, positive. In general, the share taken by agriculture in most countries over time is falling. Therefore, this tells us the rate of that decline is negatively correlated with nominal and real exchange rate appreciations. A lack of negative association between exchange rate changes and agricultural share changes is surprising only if agriculture were identified with export

[15] Goldfajn and Valdés (1999) estimate that once a real exchange rate appreciation reaches greater than 25% of its current level it is unlikely to reverse smoothly.

products like coffee. In our simulations of the FAVAR we found that oil price-induced appreciations lower the growth rate of agriculture.

But the positive weak association across countries probably captures the fact that internationally a larger share of agricultural value added is generated by sales to domestic final consumption. Hence, an appreciation raises real income and the domestic demand for aggregate agricultural produce. Through this channel, the real appreciation turns out to be of some net benefit to agricultural value added.

Gardner (2005) investigates the determinants of growth in agriculture for 85 countries from 1960 to 2005 and arrives at a very similar conclusion. He finds that the growth in agricultural output is dependent on incomes earned in other sectors of the economy. Prominent among these would be incomes earned in the service sector, which would be boosted by the real exchange rate.

Indeed, there are many instances when agricultural sectors have benefited from appreciations and suffered from depreciations. Diaz-Bonilla and Robinson (2010) summarize the example of Argentina's dairy and livestock sector, which experienced a boom in the early 1990s during a period of capital inflows and strong real appreciation because of its domestic orientation, whilst the export-directed crop-producing sector shrank. They also compare the experiences of farmers in Thailand and Indonesia in the post Asian-crisis devaluations. As Thai farmers' production was on average more targeted to domestic markets, in aggregate they suffered more. But within in both countries, the more export-directed subsectors benefited from devaluation.

Table 10 identifies a small negative correlation between real exchange rate appreciations and manufacturing value added. This arises, most likely, because in many fuel exporting countries, manufacturers are more likely to take the form of exporters rather than producers for domestic markets. Though as the correlation is weak, this is again likely to be only true for an aggregate or average description of manufacturing.

In general, we can firmly conclude that there is no evidence in these correlations that appreciations have been harmful for the share of the agriculture sector in fuel-exporting countries in aggregate, and they may well have been positive. The first part of this conclusion is broadly in line with the finding of Diaz-Bonilla and Richardson (2010) – that there is no correlation between the real exchange rate and agricultural output growth in developing countries since 1980.

At this stage it is relevant to consider the implications of fuel export dominance for changes in the value-added revenue per worker in agriculture. Clearly the reaction of agricultural value added per employee would be crucial, as a favourable outcome of a fuel boom would be an improvement in the revenue productivity of agricultural sectors. However, experiments with World Bank data on real value added per worker failed to reveal any correlation with the per worker value added measure and exchange rate changes. That said, we can note that from 1980 to 2010, the average growth rate of gross value added per worker in Colombia was a weak 0.9 per cent, certainly much lower than those of Malaysia, Indonesia, or Vietnam, which range from 1.7–3 per cent.

Case Studies

Some lessons on the response of agricultural productivity can be gleaned from the economic literature.

Nigeria and Mozambique

It seems that the ease with which released agricultural labour can shift to other productive rural occupations is crucial in determining the reaction of agricultural productivity to oil price-induced appreciations. Schiff and Valdés (2002) discuss the effect of Nigeria's 1970s oil price boom on its agricultural sector. While agriculture's share of non-oil GDP fell from about 60 per cent during the period 1960 to 1965, to about half that figure between 1978 and 1981, its share of employment fell by less (from 75 per cent in 1970 to 59 per cent in 1982). They argue that this reflects that, even though the agricultural real wage must have fallen dramatically, Nigerian agricultural workers had no alternative but to remain in the sector.

A more recent cross-country study by McMillan and Rodrik (2011) highlights the role of intersectoral labour immobility in shaping the outcomes of oil boom-induced appreciations. They measure the degree of intersectoral immobility by the gap in labour productivity between sectors and show that since 1990 structural change has been growth-reducing in both Africa and Latin America. In Asia, labour moved from low- to high-productivity sectors, whereas in Latin America and Africa, the movement was in the opposite direction. They suggest that, in the presence of labour market inflexibility – a large productivity gap – an undervalued exchange rate might help support growth.

A relevant, though controversial, case is provided by Mozambique's cashew nut industry in the 1990s. Cashew, like coffee, is a labour-intensive crop where newly planted trees can take six years to reach maximum yield. In the 1960s, Mozambique cashews used to be primarily destined for exports and used to take a large share of the market. This changed in the 1970s when, to favour domestic cashew processers, the state imposed an export ban on unprocessed nuts, which later become an export tax. The effect was to lower the income of producers whilst supporting that of processors. By the 1980s, the sector was much in decline but still employing a large share of the population especially in processing. The World Bank advised the government to liberalize the cashew sector, removing the export tax. Horn Welch, McMillan, and Rodrik (2003) show that although the removal of the tax did bring some benefit to cashew farmers, the economy suffered a net loss because no alternative productive employment opportunity was created for released processors.

