POLICY RESPONSES TO COMMODITY PRICE FLUCTUATIONS

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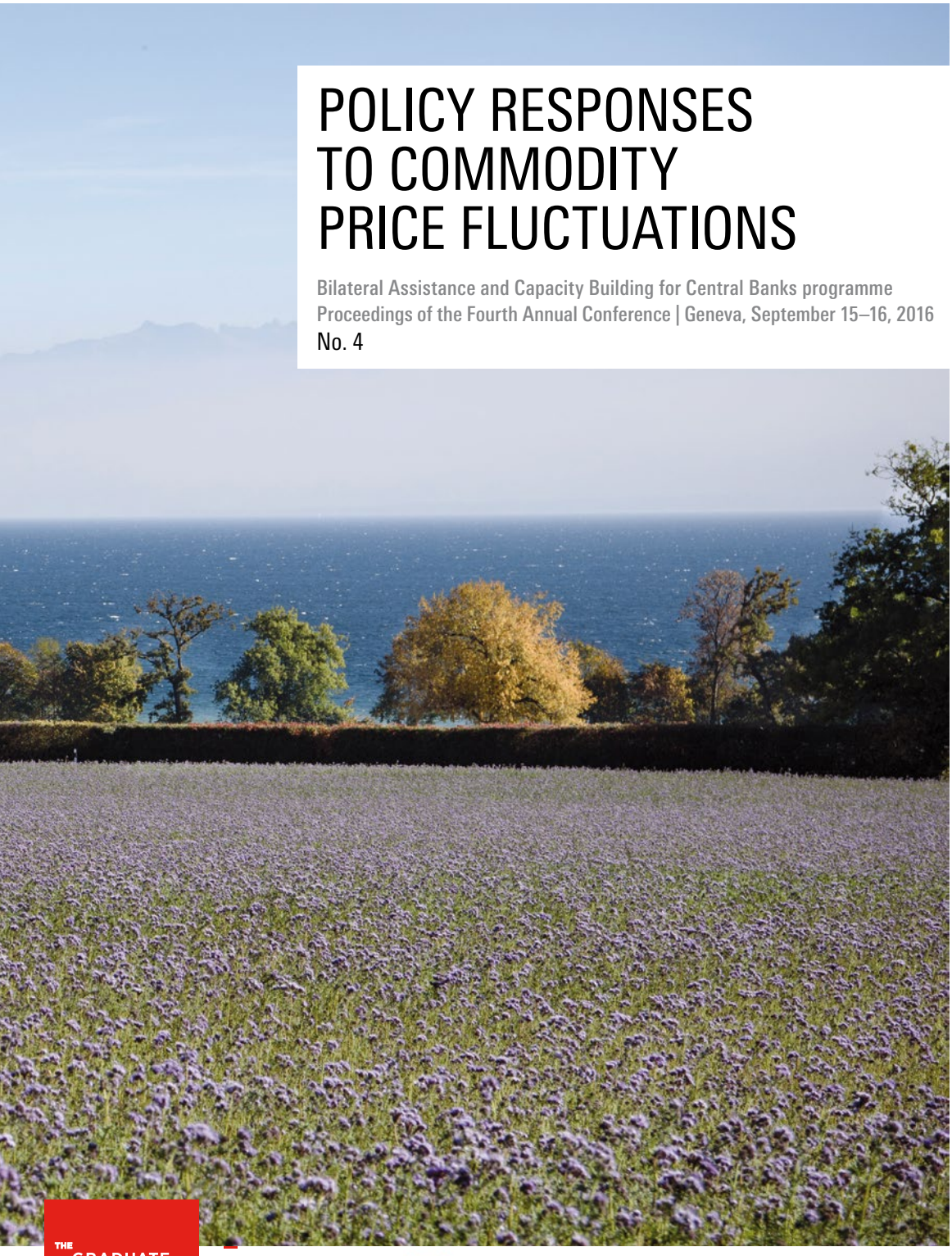

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— Tille, C.,"Foreword", in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 7–9.

I am pleased to introduce this volume of proceedings from the fourth annual conference held by the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme on the theme of *Policy Responses to Commodity Price Fluctuations*. The conference took place at the conference centre of the Graduate Institute in Geneva on September 15 and 16, 2016. The topic was motivated by a sizable cycle of commodity prices in recent years, with a persistent boom followed by sharp decreases over the last two years. An exchange between policy-makers and academics on the lessons learnt from recent events was thus particularly timely.

The BCC programme[1] is jointly funded by the Swiss State Secretariat for Economic Affairs (SECO) and the Graduate Institute in Geneva (IHEID). It is aimed at supporting partner central banks in emerging and developing countries in building analytical and technical expertise required for efficient conduct of monetary policy. It builds on longstanding expertise at the Graduate Institute in providing technical assistance through missions in partner countries tailored to their specific needs.

The conference brought together representatives from central banks of most of the eight countries in the programme,[2] and prominent academics and representatives of policy institutions, with the purpose of sharing recent research and policy experiences. In total 60 people took part in the conference.

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1 http://graduateinstitute.ch/bcc.

2 The countries are: Albania, Azerbaijan, Bosnia and Herzegovina, Colombia, Ghana, Peru, Tunisia and Vietnam.

The conference was structured around two pillars. The first day hosted a research workshop where researchers from the central banks had the opportunity to present their work and benefit from active discussions with conference participants. The day ended with a presentation by Prof. Joshua Aizenman on *Policy Responses to Commodity Price Fluctuations*. Participants were welcomed on the second day by Dr Philippe Burrin, Director of the Graduate Institute, and Dr Ivo German, Head of Operations at SECO. These opening remarks were followed by a keynote presentation by Dr Rabah Arezki, *Monetary Policy in Fossil Fuel Exporters: The Curse of Horizons*, which laid out main elements of the conference theme. Participants then shared their views and experiences in a series of three panels that led to active discussions between senior policymakers, prominent economists and members of the audience.

During the research workshop of the first day, four papers were presented during a lunchtime poster session. The authors had the opportunity to receive feedback from conference participants on that occasion, as well as throughout the conference, as their posters remained on display on both days. In the afternoon, two panels with four papers each were held, in which the authors presented their work. This was then followed by comments by two discussants in each panel.

The first panel of the second day focused on drivers of commodity prices. The panellists pointed out that standard supply and demand fundamentals continue to play a prominent role. The sensitivity of prices to demand and supply shifts is, however, heterogeneous. First, it differs between the short run, when supply is set, and the long run, when supply can react. Second, price volatility can surge in situations where availability of commodities (due to inadequate storage) is limited. Temporary demand shocks can have persistent effects, as they stimulate innovations in new extraction techniques that then permanently lower costs and boost supply, even when demand has reverted to its initial situation. The panellists stressed that forecasting commodity prices is a challenging exercise and it makes more sense to focus on forecasting broad trends and improving the ability to handle volatile prices. The panellists also debated the role of financial speculation. While some viewed it as playing a marginal role, others pointed out that the presence of new investors in the form of commodity funds has altered the behaviour of commodity prices.

The second panel discussed the impact of commodity price movements on the broader economy. The panellists considered both the boom phase of rising commodity prices and the impact of falling prices in the last two years. Some panellists focused on patterns that broadly apply to a large sample of countries, whereas others went into more detail regarding specific countries' experiences. In particular, the discussion showed that the commodity price cycle had a significant impact on the fiscal situation in commodity producing countries. It led to a contraction of fiscal policy during the bust phase, which could prove persistent in the future as commodity prices show no sign of returning to earlier heights. Commodity prices also show a strong correlation with the exchange rate, and adopting a flexible exchange rate regime can facilitate the adjustment in the bust phase at the cost of temporary (but sizable) inflationary pressures.

The final panel discussed the monetary policy response. The proper policy mix depends on the horizon: while monetary policy can focus on limiting inflationary impact in the short run, its ability to affect outcomes in the medium to long run is more limited. Other policies are then needed, including regulatory and supervisory policy to limit the build-up of financial imbalances and an adjustment of fiscal policy to the possibility that some of the commodity endowment may remain unexploited. The panellists discussed specific countries' examples and underscored the need for policy to recognise a possible persistent shift in prices instead of assuming that a contraction in commodity prices is temporary.

The conference led to active and fruitful exchanges of views among representatives from the various central banks, as well as with academics and representatives of other policy institutions. The event thereby significantly contributed towards the BCC goal of building a network of practitioners among the central banks involved in the programme, and strengthened the momentum initiated during the first three annual conferences in Geneva and various other regional conferences.

This monograph offers a focused exposition of the points addressed in the conference. The article by Dr Arezki provides an overview of the state of knowledge on management of the commodity price cycle. This lecture was followed by presentations and active discussion in the policy panels session, and we present the main points that arose during those panels. The presentation by Prof. Aizenman offers a view of recent challenges. Finally, the monograph also includes a concise presentation of papers presented in the poster session, the workshop panels, and of the ensuing discussions.

I am very grateful to all the participants for making this conference such an active and fruitful event, with particular thanks to the senior representatives of the partner central banks, Dr Philippe Burrin, Dr Ivo German, Dr Arezki and Prof. Aizenman for their contributions. I also express my gratitude to Prof. Charles Wyplosz and to the staff of BCC for their involvement in making the conference possible, as well as in the broader programme through the year.