Auty's (1990) examination as to the cause of the failure of Nigerian agriculture during the early oil boom also makes this point. While there was recognition that the rural sector needed support, that need was met, he argues, by conspicuous and poorly targeted infrastructure. Not enough was spent, and of that too much went to large farms. A sequence of strong appreciations in the early 1970s, and a decade later in the early 1980s, exposed the ineffectiveness of these transfers. Inflation and indebtedness limited the country's ability to maintain competitive exchange rates. He argues that if real exchange rate appreciations had been resisted and resources had instead been spent on improving the productivity of underperforming agricultural sectors as well as stimulating new productive sectors, the outcome might have been different.

Malaysia and Indonesia

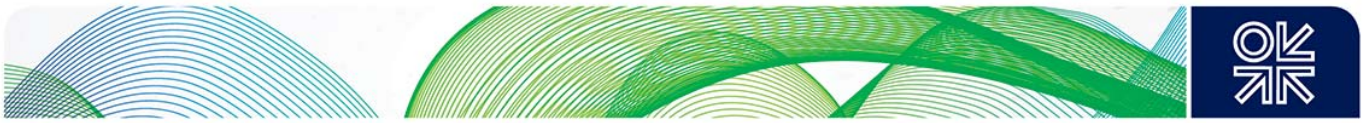
Judging from our analysis of fuel exporters, it seems then that relevant examples of the management of the agricultural sector during fuel export booms might be provided by Malaysia and Indonesia. Some of the key characteristics of their experiences are given here:

Exchange rate appreciations were certainly resisted by foreign exchange intervention. However, currencies were tied to the dollar, which in the early 1990s appreciated against third-party currencies. For example, in the later period from 1994 to the Asian Crisis, the regime in Malaysia can best be described as a 'managed float', with emphasis on only stabilizing short-term fluctuations. In Indonesia, it should also be noted that there have been infrequent large devaluations against the dollar (in 1983 and 1986). Hausmann, et al.'s (2001) estimates for all countries including Indonesia from 1997 to 1999, and Umezaki (2006)'s parallel estimates for Malaysia, indicate that the degree of foreign exchange intervention was not out of line with other developing countries, and even below that of Colombia. There seems to have been recognition that even sterilized foreign exchange intervention has its costs and limitations. As Vargas et al. (2013) point out in the context of Colombia, even if foreign exchange intervention is sterilized, it can still be expansionary in terms of credit and domestic demand. Mohanty and Turner (2006) provide some evidence that foreign exchange intervention has resulted in credit expansions post 2000 and warn of the retardation of the banking sector.

Perhaps, then, it is understandable that mobilizing national savings was also a cornerstone of exchange rate policy. For example, Usui (1997) calculates that the Indonesian government ran budget surpluses during its years of currency intervention. And in Malaysia, liberalizing the capital account helped contain the real appreciation up until 1997.

Real exchange rates were also kept low by squeezing tradable sector costs, often by active policies. In this respect, it mattered that macroeconomic policy ensured that overall inflation rates were moderate. Interventionist policies, in a more export-promoting phase following the earlier import-substitution experiments, promoted cost savings in tradable goods. One example of the success of these polices was the real devaluation of the Malaysian Ringitt between 1985 and 1993.

Of course, given the understanding we now have, following the Asian Crisis, the financial stability management of Indonesia in particular, but also of Malaysia, during the 1990s must have fallen short of what was needed. Corsetti et al.'s (1999) *ex post* analysis of the crisis build-up reveals that the crisis was caused by short-term, foreign currency, bank-intermediated inflows which were pumped into local real estate and the stock market. The nature of interlinkages between domestic companies was not clear, weakening resilience. There are also counterexamples in the recent history of these countries of how periods of greater indebtedness implied a larger than expected appreciation. For example, the rise in external dollar denominated debts of Malaysia over the early 1980s made a policy of fixing the exchange rate against the dollar more attractive. As export market currencies were appreciating against the dollar, this led a nominal appreciation of the exchange rate. A similar case could certainly be made for the large build-up of Indonesia's external debt leading up to the Asian Crisis. As we have said, the real effective exchange rates of Asian countries generally appreciated from 1990 to 1996. However, the ranking of the size of real exchange rate appreciations does not match the ranking of how badly countries were hit. Thus the health of balance sheets generally, but also especially of non-tradable service sectors, were important in explaining the crisis, and real exchange rate appreciations might well have helped fuel unproductive investments.



The conclusion to draw from the Asian Crisis is not that each real exchange rate appreciation should have been systematically resisted by interventions (for that can come at high cost, not least in terms of macroeconomic stability), but that the accumulations of real appreciations should have triggered aggressive procyclical policy actions to improve financial stability. We would further emphasize that those actions should have been biased towards the non-tradables service sector. Indeed in Malaysia over the 1990s, financial stability actions were especially targeted at retail borrowers (Bank Negara Malaysia, 2009). For example, maximum loan-to-value ratios on mortgage lending and car finance were imposed or lowered, perhaps helping to limit the effect of the crisis. Currently Indonesia, Malaysia, and Singapore actively manage controls on maximum loan-to-value ratios.