Geneva, 14 October 2016

2. Welcome Address

IVO GERMANN
State Secretariat for Economic Affairs (SECO)

— Germann, I.,"Welcome Address", in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 11–13.

Distinguished guests and participants of this year's BCC conference,

In the name of the Swiss State Secretariat for Economic Affairs (SECO), I would like to welcome you to Geneva for the fourth annual conference of the BCC programme.

The main objective of this conference is to bring together the different stakeholders of the BCC programme and to provide a platform for exchanges and discussions on a current topic—a topic that is of great relevance for the BCC partner central banks. It is, therefore, a pleasure that we have representatives from almost all BCC partner countries participating in and actively contributing to this year's conference.

This year's conference is looking at the challenges induced by commodity price fluctuations and at possible monetary policy responses. Central banks are particularly concerned with commodity price volatility as it can put enormous pressure on the exchange rate and therefore on inflation, as well as on a country's reserves, compromising financial stability. At the same time, implications for monetary policy are not straightforward. The experiences of, and the challenges faced by, developing and emerging economies in dealing with commodity price volatility are quite different from those experienced in advanced economies. Developing and emerging economies are concerned with the transition to, and implementation of, a modern monetary policy framework, ensuring price stability, while taking into account the effects of further integration into the global economy.

The commodities sector plays a considerable role for the economies of many of SECO's priority partner countries. The exploitation of natural resources and the management of natural resource-based wealth has far-reaching effects on the economies of resource-rich developing and emerging economies. SECO is therefore engaged in different global initiatives dealing with this topic. More specifically, SECO supports the Extractive Industries Transparency Initiative (EITI), which aims at establishing a global voluntary standard for a more efficient and transparent recording of financial revenues coming from the management of natural resources. The commodity trade sector is also of importance for the Swiss economy, and Switzerland has a strategic interest in supporting the development of sustainable commodity trading. Furthermore, SECO is engaged in the IMF's Managing Natural Resource Wealth programme. This topical trust fund supports countries in establishing legislative and administrative capacities, including the design of exchange rate regimes, to maximise the benefits that result from the exploitation of natural resources. SECO's objective in supporting these initiatives is to increase accountability by making revenue flows to governments more transparent and by developing functional, efficient and effective systems of managing natural resource wealth. This contributes to strengthening economic, social and environmental sustainability, which are decisive for long-term development and poverty reduction.

Although, the far-reaching implications of commodity price movements have been a topic of research and theoretical papers for quite some time, there are still important issues to be thought through. In particular, it is the variety of circumstances and challenges faced by developing and emerging economies that needs further analysis. And, based on that analysis, how should proper policy responses be framed? This two-day Geneva conference provides an opportunity for BCC partner countries to share research results and experiences with their peers and with distinguished international academics and experts on this highly relevant topic. While yesterday, researchers from BCC partner central banks presented and discussed some of their most recent research work, today's programme will focus on the policy experiences of different partner central banks.

The development of stable and efficient financial sectors, along with appropriate monetary policies, are among SECO's main interests in the area of macroeconomic support. A stable and well-developed financial sector is crucial to providing the macroeconomic framework for improved competitiveness and sustainable growth. Central banks play a key role in ensuring macroeconomic stability and creating sound macroeconomic framework conditions.

The BCC programme is SECO's most important instrument for providing support to central banks. The programme was established to assist central banks in building capacities relevant to ensuring sound and independent macroeconomic management. The Geneva conference is one of main platforms of the BCC programme, via which the programme enables the exchange of knowledge between peers. We consider learning from peers to be a powerful tool with which to strengthen capacities, which lies at the heart of the BCC programme.

Therefore, I would like to invite you, dear guests, to actively participate in the different panel discussions. Each of you is operating in a different context and may have had different experiences, which will stimulate debate and add much substance to the discussions that take place during the conference. I also would like to invite you to benefit from the presence

of international experts and academics, which I am sure will allow all of us to broaden our perspectives and gain new insights. We are particularly honoured to have Mr. Rabah Arezki, Chief of the Commodities Unit at the IMF Research Department, as our keynote speaker today and we are looking forward to his presentation. Our thanks also go to all the other speakers and panellists who will guide us through today's programme, as well as to the researchers who made yesterday's exchange possible.

I would also like to take the opportunity to thank the Geneva Graduate Institute of International and Development Studies and in particular Prof. Cédric Tille and his team for the excellent and professional organisation of this event. They have put a lot of work and energy into preparing an interesting and diversified programme for this year's conference.

I hope you enjoy today's discussions and I hope the conference will enable you to gain some inspiration for your daily work.

Thank you.

3. Keynote Lecture

MONETARY POLICY IN FOSSIL FUEL EXPORTERS: THE CURSE OF HORIZONS

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Research Department, IMF

— Arezki, R., "Keynote Lecture — Monetary Policy in Fossil Fuel Exporters: The Curse of Horizons", in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 15–25.

Introduction

Fossil fuel exporters are exposed to the vagaries of fossil fuel markets. The collapse in oil prices that started in June 2014 is a stark reminder of the challenge posed by the dependence on oil and other fossil fuels (figure 1). While the literature on appropriate macroeconomic policies for fossil fuel exporters is extensive, much more attention has been paid to the role of fiscal policy. Part of the reason why monetary policy has been subject to less attention may have to do with the fact that most fossil fuel exporters have pegs or relatively fixed exchange rate regimes and hence have no independent monetary policy.

1 I thank Fahad Alshathri, Kamel Badsi, Patrick Bolton, Thorsten Beck, Olivier Blanchard, Karim El Aynaoui, Domenico Fanizza, Olivier Jeanne, Fred Joutz, Grace Li, Yang Liu, Akito Matsumoto, Maury Obstfeld, Rick van der Ploeg, Cyril Pouvelle, Fred Samama and Sunil Sharma, Cédric Tille and Charles Wyplosz. The views expressed in this presentation are those of the presenter and do not necessarily reflect those of the International Monetary Fund, its board of directors or the countries they represent. All remaining errors are those of the author.

There are however good reasons to take a fresh look at the issue of monetary policy in fossil fuel exporters. Traditionally, the horizon of monetary policy has been limited to that of the business cycle, typically 2–6 years. Considering the degree of wealth concentration, the strong complementarity between fiscal and monetary policies and the emergence of new risks to fossil fuel assets, there is a need to rethink monetary policy in fossil fuel exporters. In the present paper, I specifically examine the role monetary policy should play at different horizons.

Figure 1: 2014–16 Oil Price Slump

Source: IMF, Primary Commodity Price System.
Note: APSP = average petroleum spot price—average of UK Brent, Dubai and West Texas. Intermediate, equally weighted.

In a 2015 speech, Bank of England Governor Mark Carney weighed in on the debate as to whether monetary policy should look beyond the horizon of the business cycle.[2] Interestingly, part of his argument lies in the risk of financial instability that may result from the so-called energy transition that implies a move away from fossil fuels ultimately turning the latter into stranded assets. That transition hence threatens the financial health of corporations, insurers and other financial institutions that are exposed to fossil fuel assets. While the overall exposure to fossil fuel assets in advanced economies like that of the United Kingdom may at first glance appear relatively small, the systemic risk that may result from stranded assets should not be underestimated—we should be reminded that the global financial crisis was triggered by developments in the relatively small sub-prime mortgage market in the United States. For fossil fuel exporters, the high degree of concentration of wealth (and risks) around fossil fuel assets makes for an even easier argument—than for diversified economies—to have monetary policy look beyond the business cycle horizon.

In this paper, I break down the role of monetary policy at different horizons. In the short-run, central banks (CBs) of fossil fuel exporters should (flexibly) target inflation. The

2 See the entire speech at http://www.bankofengland.co.uk/publications/Pages/speeches/2015/844.aspx.

choice of the appropriate exchange rate regime is intimately linked to the issue of credibility. A peg is the appropriate regime if the country lacks credibility. I then make the case that CBs in fossil fuel exporters should look beyond the typical business cycle horizon. In the medium-run, resource (fossil fuel) based rents typically lead to much more pronounced fiscal (and credit/asset price) cycles. There is thus a need to ensure that monetary policy is conducted around a credible and sustainable medium fiscal anchor and credit rules. In the long-run, the risks of stranded assets are an existential threat for fossil fuel exporters. That is not typical central banking but in fossil fuel exporters CBs cannot afford to ignore these risks. They should support structural policies aimed at diversifying the economy, including through financial policies.

The remainder of the paper is organised as follows. Section II discusses issues related to the role of monetary policy in the short-run. Section III then explores monetary policy in the medium-run. In particular, it explores the complementarity between monetary policies, on the one hand, and fiscal and financial policies, on the other. Section IV lays out the new risk monetary policy has to confront over the long-run; namely, the risk of stranded assets. Section V concludes.