Despite the emphasis on foreign asset accumulation, it is crucial that most of the investment and wealth creation in these countries was in domestic assets. Domestic assets were also created, in the form of human capital and social infrastructure, especially in Malaysia. And according to Gelb (2011), investments in both were made to deliberately diversify exports. In particular, an important part of investment was originally in agriculture. For example, Indonesia diverted substantial resources to boosting agricultural output through irrigation and research, lowering input costs and developing disease-resistant high-yield strains. Auty (1990) estimates that agriculture absorbed one-quarter of public investment during the boom. Collier and Venables (2011) report than more than half Malaysia's public investment was targeted at agriculture. Government spending on agriculture in these countries is larger, as a share of GDP and of agricultural GDP, than in Colombia (Fan and Rao, 2003 and Byerlee, Janvry, and Sadoulet, 2009).

Given the threats (in particular from synthetics) faced by Malaysia's historic rubber industry, it is interesting to revisit the policy responses with the benefit of hindsight. Yusof (2011) describes how the productivity of rubber estates and smallholders was incentivized, through replanting grants directed towards new yields in the 1960s and 1970s. Once it was clear that rubber prices were likely to be permanently lower, a diversification into palm oil was organized. Later on, there was further diversification into manufacturing, and agroindustry, and away from tropical products. For example, Malaysia is now an important global producer of rubber gloves, as it once was for rubber. At the same time, the number of different Malaysian products is reported to have increased, with a greater emphasis on the domestic market and on processed food exports (Athukorala and Loke, 2009 and Briones and Felipe, 2013). At the current time, it appears that labour-intensive plantations are dependent on foreign workers and are under some strain, as they struggle to compete for native workers attracted by higher-paid manufacturing and services employment and urban living, while at the same time facing lower prices for their products (Athukorala and Loke, 2009).

Whether or not these spending commitments and diversification initiatives were successful in Indonesia is more controversial. Certainly Tabor (1992) argues that much of Indonesian spending on tree crops in the 1980s was inefficient. However, studies on later years, especially following the Asian Crisis, indicate that the government's policies in research and development had some beneficial effect on plantation crops (Rada and Fuglie, 2012) of which Indonesia is now a major global producer.

Finally, it also worth considering whether changes in the form of agricultural price support had some effect on shaping the exchange rate consequences of oil booms. A recent World Bank study calculates these supports by product and as an aggregate for 55 countries including Colombia, Indonesia, and Malaysia. Chart 12 plots the net rate of assistance, a measure of how much higher farm income is as a result of government policy. While assistance rates have been rising in general for all countries, they are higher in Colombia, having risen earlier in the early 1990s. As Guterman (2007) explains, this elevated support was the consequence of the agriculture crises of 1992, and late in 1995, which meant that earlier efforts to liberalize agriculture were overturned.

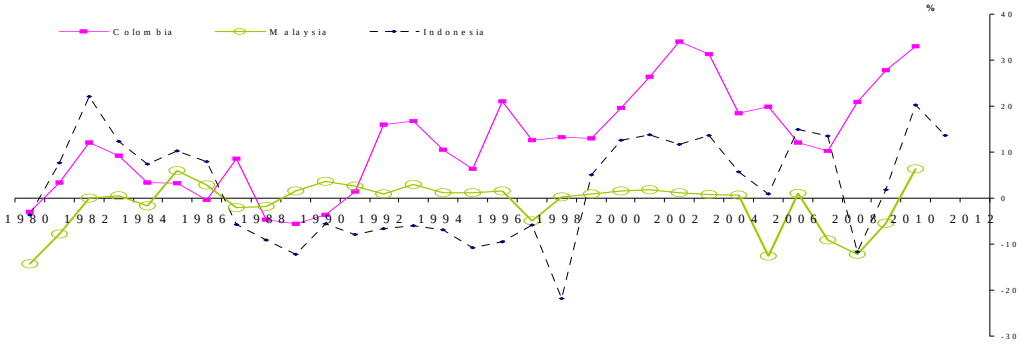
It is also interesting to consider the skew of assistance policies along two axes: do they favour agriculture or non-agricultural products? And do they favour importables or exportables?

To answer these questions, Chart 13 shows that in Far Eastern countries, subsidies have been rather more neutral across agriculture and other sectors, whilst in Colombia, they has become clearly biased towards agriculture. Chart 14 indicates, however, that it is only recently that the emphasis of agricultural support in Colombia has shifted towards exportables such as coffee. In the past, support has been relatively greater for import-substituting sectors, such as rice. In Malaysia and Indonesia, support is still more in the form of import-substitution and continues to be so (Fane and Warr, 2009).

Indonesia and Malaysia have supported their agricultural product prices through various schemes. As we shall see, price support has tended to be towards import substitution. Knudsen and Nash (1990) analyse Malaysia's export taxes on rubber and palm oil. Their calculations reveal that as the world dollar price of these exports fell by 38 per cent and 18 per cent respectively, their export tax rates were reduced such that the domestic producer prices fell by 23 and 15 per cent. Hence there was only partial shielding from world price movements. The export tax on crude palm oil is typically less onerous than that on rubber to encourage diversification out of rubber into oil.

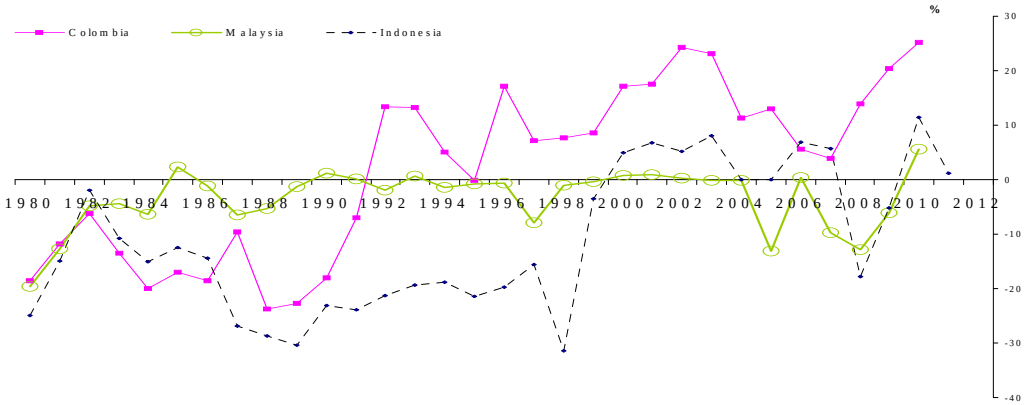
Hence, the picture that is built up from these figures is that Colombian support of agricultural prices is higher, more directed to agriculture, and more directed to export-orientated agriculture than that of these two Asian oil exporters (Cano, 2013). Clearly this excludes support of other kinds, such as in the provision of physical and social infrastructure, which can be considered a substitute to price subsidy in achieving the ultimate objective of supporting farm welfare (López and Galinato, 2007).

Chart 12: The Net Rate of Assistance to Agriculture in Selected Countries



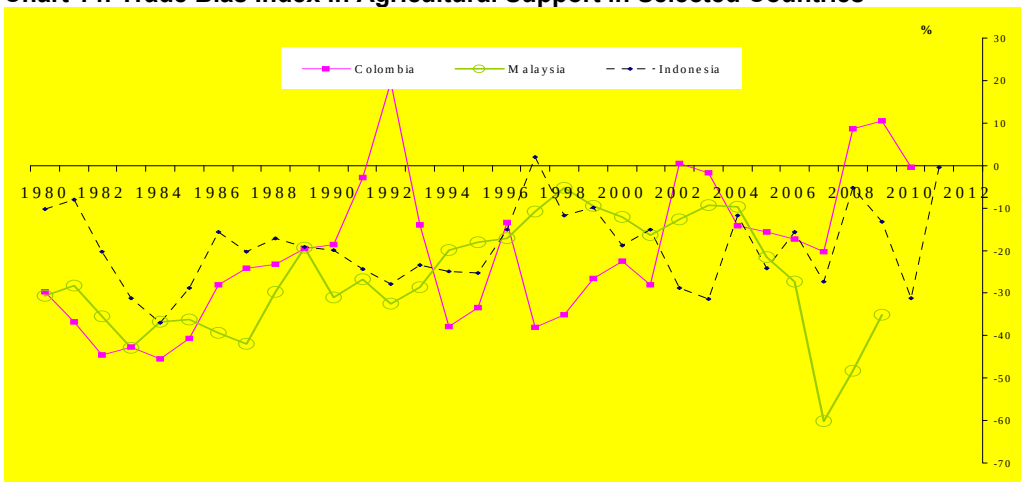
Source: Anderson and Nelgen (2013). Note: The Net Rate of Assistance (NRA) measures the percentage to which gross returns to farming is raised by government policies.

Chart 13: Relative Rate of Assistance to Agriculture in Selected Countries



Source: Anderson and Nelgen (2013). Note: The Relative Rate of Assistance measures the extent to which NRAs for agricultural sectors are greater than for non-agricultural sectors, with zero indicating neutrality, 100 indicating a complete pro-agricultural bias, and –100 a complete anti-agricultural bias.

Chart 14: Trade Bias Index in Agricultural Support in Selected Countries



Source: Anderson and Nelgen (2013). Note: The trade bias index measures the extent to which NRAs for exporting agricultural sectors are greater than those for import-competing agricultural sectors, with zero indicating neutrality, 100 indicating a complete export bias, and –100 a complete anti-export bias.

Summary and Recommendations

Summary of Findings

1. We have shown that aggregate sectors are heterogeneous in nature, combining both tradable and non-tradable elements, serving both domestic and international markets, and facing competition from imports and being insulated from external competition. At this level of aggregation, Colombia's coffee sector is shown to be particularly vulnerable to exchange rate changes in that most of its income goes to labour and most of its product to export. Agriculture, fishing, and forestry (excluding coffee) represented 18.7 per cent of Colombia's formal employment in 2011, and manufacturing 13.4 per cent. However, it is likely that there are smaller subsectors within agriculture and manufacturing that face a high exposure to the exchange rate, similar to that faced by coffee.

2. It seems that the root cause of the vulnerability is the limited scope of workers to access alternative adequate returns. This lack of diversification may itself be a consequence of the rural location of workers and their relatively low skill levels.

3. We estimate that oil price-induced exchange rate appreciations have important, and sectorally very different, impacts on the Colombian economy. Non-tradable sectors are estimated to fare well, raising the aggregate level of GDP, even while some exporting or import-competing sectors are worse off.