The Short-Run

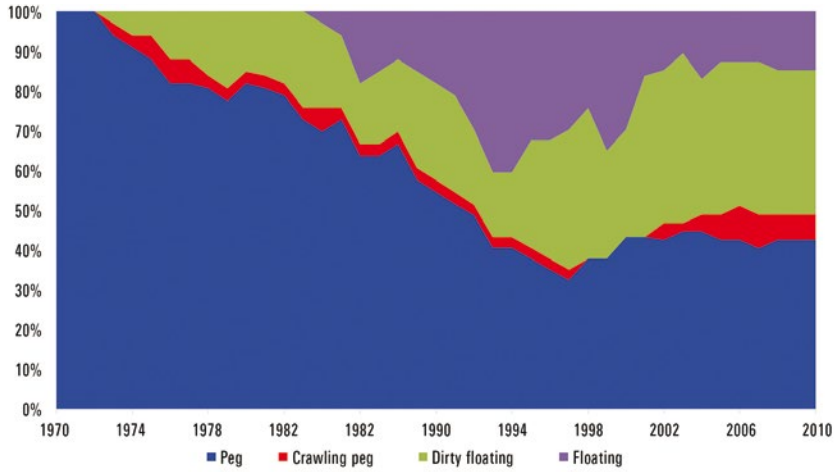
In this section, I explore the choice of appropriate exchange rate regimes in fossil fuel exporters. I then discuss the polar views of the (independent) monetary policy response to a drop in oil prices. I also touch upon the issue of the transmission of monetary policy.

Choice of Exchange Rate Regime

Adopting a flexible exchange rate regime is appropriate in countries where inflation expectations are well anchored. That flexible arrangement allows for an instantaneous adjustment of the nominal exchange rate following a terms-of-trade shock resulting from, say, fluctuations in the prices of fossil fuels

In practice, we observe however that many commodity exporters are pegging to the currency of their main trading partners (dollar or euro) or have adopted managed float (see figure 2). There are two main reasons for this. First, a fixed exchange rate regime maintains the parity between the domestic currency and a foreign currency, thus limiting fluctuations in the price of imported goods and inflation—also pertinent given that domestic prices are often sticky. A fixed exchange regime may also contribute to building credibility for monetary policy by anchoring inflation expectations. Second, the lack of exchange rate flexibility has to do with the so-called fear of floating (Calvo et al., 2002). Indeed, currency mismatch can be fatal and lead to crisis. Hence, countries are often afraid of allowing their currencies to float. That said there are important *risks associated with adopting a fixed exchange rate regime if the countries run pervasive external deficits that often stem from internal deficits*—so called twin deficits.

Figure 2: Evolution of Exchange Rate Regimes over Time



Source: Ilzetzki, Reinhart and Rogoff (2010).

Besides pegs, many countries operate 'managed floats'. This arrangement allows them to choose how much of the adjustment to a terms-of-trade (hereinafter ToT) shock should come from exchange rate adjustment vs domestic price adjustment. A ToT shock amounts to a negative wealth shock suggesting the real exchange rate has to adjust towards a new equilibrium level. A resource windfall is also typically associated with the so-called Dutch 'Disease'. In other words, a positive oil price shock leads to a relative price change between non-oil tradables and non-tradables.

In the case of a pure float, a ToT shock leads to immediate adjustment of the real exchange rate through the nominal exchange rate when goods' prices and wages are rigid. Empirical evidence suggests that flexible exchange rate regimes allow for a smoother real adjustment—that is, lower output volatility (see Broda, 2004; Aghion et al., 2009 on productivity growth).

In the case of a managed float, it might not be desirable to force such a speedy adjustment through the nominal exchange rate, so managed float allows countries to combine a nominal exchange rate movement with a gradual adjustment in the domestic price level. This however could come at a cost to the credibility of policies. Fiscal policy could help counteract the effect of a ToT shock and hence limit/spread domestic price adjustment over time. There are also important issues associated with the 'asymmetrical' nature of the Dutch Disease (Arezki and Ismael, 2013) stemming from downward nominal stickiness. It these circumstances it may make sense to resist nominal appreciation and let inflation increase above target to facilitate this relative price change.

There are also issues associated with capital account openness and the conduct of monetary policy. Brazil is a good example of a country that has struggled with the consequences of a rapid exchange rate appreciation resulting from the surge in capital inflows during the boom in commodity prices.

The Two Polar Views of Independent Monetary Policy

A dilemma for fossil fuel exporters is that an oil price drop may lead to two polar views in terms of what the appropriate response of independent monetary policy should be. On the one hand, a central bank pursuing a (strict) inflation mandate would tighten monetary policy in the face of a drop in oil prices. Indeed, a drop in oil prices would lead to a depreciation of the exchange rate, hence leading to a rise in inflation justifying a tightening of monetary policy. On the other hand, a central bank focused on stabilising output would loosen monetary policy in the face of drop in oil prices. Indeed, an oil price drop would reduce demand from the oil sector to the non-oil sector. That would in turn generate a rising negative output gap for the non-oil economy, hence justifying a loosening of monetary policy. That would in turn make the output gap of the non-oil economy rise, hence justifying a loosening of monetary policy. The channels include large backward and forward linkages between oil and non-oil sector (e.g. Norway, Russia) and changes in government spending/taxes and the credit channel.

In theory, the new Keynesian framework with wages or goods price rigidity offers guidance on the correspondence between targeting inflation and targeting output. In a 'closed economy', the so-called divine coincidence—the equivalence between targeting inflation and output stabilisation—holds under the assumption of limited frictions (Blanchard and Gali, 2007). In the context of so-called commodity openness (both consumption and production openness), there appears to be no divine coincidence under standard assumptions. Flexible inflation targeting is (constrained) efficient (Monacelli, 2013; Catao and Cheng, 2013; Hevia et al., 2013; Ferrero and Seneca, 2015). Some research has also shown that headline rather than core inflation targeting is more appropriate in the presence of credit constraints and a large share of food in the consumption basket (Anand and Prasad, 2012). Some authors have argued for setting the exchange rate to stabilize the domestic currency price of commodity exports (Frankel, 2011). While that rule would smooth government oil revenue in terms of local currency, it has no clear welfare rationale.

In practice, most countries loosen monetary policy in the face of a drop in oil prices suggesting that output stabilisation is more important than strictly targeting inflation.

Other Issues

Monetary policy in fossil fuel exporters should also be mindful of issues related to the effective transmission of monetary policy (see Prachi et al., (2014) for a discussion with regard to developing countries). In fossil fuel exporters, excess liquidity indeed incapacitates the transmission of monetary policy. Structurally, the financial system in fossil fuel exporters is subject to a 'financial curse' (Beck, 2011) in that its reach is limited. Banks do not rely on refinancing from the central bank as they instead earn relatively high risk-free returns on securities issued for sterilisation purposes. That situation hence incapacitates the traditional monetary policy tools (no base rate to speak of).

All in all, a peg allows fossil fuel countries to stabilise (imported) inflation and build credibility if the country maintains fiscal discipline (by avoiding pervasive current account deficits).

In the case of a float, the central bank should set an inflation target. If inflation expectations are anchored, the central bank can afford to also worry about output stabilisation—that is, loosen monetary policy in the context of negative ToT shock. If inflation expectations are not well anchored (because of limited credibility) and if the share of imported goods in the consumption basket is large, a tightening of monetary policy in the face of a negative ToT shock may be warranted.

The Medium-Run

In this section, I examine the role monetary authorities should play beyond the business cycle horizon. I first explore the issue of the complementarity between fiscal and monetary policy in fossil fuel exporters. Then, I discuss the need for macroprudential policies. I then draw lessons from the recent collapse in oil prices and the associated policy responses.

Complementary between Fiscal and Monetary Policies

Commodity exporting countries in general—and fossil fuel exporters are no exception—tend to overspend in good times, leading to excessive indebtedness and crisis in bad times (Arezki and Brueckner, 2012). The effectiveness of CBs' contribution to stabilisation thus rests on the existence of a credible/sustainable fiscal anchor. The cost of borrowing rises with falling commodity export prices (figure 3) (Arezki and Brueckner, 2012). Weaker political institutions typically make things worse considering the risk premium associated with them. There is a need for fiscal (and credit) rules to limit the amplification of the effect of a ToT shock. Interestingly, many countries, including Chile, have graduated from pro-cyclicality by setting up fiscal rules (Frankel et al., 2013).[3]

Figure 3: Rising Sovereign Bond Spreads

Source: Bloomberg, L.P.; and IMF staff calculations.
Note: Oil exporters are comprised of Angola, Bolivia, Colombia, Ecuador, Gabon, Iraq, Kazakhstan, Nigeria, Russia, Trinidad and Tobago and Venezuela.

3 Pieschacón (2012) compares the differentiated macroeconomic impact of oil shocks on Mexico and Norway. The latter country is at odds with the former due to the fiscal discipline it has subjected itself to.

Chile provides an example of a commodity exporter that has set up a fiscal rule and graduated from pro-cyclicality. The set-up is that an independent council of experts determines the 'volume' of spending while members of parliament decide on the 'composition' of spending—by picking from projects that have been pre-screened by a fiscal authority. The presence of a fiscal rule in Chile has arguably supported the implementation of monetary policy and specifically inflation targeting (De Gregorio, 2012; Cespedes and Velasco, 2013). Short of building the needed constituency to set up and implement a fiscal rule, Mexico settles for a large-scale hedging programme against oil price volatility (Duclaud et al., 2012). The difficulty with hedging programmes, of course, is the tension that may arise over the perceived excessive cost of the programme during boom times. To allay that concern, the Mexican programme has been designed to capture the uptick from high oil prices using Asian options. It should be noted however that both tools (fiscal rules and hedging programmes) are often politically difficult to put in place and implement.

Macroprudential Policies

Credit and asset prices in commodity exporters tend to amplify macroeconomic fluctuations (see Sousha, 2016). The concentration of wealth in one sector makes the concerns over systemic risk much more prevalent in commodity exporters. Macroprudential tools are thus all the more important in these economies to help limit the amplitude of boom and bust cycles in credit and asset prices (e.g. stocks, real estate prices) hence reducing the risk of financial instability.

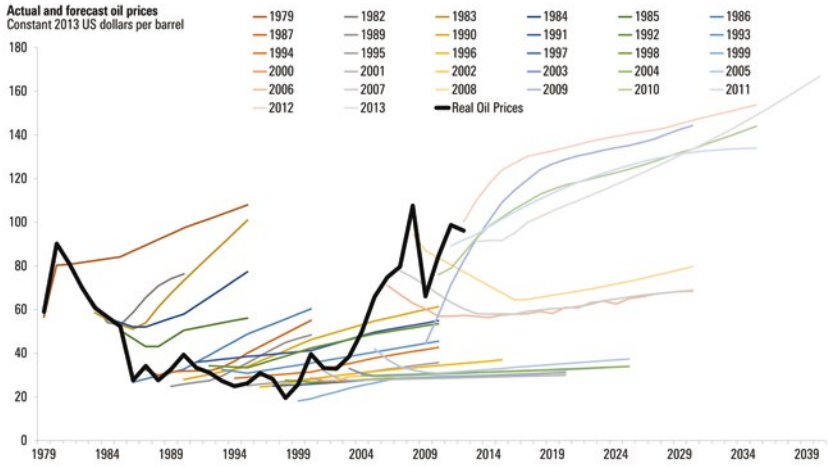
The IMF (2016) recommends that the use of these tools—which are to a large extent commonly used separately—be coherent in order to limit perverse and countervailing effects. The most common prudential tools include capital buffers, risk-based supervision, time-varying loan-to-deposit and loan-to-value ratios. Sector specific tools aim to limit sectoral exposure, particularly for real estate and personal loans. Other efforts to limit systemic risk include liquidity management, the development of domestic interbank money and debt markets. The modernisation of insolvency regimes and the strengthening of crisis management and resolution systems are also area where progress is needed in many fossil fuel exporters.

Lessons from the 2014–16 Oil Price Collapse

The policy response to the spectacular oil price collapse has been quite different across countries (Arezki and Blanchard, 2015; Obstfeld et al., 2016). Conceptually, one needs to distinguish between countries that have buffers and those who have none. Those with buffers should use them to adjust gradually to the medium anchor. Those with no buffers have no choice and need to let the exchange rate depreciate. In practice, the differences in responses reflect different countries' circumstances, including the presence of buffers but also the share of imported goods in total domestic demand (e.g. 11 per cent for Russia compared to 40 per cent for the Cooperation Council for the Arab States of the Gulf (GCC)).

Russia and Azerbaijan have either devalued or let their currency depreciate early on (with some risks of currency mismatch). Inflation from imported goods in turn pushed the central banks in these GCC countries to raise rates. GCC countries have kept their pegs unchanged reflecting their very large share of consumption concentrated around imported goods and their open capital account. On the fiscal front, many GCC countries have however embarked on an ambitious reform programmes (subsidy cuts) to reduce spending and also diversify their economy (e.g. the Saudi 2030 plan). Nigeria had initially opposed devaluing its currency and hence losing most of its reserves and leading to an explosion of the black market premium. The authorities recently opted for devaluation and a managed float.

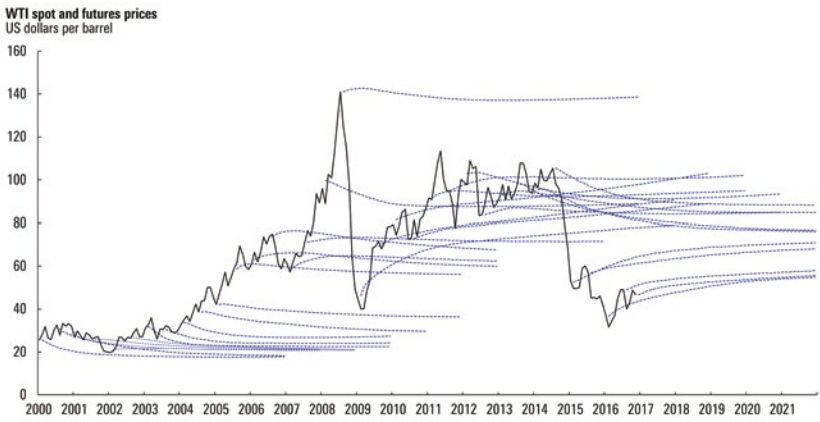
Figure 4: Hard to Forecast



Source: Energy Information Administration.

Another issue to consider when responding to a commodity price shock is the nature of the shock, especially the permanent vs transitory aspects. This is, of course, hard to know a priori. Typically one can distinguish between demand and supply. While monetary policy needs to respond swiftly, erring on the side of caution by assuming that part of the shock is temporary and part is permanent is appropriate. Oil prices are notoriously hard to forecast (figure 4). The market seems to learn only gradually as the evolution of futures curves suggests (figure 5). The uncertainty surrounding the nature of the shock calls for precautionary saving in the form of (fiscal and 'financial') buffers. Hedging reduces the need for precautionary saving (Borensztein et al., 2013). It is often forgotten that uncertainty about oil price also has an independent effect that affects investment and consumption decisions.

Figure 5: Oil Prices and Futures, 2000–21



Source: Bloomberg, L.P.
Note: Updated from Leduc et al. (2015). WTI = West Texas Intermediate. Futures path as of first business day at six-month intervals.

The key lesson in the medium-run is that the choice of monetary policy is influenced by the structure of the economy including the sustainability of fiscal policy (depleting reserves; share of imported goods in aggregate demand; credibility; polarisation…). With regards to the choice of exchange rate regime, fiscal policy can help buffer the shock and smooth the adjustment to a ToT shock. Macroprudential policies can help limit credit and asset price booms and busts, and currency mismatch.

The Long-Run

The historical COP21 agreement to keep global warming below 2 degrees Celsius and ensuing technological innovations (declining cost of renewables; electric cars) have further boosted the energy transition away from fossil fuels (IMF, 2016). This means that gigatons of reserves will have to stay underground unexploited. While this risk of stranded assets for fossil fuel exporters appears to be remote, it does pose an existential threat that monetary authorities cannot afford to ignore (van der Ploeg, 2016). It is not easy to define the contours of how monetary authorities should engage on these issues. They appear structural in nature, but as they pose a systemic risk it is urgent that monetary authorities take up the challenge of rethinking their role in light of these new risks.

To keep the mean global surface temperature rise below 2 degrees Celsius, only 300 to 400 gigatons of carbon can still be burnt, but the reserves of private oil and gas majors alone are at least three times as high. To abide by international commitments to limiting global warming a third of oil, half of gas, and 80 per cent of coal reserves should be kept in

the ground forever (see, e.g., McGlade and Ekins, 2015). This would mean keeping unburned one-third of oil reserves in Canada and the Arctic, 50 per cent of gas and 80 per cent of coal (mainly China, Russia and the US). In the Middle East, reserves are three times larger than their 'carbon budget'. In other words, 260 billion barrels of oil from the Middle East cannot be burnt. In addition to stranded reserves, the structures and capital used in the extraction and exploitation of fossil fuels can become stranded.

Recent discoveries of giant oil and gas reserves (Israel, Egypt, Lebanon, Mozambique and Senegal) are expanding the list of countries that are faced with the risk of stranded assets and capital (Arezki et al., 2016). It is hard to reconcile this trend with the objective of keeping planetary warming below 2 degrees Celsius. Nonetheless, the large number of countries that are increasingly exposed to stranded assets makes it a priority for monetary authorities in concert with fiscal authorities to communicate and help adapt to and mitigate these risks.

What to Do about Stranded Assets?

Obviously, many fossil fuel exporters have been concerned with regard to the need to diversify their economies. Very few, however, have successfully moved away from their dependence on fossil fuels (Venables, 2016). The regulatory and technological change sweeping the energy market may make it a more urgent priority. To help structural policies, working on the longer end of the yield curve would facilitate longer-term investment and diversification. The response to the risk of stranded assets may have a bearing on the asset allocation of fossil fuel exporters. Many oil exporters have accumulated vast financial assets and the strategic asset allocation of these exporters is all the more important given the new risk. Investing away from financial assets that are based on fossil fuel assets is an obvious policy.