4. To explore this further, we simulated the effect of a higher oil price in an economically coherent structure, separating out tradable and non-tradable production and also allowing for the special role of banks. We found that macro-level policies, designed to control inflation and stabilize credit in the face of oil price rises, themselves have sectorally different effects. In general, tighter policies tend to lean more heavily on tradable sectors in order to achieve a given aggregate adjustment, because of rigidities in transferring labour, capital, and collateral between sectors.

5. In surveying the international experience of fuel-exporting countries, we found that while those with a greater dominance of fuel tended to create less wealth, there was no strong relationship between exchange rate changes and the rate at which national wealth accumulated. Many of these countries intervene in foreign exchange markets, but we showed that the more successful wealth creators also maintain a degree of macroeconomic stability which can encourage the real exchange rate to appreciate. Appreciations can be linked to rises in the service sector share and greater financial instability. But greater real or nominal appreciations are not, in general, associated with a shrinking share of the aggregate agricultural sector. Interestingly, Malaysia and Indonesia have supported their agricultural sectors during oil booms with the purpose of improving competitiveness. Compared to these countries, Colombia tends to give greater support to its export-orientated agriculture.

Policy Recommendations

Before we lay out our policy recommendations we should describe the criteria that guide our advice. In our view:

a. First, a good policy should have a clear objective.
b. Second, a good policy should be justified as the most important (or as the second-best) solution to a failure of the market.
c. And third, it should be considerate of the distributional and political economy dimension of actions (Acemoglu and Robinson, 2013).

The objective of the policy we propose is to reduce the economic vulnerability of particular groups of workers. Building on our findings, we think that the market failure that should be addressed by policy is: there is insufficient scope for some workers to support their earnings – earnings that might be affected by the exchange rate – through other productive activities on a permanent or temporary basis, either directly or through their family or community members.

1. At least in the case of Colombia, care should be taken to avoid price support becoming a permanent maintenance of a gap with the world price.

a. The underlying problem seems to be the lack of diversification in incomes. It would be more efficient to attempt to alleviate those vulnerabilities directly. A policy of targeting excessive support on particular products is inefficient from the point of view of the objective of removing the underlying problem – vulnerability. As such a policy would uniformly support all producers of the product, it would risk supporting practices that create vulnerability.
b. There may well be small sectors, especially within agriculture but also within manufacturing, that suffer proportionately from the same degree of exchange rate exposure as a larger sector like coffee, but which are less easy to identify or delineate by product. Thus the policy should not be applied to single sectors in a piecemeal fashion. Also, the political economy consequences of supporting the producers of one sector could be to trigger voracious lobbying by others. One result of the recent literature on the fiscal policy of oil exporters (Ross, 2012) is that in order to achieve the best economic outcomes, it is at least as important to be fair and transparent about how to spend oil wealth as how to earn it.
c. There is insufficient data on the true returns to labour across economic activities to identify the sectors that are particularly vulnerable.

2. Rather, a price support scheme should be thought of a temporary smoothing facility or risk management device. Market-based financial instruments that manage the risks should be considered as substitutes for price support in this role, as discussed in Claessens and Varangis (1993).

3. Instead, the results favour policies that seek to mitigate the vulnerability of income of workers in isolated regions. This may require improvements in basic (primary level) human capital, as well as in the physical and social infrastructure, to facilitate commuting and job matching.

4. Also worth exploring are policies to stimulate the creation of new productive activities in isolated areas; activities producing both familiar and new products, but always operating within these regions – without requiring permanent migration. Some of these new activities in rural areas may be both socially productive and wealth creating (Byerlee, Janvry, and Sadoulet, 2009 and Cano, 2013).

5. As important as offering support is to withdraw it: the profitability of these activities should be monitored and support removed if they are not performing. Also, along the lines suggested by Rodrik (2004), there could be increased government infrastructure support for improvements in productivity, but always prompted by the particular demands of these activities. Whichever of these directions is taken, the objective should be to assist isolated rural workers to diversify their income out of a set of low productive alternatives, without requiring them to migrate to cities. The policy is thus defined by location of the recipient and not by product (OECD, 2003).

6. In so far as the real exchange rate policy of Colombia is concerned, we see no reason to change the existing monetary and financial stability regime objectives in favour of encouraging more foreign exchange intervention. The main objective is to stabilize the economy in the face of fuel price shocks and associated exchange rate changes which can lead to large sectoral divergences.

7. Hence we would advocate the use of sectoral countercyclical macroprudential tools in fuel exporting countries – tools that can be used to reduce lending only to the non-tradable sectors – in times of oil price-induced exchange rate appreciation. The justification is that given sectoral immobility, a side effect of pursing macroeconomic and financial stability is a lower-than-otherwise level of activity in some tradable sectors, such as coffee. Examples of these tools are discussed by the Committee on Global Financial Stability (2012) and can take the form of: temporarily higher loan-to-value ratios and risk weights on mortgages, on the commercial retail sector, and on personal loans, together with regulatory capital ratios, sectoral liquidity buffers, or taxes on housing sales. A full investigation of the operationalization of these tools is required, but we note that macroprudential policies have already targeted sectors such as those more dependent on foreign exchange or short-term lending. Clearly, for some countries, this would have to do with fiscal management.