One implication of the spectre of stranded asset is that it could lead to a race to burn the last ton of carbon. That could in turn lead to the so-called green paradox whereby regulation aiming to limit carbon emissions ends up raising them, at least in the short-run (van der Ploeg and Withagen, 2012). Some commentators have argued that the collapse in oil prices is a deliberate attempt on the part of major oil exporters with low marginal costs of production to not only crowd out higher marginal cost producers but also to delay the energy transition. There is indeed evidence that low fossil fuel prices can potentially delay the transition (Arezki and Obstfeld, 2015).

All in all, the risk of stranded reserves and capital is a much bigger risk for fossil fuel exporters than for advanced economies. Monetary policy needs to reflect and communicate on such an existential threat and advocate that appropriate structural policies are adopted to diversify the economies in question. It should also provide supportive financial policies to help with the necessary diversification, and adapt strategic asset allocation.

Conclusion

This paper has examined the role monetary policy in fossil fuel exporters should play at different horizons. The central argument is that the concentration of wealth entails a concentration of risks, which monetary policy needs to address. In the short-run, monetary policy should (flexibly) target inflation. If CBs are not credible, a fixed exchange regime can help build such credibility. In the medium-run, fiscal and credit rules are needed to limit the risk of macro-financial instability in the face of ToT shocks. Coordination with fiscal authorities is needed to ensure that a credible fiscal anchor is in place. There is a need for macroprudential policies. In the long-run, the risks of stranded assets pose an existential threat to these economies. CBs need to communicate on the issue and on the need for structural policies if diversification is to be achieved. Supportive financial policies and risk management strategies in the form of the choice of asset allocation are also appropriate.

4. Panel Discussions

Panel Participants

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4.1 Panel 1
WHAT DRIVES COMMODITY PRICES?

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— "What drives commodity prices?", Panel 1, in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 27–34.

Presentations by the Panellists

The first panellist argued that commodity prices are driven primarily by the usual supply and demand considerations, but other confounding factors may also have an additional effect. The analysis must take the theoretical underpinnings of commodity prices as an important starting point from which to assess booms and busts in prices.

The basis for analysing commodity prices is the link with the available stock. The theoretical analysis shows that the price of commodities that are continuously storable and traded on financial markets is determined by an inter-temporal arbitrage equation that ties the current spot price to expected future spot prices, the interest rate and the storage cost. This arbitrage condition, however, breaks down for commodities that are not continuously stored when the available stock falls close to zero. In a process referred to as 'backwardation', this leads the current spot price to shoot up and the future spot price to become lower than the current spot price.

The history of commodity prices since 1900 is characterised by several temporary booms and busts, of which at least two busts were more of a permanent nature. Most of these are attributable to demand and supply factors, although there is the possibility of a speculative component. In recent years commodity prices have been back to the relative lows of the 1990s, and the 'China

super-boom' that had led to high prices has turned out to be of a temporary nature. China, which today is by some measures the largest economy in the world and a substantial commodity consumer, grew at an average of more than 10 per cent per annum for ten years. This was indeed a very unprecedented situation, which is unlikely to be repeated any time soon. Additionally, looking back there was evidence that the boom was temporary, as markets were in tight supply, stocks were low and markets were frequently in backwardation. As China grew and demanded more and more of different types of commodities, price changes across goods became more tightly correlated.

Other factors might also have been at play in addition to demand, such as post-crisis monetary policy and interest rates. After the crisis, US monetary policy became looser and the dollar depreciated against many currencies. Since commodities are priced in dollars, this led to an automatic upward pressure on commodity prices. In addition, the fall in interest rates led to a jump in the current spot price of extractive non-renewables. Low interest rates also reduced the cost of financing inventories, which lowered the carrying or storage costs, leading to further increases in spot prices.

To explain the recent bust, the panellist quoted research that shows that even booms driven primarily by temporary demand or speculative factors can have persistent effects as they foster innovations that reduce the cost of supply. Therefore, if and when the demand or speculative shock goes away, commodity prices fall back below their previous levels since the long-run cost of supply has been made permanently lower.

On forecasting, the panellist pointed out that although it is easy to ascertain that the most recent boom has been the largest historically, defining the future course of prices remains difficult. This is primarily because of inadequate length of data post June 2014 and mixed signals from the trade-offs between technological innovations and dwindling reserves. Further, most forecasts of prices, such as from implicit volatilities on traded options, tend to have larger standard errors that limit their accuracy and usefulness in guiding policy. The key reason is that future shocks are by nature uncertain. Therefore, the panellist argued that it is more important to manage likely uncertainty than to try to make accurate forecasts.

The second panellist agreed with the first's emphasis on theory and that the drivers of commodity prices are ultimately demand and supply factors. However, the impact of these factors may be made more complex because of commodity prices' differential adjustment to different shocks and information, and interactions with other events.

Starting with the supply side, in the short-run it is driven by past investment, which in turn is subject to large sunk costs and long implementation lags, both of which can be time-varying due to the arrival of technological developments. All of these interactions imply that the supply elasticity with respect to prices is much lower in the short-run than in the long-run. In addition, short- and long-run supply responses are functions of expectations and access to finance. Forecasting these is quite difficult. Turning to demand, key factors include urbanisation and population growth rates, industrialisation and the growth of manufacturing, investment,

construction booms, and increasing income and improving living standards in emerging markets. The arrival of India and China in the last thirty years illustrates the role of these demand-side factors.

The panellist began with the example of oil, as it used to be, before the crisis, the most important commodity in explaining business cycles. Real oil prices were steady until 1973–74, and the first major shock was the formation of the OPEC cartel, which led to the quadrupling of prices in what was the first oil shock of the 1970s. With a decade's lag, there was a reduction in oil use per dollar of GDP of 50–60 per cent and substitution effects due to the arrival of new, non-OPEC suppliers. This was assisted primarily by developments in shale technology. This response, along with an increase in US real interest rates, led to a drop in prices to pre-OPEC levels in 2002.

The next cycle began with the growth of China and other emerging markets, which significantly boosted the demand for commodities, leading to a price boom. In China, this was primarily due to manufacturing growth and the construction of infrastructure. The shock of the global financial crisis propagated first a short bust and then a longer boom, followed from June 2014 by another bust.

The panellist went on to stress the key role of technological innovations. Shale efficiency gains have lowered the break-even price and hence actual oil prices, thereby dominating the sector in terms of attractiveness and scale. With this technological development, it cannot be ruled out that future oil price cycles will become shorter, about five to seven years long, as advancements occur closer together. The panellist believed that the shale shock is permanent, indicating a persistent downward pressure on prices. In other words, he agreed with the first panellist on the difficulty of accurately forecasting prices, but added that the likely future trend can be gauged by considering the state of technology. Other factors depressing future prices might be the role of the sunk cost of investing in shale technology and the potential for further increases in supply by some countries in order to protect their market share and fiscal revenues.

Turning to other commodities, recent research has found a relationship between commodity prices and the global economy's growth rate, referred to as 'supercycles', each with different fundamental drivers. While the first supercycle, which began in 1870, was driven by technological innovations, the other two, which started in 1946 (till 1973) and 2000, respectively, were driven by demographic changes that affected aggregate demand. However, the panellist is sceptical of the 'supercycles' argument, as it is subject to the Lucas-critique and other econometric challenges. Second, it is possible to have different pure random walk processes that generate supercycles of varying durations.

The third panellist focused on movements in monetary policy in response to commodity price shocks, illustrating them with specific case studies. Development can lead a country to shift significantly away from a reliance on commodity exports. While commodities accounted for 32 per cent of total exports a decade ago (including 23 per cent for oil), their share has fallen to

about 2 per cent in recent years. The country in question's economy was fortunate to some extent that the reliance on commodity exports coincided with unprecedented global growth, especially in China, sustaining a large demand for a variety of commodities. Consequently, the country's government was able to use revenues from commodity exports to diversify the production structure of the country's economy.

The role of commodity prices is vital, with three aspects being of particular interest. The first is the link with fiscal policy. From 2005 on, oil exports contributed significantly to fiscal revenues, which used to be positive and high, but this contribution has been diminished by the reduction in prices that began in 2014. This has led to the emergence of a fiscal deficit and to a growing reliance on public-private partnership (PPP) programmes in the funding of investment projects.

The second aspect is the impact of commodity prices on social welfare. The country in question also exports other agricultural commodities, and though these represent only a low share of exports they do represent the main source of income for a sizeable number of farmers. The government and the central bank have thus introduced subsidies for the affected farmers during times of falling commodity prices.

The third point pertains to forecasting. The panellist stressed the challenges of accurately forecasting commodity prices, as mentioned by previous panellists. An alternative is to keep a close eye on the market and continuously monitor forecasts made by international organisations such as the World Bank, IDB and IMF. The central bank can compute its forecasts considering the growth of BRICS and other G20 countries on the demand side and technological innovations on the supply side. The impact of technology on future commodity prices is, however, uncertain, especially in countries where the economy depends a lot on labour-intensive industries that could be rendered obsolete. Lastly, the panellist underscored the role of political developments in the world, which might affect prices.

The fourth panellist argued that the commodity price swings of the last decade have raised several concerns for fiscal sustainability, financial stability and growth, among other issues. This is the case for both exporting and importing countries. Managing this volatility has become the main aim. Though there have been many questions over falling prices over the past year, a consensus view is that the supercycle was primarily driven by fundamentals, although other factors such as financialisation have also contributed.

After having risen dramatically for a decade, prices of commodities like energy and metals have strongly declined since 2011. Research shows that the boom was driven by growth in emerging markets. The shift in world growth to commodity-intensive regions has increased the correlation between their business cycles and commodity prices over the last few years. On the supply side, the emergence of new suppliers and technologies—like shale production and new transportation methods—have held prices down. The introduction of subsidies, taxes and bans by the government in question with the aim of influencing supply has also tended to compress prices. World growth, an increase in the standard of living, and

higher demand for food have also had an impact on prices.

Commodity prices are in general much more volatile than other prices, for several reasons. In the short term, supply and demand are very inelastic, and so prices can move a lot. Traditionally, there are large implementation lags in investment, and new supplies of minerals from new production centres can take between three and five years to have any impact on prices. Meanwhile, prices have been shown to be quite sensitive to new information, geopolitical tensions, disasters and weather conditions, and this is reflected in fluctuations. Financialisation—the process of commodity futures becoming important as asset classes for portfolio investors—and speculation activities in commodity markets may have contributed significantly to volatile short-term movements in prices.

Financialisation has increased the efficiency of commodity markets through better risk sharing and hedging among a broad range of participants, thereby allowing better price discovery and contributing to market stability. However, several new developments are worth noting. First, the composition of participants in commodity price futures markets has changed dramatically. In addition to traditional market participants, which include commercial hedgers, non-commercial traders and hedge funds, there has been a large inflow of capital from commodity index fund investors since 2000. These funds tend to look at commodity futures as part of their broader portfolio strategy. Between 2000 and 2010, the participation of non-traditional institutional investors, hedge funds and a number of traders has increased, as have gross positions—with producers generally taking short positions in the funds, and commodity index investors taking long positions. The incentives of these new investors differ from those of traditional investors. Some recent research has argued that the appearance of all these new participants has led to a closer integration of commodities futures markets with other financial markets, and portfolio rebalancing movements can then cause volatility spillovers to commodity markets.

Commodity prices are inversely correlated with the value of the dollar. Some studies have considered not only whether a decline in real interest rates and the value of dollar contributed to higher commodity prices, but also whether prices displayed an overshooting pattern in response to changes in real interest rates. They found that prices increase when real interest rates fall or when the dollar becomes weaker.

General Discussion

One participant was interested in the role of financialisation, and in particular in whether there is a role for global financial conditions in driving the relevance of financialisation matters for commodities. For instance, the advent of quantitative easing and low interest rates could encourage more risk taking behaviour with regard to exotic investments.

Another question pertained to the complementarity between fiscal rules and hedging. If many exporters are 'hand-to-mouth' producers with limited participation in financial market, asking them to save some of their

income in good times while also paying for hedging instruments can be quite difficult politically. This raises the question of why fiscal rules should be complementary to hedging.

Another participant inquired about the impact of technological innovations in renewable sources of energy on oil prices. Renewables such as solar energy have seen decreases in costs and improvements in efficiency.

A participant asked about the end of the Chinese super-boom and about other candidates that might be able to replace China in terms of demand for commodities. How would the arrival of new sources of demand impact oil prices?

One member of the audience commented on international monetary systems and acknowledged that most commodity trading currently takes place in dollars. Therefore, could it be possible in the future that countries will hedge simply with a basket of currencies instead of investing in alternative expensive hedging mechanisms? In addition, the participant was interested in the panellists' thoughts on the advantages and disadvantages of financial and operational hedging.

Replies from the Panellists

In response to the question on financialisation, a panellist commented that commodity futures markets and speculation have both been around for many years. The only new and big recent change that could explain the volatility of prices is the emergence of commodity funds. However, their contribution to short-run volatility is questionable since these are long-run investors taking long positions. The panellist argued that while these investors might add some froth to prices, it is the fundamentals that ultimately count. On the same question, another panellist argued that commodity index funds have indeed constituted a substantial change in recent years. The panellist was of the view that this development, independently of supply, demand, technology and other factors, has been a major driver of short-term volatility in markets. The example discussed was from experiences that took place during the sub-prime crisis, when the main drivers of commodity prices were transactions on derivatives markets, and the question was no longer one of demand and supply, but rather one of cash and carry. During this time, commodities like gold, oil, copper and iron became safe-haven assets, and valuations were driven away from fundamentals, as hedge funds even built storage capacities to hold these commodities and carry them to maturity. In this example, speculation was the main driver behind volatility. Another panellist agreed with the points made by the others and added that it was the interaction between deeper financialisation and the real interest rate that would prove to be key in the future. The panellist expressed concerns about possible market volatility when real interest rates are hiked, which is likely to be higher today as compared to 20 years ago.

On the role of global financial conditions, a panellist expounded on the theories that exist regarding the effect of quantitative easing on dollar-denominated commodity prices, both through the currency channel and the interest rate channel. The panellist felt that there is less emphasis on risk-taking,

which may be related to the composition of participants in the market as pointed out earlier, but was sceptical of the change in the strategies of these participants. The panellist pointed to the coexistence of two markets, well-regulated exchanges with good risk-sharing, and over-the-counter (OTC) markets, which have more lax regulation, which can lead to higher risk-taking by participants. To the extent that broader financial regulation has shifted trading from OTC to exchanges, it has actually made the markets less risky by moving participants to safer ways of trading.

Concerning the question of complementarity between fiscal rules and hedging, one panellist stated that the first best solution would be to have complete markets, where producers could hedge freely. But since some markets are incomplete, non-existent or inaccessible, one needs to dig deeper into the specific workings of the individual commodity market, because this is what determines the extent to which producers (at the micro level) and countries (at the macro level) are able to manage uncertainty. One option is to bring local hedging markets to small producers, provide interventions where prices can be stabilised, or set up national organisations that hedge on behalf of the small producers. It is admittedly not an easy thing to do, as many such actions and plans have failed in the past, and it has proven difficult to hedge medium-term shocks. However, countries need to think in different ways with regard to how to wade through the market, depending on the specific commodities involved. Another panellist argued that hedging is mostly a matter of timing and a good understanding of future trends. For example, countries can buy put options if they anticipate a decrease in oil prices. If oil prices increase instead, there would be several critics of this government policy, as the country would have paid a premium with no benefit. By contrast, there would be much less praise if the hedging strategy proved successful. In answering this question, a different panellist acknowledged the prevalence of agency problems, but gave the example of mandatory insurance for drivers: while there is no accident the majority of the time, the importance of insurance is understood only when there is one. Therefore, it makes sense to focus on governance and how to improve it. It might be possible to anchor this in the country in question's Constitution so that there is no need to bargain over the hedging strategy every year as the political climate changes.

On the question of innovations in the renewables sector, one panellist agreed that they are important, but the long-run impact depends on the complex interaction between private incentives and government interest to intervene.

With respect to the question of whether a new source of growth will replace China, one panellist agreed that while there may be many smaller countries that might fill the vacuum, they are unlikely to grow fast enough. The China experience of the decade prior to the crisis was highly exceptional, primarily due to other enabling factors such as the willingness of advanced economies to accept the growing current account surplus of China. A different panellist mentioned that, rather than just slowing, China is also rebalancing towards a more consumption-driven economy. This shift might put downward pressure on metals, but support food prices.

The panellist seconded the earlier point that Chinese growth of more than 10 per cent was unprecedented and unlikely to be seen again. India could be a replacement, but only in a limited manner as it is not as big as China and is less commodity-intensive. The hope is that Africa will be the powerhouse in the future, although this will take some time. A different panellist added that the BRICS countries, and Indonesia and Vietnam are going to be important future sources of demand for commodities. However, it was mentioned that the more important question concerns what policies will give commodity exporting countries a greater incentive to diversify.

Finally, one panellist was sceptical of the extent to which hedging with a basket of currencies matters for the intermediate-term and the long-run, even if it does have some role to play in the short run. The panellist commented that the role of the real interest rate is more important, especially in phases of interest rate increases. Another panellist felt that the dollar is a bad numeraire for measuring commodity prices since it has its own dynamic and keeps moving independently. Therefore, measuring commodities in other terms might be more useful. Another panellist mentioned that the effect of dollar movements has been a concern for some central banks. Policymakers can rely on two policies; namely, asking firms to reduce their holdings of dollars and other foreign currencies, and allowing exporting firms to hedge with the central bank.

4.2 Panel 2

THE ECONOMIC IMPACT OF COMMODITY PRICE FLUCTUATIONS

Chair
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— "The Economic Impact of Commodity Price Fluctuations", Panel 2, in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 35–40.

Presentations by the Panellists

The first panellist summarised the experience of oil-exporting countries in the face of the recent oil price decline. According to the panellist, it has yet to be seen whether this decline is a short-term trend or whether it is of a more permanent nature. Almost all commodity prices, including food, metals and oil, have dropped. Since these prices move together, the negative effects are magnified for countries that export not only oil but also other commodities. The panellist considered a group of more than 20 oil exporters across all regions and income groups, and indicated several trends.