8. A final, but nonetheless important, message of this study is the urgent need for comparable data and analysis on the economic vulnerability of workers to external forces. Our analysis on Colombia has been hampered by a lack of standardized sectoral wage data. Without nationally comparable data on workers' earning opportunities, one is not able to quantify the extent of their economic isolation and compare them with those who work in other agricultural exporting sectors; in the absence of such data, it is difficult to estimate the consequences for the regions in which they work. Such an economy-wide analysis is needed to build a fair and properly prioritized policy of supporting the income of specific sectors.

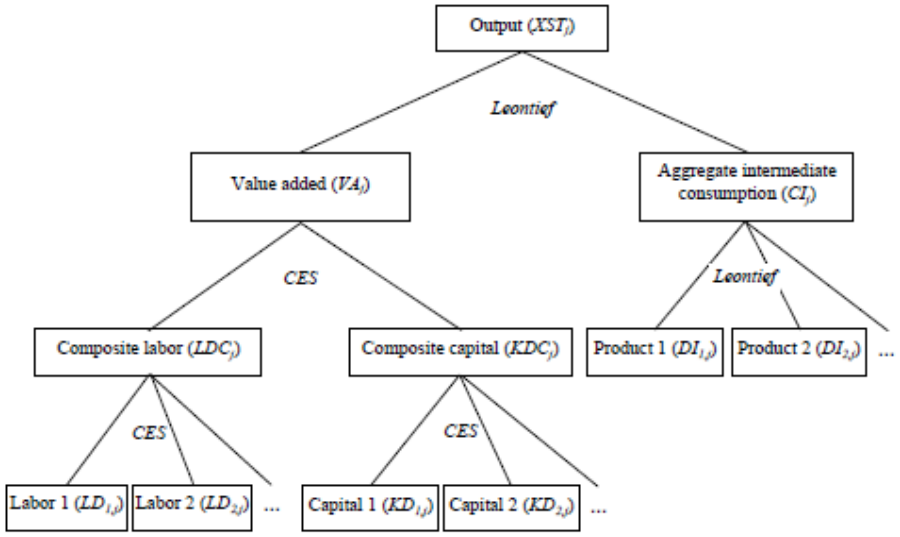
Appendices

Appendix 1. The Computable General Equilibrium (CGE) Model

General structure

As mentioned, the model follows a neoclassical structure in which it is assumed that agents are price takers operating in a perfectly competitive environment. Production is characterized by representative firms (one for each sector or activity) that maximize profits subject to its production technology. Production is modelled as a nested structure with a fixed proportions (Leontief) relationship between value added and aggregate intermediate consumption at the top level, as shown in Chart 15. In the second nest, value added is generated through a constant elasticity of substitution (CES) relationship between composite labour and composite capital, the latter being a CES combination of the different labour types in the third nest, while there is no third nest on the side of capital as there is only one capital type in the SAM. Finally, aggregate intermediate consumption is a Leontief combination of the different commodities used as inputs.

Chart 15: Structure of production in the CES Model



Source: taken from Decaluwé et al. (2009)

On the demand side: demand for goods and services comes from households' consumption, investment demand, governmental demand, and demand as transport and trade margins. Households have Stone–Geary utility functions, from which the Linear Expenditure System arises, offering a greater degree of flexibility in modelling consumption responses before relative price changes than other alternatives (such as the Cobb–Douglas formulation). Investment demand comprises both gross fixed capital formation (GFCF) and changes in inventories, the first determined through the savings–investment equilibrium constraint and the second assumed fixed in volume (exogenous to the model).

Government demand is distributed among commodities in fixed shares, so, as in the case of GFCF, the quantity demanded of each commodity is inversely related to its price, given a current expenditure budget. Some commodities (services) are used to move commodities to become available in the market, so margin rates are applied to the volume of domestic production and imports in order to determine quantity use of these margin services.

With respect to income, households' income comes from three sources: labour income, capital income, and transfers from other agents. Business income arises from its share of capital income and transfers from other agents, while government income comes from a variety of tax instruments, part of the remuneration to capital, and transfers from other agents. In all cases, savings is a residual after all types of expenses are deducted from gross income.

The rest of the world receives payments for the value of imports, part of the capital income, and transfers from domestic agents, while its expenditure is seen in the value of exports from the domestic economy and in transfers to domestic agents. The difference between its income and expenses represents its savings, which are equal in absolute value to the current account balance.

The output product composition of activities is modelled as a constant transformation elasticity (CET) function. The same is true of the destination of commodities to the domestic or export markets. A mild departure from the small country assumption is permitted in the model: exporters cannot export any quantity at the (exogenous) international current price, but instead, they can increase their share in the international market only if they offer a (f.o.b.) price that is advantageous in relation to the international price, subject to a price elasticity of export demand. On the other hand, buyer behaviour is analogous to producer behaviour in that domestic products are imperfect substitutes with imports. Therefore, commodities demanded in the domestic market are composite goods, that is, (CES) combinations of domestically produced and imported goods. In the same way as sellers maximize revenue, buyers minimize expenditure subject to the CES aggregation function described above, while imports are assumed to be offered at an infinite price elasticity at the international price.

Data

The model is calibrated to a 2005 Colombian Social Accounting Matrix prepared by the National Planning Department, as documented in Corredor and Pardo (2008). To have a more stylized view of the economy and highlight its trade structure, the SAM was aggregated to 12 sectors, as presented in the main text.