From 2013 to 2015, almost all countries in the sample experienced a slowdown in real GDP growth. Relatively few countries experienced outright contractions in 2015 however. The picture is different for the current account balance. In most countries, the balance turned into a deficit in 2015; that is, countries stopped being net savers. The majority of the countries analysed show a rising

general government deficit. This suggests that they did not build up enough buffers at the time of high oil prices to counteract a future price decline. General government gross debt increased in 2015 compared to 2013, and only few countries have low debt-to-GDP ratios. General government net debt, in contrast, is negative for some countries, particularly for those that have established sovereign wealth funds. Moreover, changes in the balance of payments have affected the exchange rate. Between June 2014 and September 2015 several countries experienced considerable depreciations of their currencies against the dollar. As, however, even economies that are not commodity exporters have seen their currencies depreciate, the adjustment can be attributed in part to a general strengthening of the dollar. Finally, the oil price shock does not appear to have impacted inflation.

Overall, more diversified economies have been less affected by the oil price shock. Among countries highly dependent on oil production and exports, those that responded with a large-scale fiscal stimulus have managed to mitigate the impact of lower prices on growth. This however, came at the cost of a deterioration of their fiscal positions and current account balances. In the long-term, the sustainability of such a policy depends on future oil prices, the size of fiscal buffers, central banks' international reserves and the elasticity of the supply side to oil prices. The impact of monetary regimes on macroeconomic adjustment is less clear. Floating exchange rate and inflation-targeting countries saw a smooth exchange rate adjustment; but these countries are typically not the most dependent on oil exports. Countries with strong exchange rate pegs also avoided financial turbulence and continued growing. For those countries, the fixed exchange rate provided an important anchor for price stability and macroeconomic credibility. Countries that ran hybrid regimes and were forced to change them in the midst of the crisis have suffered the greatest macroeconomic and financial turbulence. Overall, the potential of monetary policy as a response to the oil price shock seems to be limited, and the burden falls more on fiscal and structural policies.

The next panellist highlighted that a majority of the world's countries are net commodity exporters. For a sample of eleven commodity exporters the panellist documented a positive relationship between the share of commodities in exports and exchange rate volatility. To assess whether this correlation is spurious or whether commodity exports play a distinctive role, one needs to pin down the specific commodities exported. While there has been considerable co-movement in commodity prices over the last decade, there are also important instances of divergence. This might denote the presence of supply and demand factors specific to certain commodities. For example, a distinction should be made between oil and copper. While the demand for copper is highly dependent on China, the demand for oil is much more spread across the world.

A commodity export price index (CXPI) based on 83 commodity groups shows a high daily volatility of commodity prices. The volatility of the country-specific CXPI indices shows that there have been daily variations in excess of five percentage

points for all eleven countries in the sample. The analysis shows that the countries with a more diversified commodity base have a less volatile CXPI. A regression analysis suggests that high-frequency movements in commodity prices can influence the exchange rate. For all countries the CXPI is highly correlated with the global risk-adjusted exchange rate even at daily frequency. Exchange rate fluctuations, in turn, can affect output growth and other macroeconomic factors, particularly if commodities represent a large share of total exports. Potentially, there can be amplifying feedback loops. For small commodity exporters, higher commodity prices lead to an appreciation of the currency and possibly a boost in credit due to a loosening of the value-at-risk constraints faced by global banks. Looser constraints boost the credit supply to the country, which raises output and feeds into a new round of currency appreciation. While this feedback loop does not seem to be strong for advanced economies, it appears to play a role for emerging markets, especially for those that are not well financially integrated. It is thus important to understand the links between currency appreciation and credit easing in different countries. Pairwise correlations suggest that the CXPI is linked to major macroeconomic indicators: a higher CXPI is associated with higher output, currency appreciation and lower real and nominal interest rates. All of these tend to translate into the expansion of credit. Additional potential mechanisms contributing to the nexus between currency appreciation and credit expansion are the currency risk-taking channel, the effects of debt securities issued by emerging market corporates, and inflows that lead to sterilised foreign exchange purchases by central banks.

Overall, exchange rate flexibility raises robustness to shocks. Since commodity export prices have a first-order effect on the exchange rate, it is crucial to understand the impact of exchange rate fluctuations on credit growth. In light of the fact that credit can amplify shocks originating from the real sector, effective macroprudential policies should be put in place to prevent excessive leverage. This is particularly important in commodity-exporting emerging markets. In addition, foreign exchange reserves could be used to counter the effects of commodity price shocks and reduce volatility. Finally, gross positions of residents could potentially play a stabilising role.

Another panellist drew on case studies of a country's experience of adjusting to the oil price collapse. As background the panellist stressed the important economic role of oil in the country, as development of extraction was a major factor for growth between 2004 and 2014. A tenfold increase in oil exports led to a large current account surplus and sustained a substantial increase in the government's budget. Oil revenues led to a substantial increase in living standards through employment and social benefits. The boost in domestic demand also led to a large growth in the non-oil economy. Growth was however concentrated in the non-tradables sector, as the non-oil tradables sector suffered from a loss in competitiveness due to the appreciation of the currency.

Since 2015, the economy has been adversely affected by the sharp decline in oil prices and the devaluation of its trading partners' currencies against the dollar, which translated into a 60 per cent appreciation of the currency against the country's major

trading partners. Lower oil prices led to a rapid fall in the current account surplus. Large foreign exchange reserves allowed fiscal expenditures to be sustained and a fixed exchange rate with the dollar to be maintained however. Since the oil price shock is likely to be of a permanent nature, the government recognises the need for diversification of the non-oil sector.

The macroeconomic adjustment to the low oil price environment led to a shift to a managed floating exchange rate regime through a two-step devaluation. The reduction of oil revenues also translated into a tightening of fiscal revenue and a reduction in investment expenditure. Medium term fiscal consolidation is planned to contain the fiscal deficit in a recessionary environment. The move to a flexible exchange rate has seen a weakening of the currency, which could lead to a pickup in deposit dollarisation, raising financial stability concerns over banks' and private sector balance sheets. It also put upward pressure on inflation.

In the medium term, macroeconomic policies are to be aligned with the new environment. Increasing risks and persistent exchange rate pressures could require additional adjustment of the fiscal deficit, as well as a tightening of monetary policy to counter inflationary pressures. Structural reforms are also to be undertaken to foster private sector-led growth and strengthen policy frameworks, including handling the issues of weak banks and reinforcing the macroprudential framework and the financial safety net.

The fourth panellist focused on the macroeconomic impact of the 2014 oil price shock on a small, open economy. During the previous years, domestic demand growth had been strong, exceeding GDP growth and leading to a widening current account deficit as the real exchange rate was overvalued. The underlying disequilibrium in the current account was particularly large for the non-oil sector. Moreover, the fiscal situation showed a growing imbalance when oil revenues were subtracted from the observed figures. By the outset of the 2014 price shock, commodities, and especially oil, represented the bulk of the country's exports, a large source of GDP growth, and a large source of fiscal revenues, while a large share of capital flows went to the oil sector.

Falling commodity prices led to a sharp slowdown of growth. The current account deficit deteriorated substantially, whereby additional negative effects originated from major trade partners, which were also oil exporters. Both the nominal and the real exchange rate depreciated sharply and inflation rose above target.

To evaluate the macroeconomic impact of the oil shock on the economy, the panellist built, identified and estimated a structural VAR. It indicates that oil price shocks lead to increases in growth, in inflation because of the positive impact of the terms of trade on domestic demand, and in the interest rate, and to an exchange rate appreciation. Historical decompositions indicate that movements in the oil price play an important role for fluctuations in the exchange rate, inflation and the interest rate.

The last panellist discussed the impact of the commodity price through both commodity imports and exports, focusing on a

country where the effect through imports prevailed. Lower commodity prices have reduced import prices and resulted in disinflationary pressures. Oil and oil products matter for inflation as they are among the most volatile subgroups of the CPI. While the elasticity of inflation to oil has declined over time, its weight in the CPI basket has increased. Overall, a one percentage point change in the price of oil and oil products is estimated to contribute 0.6 percentage points to inflation. An econometric analysis indicates that commodity prices impact inflation with a time lag of one quarter.

Several studies analyse how international commodity price shocks are transmitted to the local economy. There appears to be a strong link between import prices and producer prices. The effect is asymmetric, as price increases are transmitted faster and more strongly to producer prices than are price decreases. This can be explained by the importance of oil prices in the economy and by the importance of oil imports for government revenues. Specifically, tax collection from oil imports is high during periods of high oil prices. When prices drop, the tax rate is adjusted to stabilise the overall tax receipts from oil at a constant level, which prevents the price including tax from falling.

In addition, the transmission of foreign prices is stronger to imports than to exports. Recently, effects on commodity exports have become more visible as the share of minerals, oil and electricity in total exports quadrupled during the commodity price boom. High demand for commodity extraction has promoted foreign direct investment. This pattern has reversed with the fall in commodity prices. Overall, the impact of commodity prices on exports exposes the economy to foreign macroeconomic conditions and raises new challenges for monetary policy.