Simulation

As mentioned in the main text, being a small open economy model, the effect of the exchange rate on the economy depends on the nature of the sectors in the SAM. As basically all sectors (with the exception of infrastructure) are tradable, the exchange rate has no effect on the economy as (the exogenously given) international prices (almost fully) determine domestic prices. Therefore, to simulate an effect similar to an exchange rate appreciation, we shock down international prices so as to have a decrease in exports receipts in domestic currency and a decrease in (domestic currency) prices for importables. As we want to have an oil price-induced exchange rate shock, all international prices but those of crude oil and refined oil were shocked down by 10 per cent; this way we have a change in relative prices favouring oil and refined oil before the other commodities.

The closure of the model is characterized as follows. Labour and capital are mobile between sectors and fully employed, so factor market clearing occurs through prices (salaries and rents). Labour supply is fixed, government expenditure is fixed, and changes in inventories are fixed. The current

account balance is endogenous so as to allow for a more flexible international trade adjustment, and total investment is kept fixed to allow for savings to make up for changes in rest of the world-savings.

Appendix 2. The Factor Augmented Vector Autoregression (FAVAR) Model

The FAVAR model employed in this article is the one described in Bernanke, Boivin, and Eliasz (2005).

FAVAR models are an alternative to VAR models when the number of variables under study is large. One of the uses for VAR models is to describe the dynamic effect of a shock over the economy. These models, however, are meant to study only a few variables. The reason for this is that the number of parameters in VAR models increases more than proportionally with the number of variables. Nevertheless, Sims (1980) and Stock and Watson (2005) argue that it is important to include enough variables in VAR models for two reasons. First, this helps to identify structural shocks from the residuals. Second, because omitting an important variable can bias the estimation of the dynamic effect of the shock.

Our FAVAR model can be described by the following equation:

$$C_t = \Phi L C_{t-1} + u_t$$

Where $C_t = (op_t, F_t)$, op_t is the oil price in US dollars, L is a lag operator, u_t are residuals and F_t is a K×1 vector containing the latent factors that summarize the economy's behaviour. These factors are extracted from a large number of macroeconomic variables which we denote X_t. X_t evolves according to the following equation:

$$X_t = \Delta F_t + \varepsilon_t$$

Where Δ is an N×K matrix of factor loadings and ε_t is a vector of idiosyncratic components for each of the time series included in X_t. This idiosyncratic component may display serial correlation but must not be correlated with F_t.

Our FAVAR model was estimated using quarterly information starting in 1994. The vector X_t comprises 105 macroeconomic variables. The international oil price is measured by the price of Brent. A complete description of the FAVAR model employed and its specification can be found in Echavarria, González, and Gutierrez (2013).

The oil shock is identified using Cholesky ordering, where order is defined by the appearance of variables in vector C_t. Note that this ordering assumes that the oil shock is exogenous to Colombia's oil production. This assumption is not very strong given that Colombian oil production accounts for less than 1 per cent of the world's total oil production. Therefore, it can be assumed that Colombia is actually a price-taker in this market.

Appendix 3. Average Characteristics of Fuel Exporters (1980–2010)

Table 11: Fuel Exporters and Adjusted Net Savings

	Average share of fuels in exports (% of merchandise exports)	Adjusted net savings (excluding particle emissions) % GNI	Gross savings %GNI
Brunei Darussalam	97.5	0.1	46.9
Libya	97.0		65.6
Algeria	96.8	19.6	38.6
Yemen, Rep.	93.5	–16.1	21.4
Nigeria	95.6		
Saudi Arabia	90.8	–0.9	29.7
Kuwait	90.0	–2.7	29.8
Iraq	87.2		
Congo, Rep.	85.5	–37.9	26.0
Venezuela, RB	85.2	1.6	27.3
Oman	84.7	–14.9	25.0
Qatar	84.5		
Sudan	83.9	1.0	22.5
Azerbaijan	83.2	–18.1	32.3
Gabon	80.1	–3.2	42.0
Iran, Islamic Rep.	79.2	6.9	36.2
Bahrain	70.7	3.5	29.7
United Arab Emirates	69.7		
Trinidad and Tobago	66.3	–5.0	26.5
Syrian Arab Republic	61.0	–5.9	21.8
Kazakhstan	56.7	–16.0	25.7
Norway	55.4	11.6	30.7
Russian Federation	55.3	2.4	29.3
Ecuador	49.0	–1.0	18.3
Egypt, Arab Rep.	45.0	9.7	22.4
Cameroon	43.0	0.8	15.6
Mexico	40.7	10.7	22.8
Bolivia	39.1	–1.4	16.2
Indonesia	39.0	12.5	27.4
Colombia	36.6	4.2	18.0
Bhutan	33.0		
Tunisia	31.0	9.2	24.2
Belarus	29.3	16.3	25.3
Cote d'Ivoire	27.0	1.7	11.8
Kenya	23.4	11.7	17.5
Australia	22.6	6.2	22.9
Malaysia	22.1	15.6	29.1
Lithuania	21.7	5.8	15.9
Senegal	21.6	5.6	11.7
Vietnam	21.2	15.0	31.1
Singapore	21.1	34.9	42.4
Kyrgyz Republic	19.4	2.7	15.2
Source: World Bank Data Indicators			

Table 12: Fuel Exporters and the Exchange Rate

	average share of fuels in exports (% of merchandise exports)	average real exchange rate (% annual change)	average nominal exchange rate (% annual change)	maximum nominal appreciation (% annual change)
Brunei Darussalam	97.5	0.1	2.0	7.3
Libya	97.0	3.9	4.4	21.8
Algeria	96.8		–5.3	9.9
Yemen, Rep.	93.5	–3.3	–10.3	10.5
Nigeria	95.6	2.4	–10.6	12.0
Saudi Arabia	90.8	–1.8	1.4	9.7
Kuwait	90.0	1.3	2.4	10.0
Iraq	87.2	20.6	5.3	24.1
Congo, Rep.	85.5	–2.1	–2.4	14.0
Venezuela, RB	85.2	1.9	–13.6	15.2
Oman	84.7	–1.5	1.2	11.7
Qatar	84.5	0.8	0.4	8.6
Sudan	83.9	5.3	–0.4	11.6
Azerbaijan	83.2		5.7	24.5
Gabon	80.1	–1.8	–2.3	4.9
Iran, Islamic Rep.	79.2	4.9	–6.7	12.6
Bahrain	70.7	–2.5	–1.6	5.3
United Arab Emirates	69.7	1.1	0.9	8.4
Trinidad and Tobago	66.3	1.4	0.0	10.2
Syrian Arab Republic	61.0	7.1	3.6	17.8
Kazakhstan	56.7	5.7	–5.7	5.2
Norway	55.4	0.4	0.8	9.3
Russian Federation	55.3	4.9	–8.1	4.8
Ecuador	49.0	–0.4	–12.6	12.5
Egypt, Arab Rep.	45.0	2.5	–2.6	17.4
Cameroon	43.0	1.7	1.4	9.3
Mexico	40.7	1.2	–20.8	0.4
Bolivia	39.1	–2.6	–11.6	53.6
Indonesia	39.0	–0.6	–5.4	24.7
Colombia	36.6	0.6	–3.8	14.9
Bhutan	33.0	–1.1	–3.0	1.8
Tunisia	31.0	–2.8	–3.1	2.2
Belarus	29.3	–1.4	–19.7	
Cote d'Ivoire	27.0	–0.1	0.1	3.0
Kenya	23.4	0.2	–3.3	4.9
Australia	22.6		0.9	14.6
Malaysia	22.1	–2.0	0.4	7.8
Lithuania	21.7	9.9	4.0	12.2
Senegal	21.6	–2.4	–1.1	10.7
Vietnam	21.2	1.4	–2.6	4.5
Singapore	21.1	1.4	3.8	8.9
Kyrgyz Republic	19.4	4.1	–0.7	15.8
Source: World Bank Data Indicators				

Table 13: Average Annual Changes in Shares in Sectors, across Fuel-dependent Years, 1980–2011

	average annual change in agricultural value-added share (pp of GDP)	average annual change in services value-added share (pp of GDP)	average annual change in manufacturing value-added share (pp of GDP)
Brunei Darussalam	0.00	0.45	–0.05
Libya	–0.22	–1.56	–0.03
Algeria	–0.05	–0.10	–0.17
Yemen, Rep.	–0.86	0.93	–0.42
Nigeria	–3.17	1.14	–0.21
Saudi Arabia	0.03	0.22	0.19
Kuwait	0.01	1.02	–0.14
Iraq	1.82	3.69	0.30
Congo, Rep.	–0.26	–0.70	–0.12
Venezuela, RB	0.03	–0.23	–0.07
Oman	–0.03	0.62	0.32
Qatar			
Sudan	–1.61	0.94	–0.16
Azerbaijan	–1.45	–0.40	–0.41
Gabon	–0.07	0.08	–0.02
Iran, Islamic Rep.	–0.46	–0.59	–0.34
Bahrain	0.00	–2.53	2.97
United Arab Emirates	0.01	0.27	0.04
Trinidad and Tobago	–0.07	–0.36	–0.17
Syrian Arab Republic	0.04	–0.35	–1.12
Kazakhstan	–0.46	–0.09	–0.11
Norway	–0.08	0.06	–0.22
Russian Federation	–0.19	0.31	–0.12
Ecuador	–0.22	–0.08	–0.15
Egypt, Arab Rep.	–0.14	0.14	0.10
Cameroon	–0.43	0.23	0.26
Mexico	–0.17	0.08	–0.13
Bolivia	–0.21	0.00	–0.04
Indonesia	–0.30	0.12	0.36
Colombia	–0.41	0.32	–0.32
Bhutan	–0.84	–0.13	–0.02
Tunisia	–0.28	0.35	0.21
Belarus	–0.38	–0.09	0.45
Cote d'Ivoire	0.03	–0.51	–0.02
Kenya	–0.22	0.29	–0.04
Australia	–0.15	0.82	–0.32
Malaysia	–0.35	0.37	0.09
Lithuania	–0.47	0.93	–0.58
Senegal	–0.17	0.05	0.01
Vietnam	–0.41	–0.28	0.30
Singapore	–0.05	0.36	–0.21
Kyrgyz Republic	–2.07	1.24	0.81

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