General Discussion

With respect to the international transmission of commodity price shocks, a participant observed that the ownership structure of commodity firms might play a role. Presumably, shocks are transmitted differently by state-owned and private firms. In addition, domestic firms might pass on shocks in a manner different to that observed at foreign affiliates.

One participant wondered about the benefits of a flexible exchange rate regime during a commodity price shock. Another participant was puzzled by the fact that some countries recorded low inflation or even disinflation in spite of currency depreciation.

A participant asked about the importance of the linkage between the oil sector and other sectors in the economy, as well as between the oil sector and the government's budget. Another participant highlighted that for small, open economies, linkages between the non-oil sector and other sectors are limited. Yet, for some countries, spillovers to the non-oil sector are important when, for instance, local firms are involved in commodity extraction.

Another participant noted that the allocation of the oil rents to different levels of the government might result in suboptimal behaviour in the context of commodity price swings. The structure of the government is thus a factor that needs to be taken into account when the transmission of oil price shocks to the economy is analysed.

Replies from the Panellists

In response to the remark on international shock transmission, a panellist agreed that the ownership structure of commodity firms matters. Sovereign wealth funds, for example, are easier to set up when oil rents are in the hands of the government. When commodity firms are privately owned, foreign exchange reserves play the role that the sovereign wealth fund would have occupied otherwise. Another panellist added that there is some evidence that market structure is an additional factor that has an impact on the transmission of oil shocks.

Concerning the benefits of a flexible exchange rate regime, one panellist explained that a flexible exchange rate facilitates current account adjustment. This adjustment, however, comes at the cost of higher inflation. Another panellist noted that countries that simultaneously experienced currency depreciation and low inflation might have implemented compensating measures or benefitted from increasing domestic money demand.

With respect to the linkage between the oil sector and the budget, a panellist remarked that governments can either decrease expenditure or increase the tax burden on the non-oil sector in response to a negative oil price shock. Another panellist added that it is easier to cut investment expenditure than current expenditure but that such a move comes at the expense of lower growth in the future. One panellist explained that the linkage depends on the size of the oil sector in the economy and the sector's role in financing the balance of payments. Another panellist mentioned that the transmission of the oil shock depends on the structure of the fiscal budget. If oil rents are spent on productivity growth in other, non-oil sectors, these are not strongly affected by a negative oil price shock. This is why the structure of fiscal policy and the institutional framework are crucial.

With respect to the discussion on the suboptimal government behaviour resulting from the distribution of resources across different levels of government, a panellist noted that there might be a role for coordination. Whereas one level of government might implement countercyclical policies, another level might act in a procyclical way and the two might thus offset each other.

4.3 Panel 3
MONETARY POLICY RESPONSES

Chair
CÉDRIC TILLE
The Graduate Institute, Geneva

— "Monetary Policy Responses", Panel 3, in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 41–45.

Presentations by the Panellists

The first panellist discussed monetary policy responses over different time horizons. In the short-run, independent monetary policy could address issues arising from the linkage between the oil sector and the non-oil sector and thereby stabilise output. This, however, potentially calls for a flexible inflation target. Thus, in countries where inflation expectations are well anchored, adopting a flexible exchange rate regime is appropriate as it allows for instantaneous adjustment of the nominal exchange rate in response to a commodity price shock. In practice, however, many commodity exporters are pegging to the currencies of their main trading partners or have adopted a managed float. This can be explained by the fact that a fixed exchange rate regime limits fluctuations in the price of imported goods, and thus inflation. It also addresses other issues, such as currency mismatches. This strategy entails important risks, however. If countries run pervasive external deficits that often stem from internal deficits—so called twin deficits—they expose themselves to disorderly adjustments. Hence, while a fixed exchange rate regime addresses currency risk and helps to build credibility, it requires the discipline not to run a twin deficit.

While monetary policy can stabilise the economy in the short-run, there is a possibility that it could eventually run against credit cycles and asset price booms and busts. Therefore, fiscal rules and credit rules in the form of macroprudential policies are needed to stabilise the economy in the medium-run. A coherent set of prudential tools can be used to avoid systemic risk, given concentration of wealth in one sector. Examples of such tools include capital buffers and risk-based supervision, time varying loan-to-deposit and loan-to-value ratios and sectoral exposure limits. In addition, coordination between fiscal and monetary policies is of paramount importance, especially for commodity exporters.

Finally, in the long-run the energy sector will be transformed. Important climate agreements have been adopted, such as that reached at COP21. This, along with rapid technological innovation, will lead the energy transition away from fossil fuels, implying that large amounts of reserves will stay unexploited. There is thus a potential risk of stranded assets and capital. This might be disruptive for economies that produce and export fossil fuels and result in financial stability risks. Monetary policy needs to reflect on and communicate such challenges and advocate the adoption of appropriate structural policies with which to diversify the economy.

The next panellist discussed the macroeconomic policy response to shocks in recent years, and focused on four points. First, the panellist described the shocks and their effects on the economy. Before the shock the economy experienced growing excess demand but inflation remained on target. The balance of payments was heavily dependent on oil, directly through oil exports, indirectly through non-commodity exports to oil-dependent trading partners, and finally through foreign direct investment in the oil sector. Moreover, public finances were highly dependent on oil exports. The economy was subsequently hit by a combination of three shocks: the oil price drop, monetary policy tightening in the US, which led to an increase in the sovereign risk premium, and severe droughts. The first two shocks are considered long-lasting whereas the last shock is thought to be of a transitory nature. These shocks led to a deterioration of the terms of trade, an increased fiscal deficit, a widening current account deficit, a strong depreciation of the local currency, a large increase in inflation and a slowdown of growth.

Second, the policy response treated the lower oil price as a permanent feature. Hence, policy should react to a persistent fall in national income. This calls for a reduction in expenditure to limit risks to fiscal and external stability, and thus a slowdown in growth is to be expected. As the shocks occurred during a time of excess demand, this deceleration could be large, and thus the practical scope for countercyclical policies is limited. Finally, the adjustment to the persistent oil shock includes a sectoral reallocation of production and expenditures, which will be facilitated by higher relative prices for tradable goods through a real depreciation.

Third, the fiscal policy response consisted of smoothing the adjustment of public finances to the oil shock and allowing for an increase in public debt. Additional measures have been taken to absorb the shock through a tax reform and a reduction in government

expenditure. The tax reform was especially burdensome on businesses. The adjustment in primary government expenditure focused on investment. Given the persistent nature of the shock, a permanent fiscal adjustment is required, and there are plans for a more structural tax reform.

Finally, the immediate response of the central bank focused on ensuring that inflation converged to target, preventing the second round effects of the shock on inflation. The difficulty lies in determining the size and persistence of these second round effects. Another challenge is that while the central bank recognised the need for a growth slowdown to restore external balances, it has to avoid an *unwarranted* slowdown. By the third quarter of 2015 the behaviour of the economy indicated that the balance of risks was tilting towards long-lasting deviations of inflation from target and un-anchoring inflation expectations. Hence, a tightening cycle was undertaken. Furthermore, the central bank has allowed ample exchange rate flexibility as a way of facilitating external adjustment.

Another panellist shared the experience of an economy that is a multi-commodity exporter and therefore less dependent on oil than certain other economies. This is a relatively favourable situation as not all commodities' prices are highly correlated. Nonetheless, the slowdown in the global economy has affected the country through a deterioration in the terms of trade and lower external demand for commodity exports. The growth slowdown in China has been particularly important. It has been one of the major drivers of the fall in the terms of trade, which are highly concentrated in mineral prices. The worsening of the terms of trade is, in turn, highly correlated with domestic output growth, with a 10 per cent drop in the terms of trade estimated to trigger an output fall of 1 per cent after one year. This can mainly be explained by a reduction in investment in the mining sector. This decline in the terms of trade has been persistent, and the economy thus faces a classical external shock that affects the output gap.

Moreover, the strengthening of the depreciation of the currency against the dollar has impacted inflation dynamics. Due to high dollarisation, the exchange rate pass through is relatively strong. As a result, inflation expectations have moved outside the inflation-targeting range. To keep inflation expectations anchored, the central bank has responded by raising the interest rate despite the negative output gap. This has led to a reduction of inflation expectations to a level within the targeting range. A supporting factor was the reversal of depreciation expectations, which was reflected in a net supply of dollars from non-resident agents and local pension funds. The central bank intervened in the foreign exchange market mainly through the unwinding of its swaps and certificates of deposits. These interventions have helped reduce volatility and facilitated the adjustment of the real sector.

The reduction of commodity prices has weighed on government revenues and raised the fiscal deficit. Public debt remains low in spite of the recent reversal in its downward trend. The net debt-to-GDP ratio is relatively low as the treasury has accumulated deposits with the central bank that can be used for the implementation of countercyclical fiscal policy. This is expected

to lead to a reduction in inflation and an increase in economic growth.

General Discussion

The first remark was about drawing lessons from the literature on the management of capital inflows for commodity prices, which recommends taxation on inflows and borrowings in good times. Similarly, a government may want to tax exporters during booms to build up reserves that can be relied on during busts.

One participant mentioned the contrast between the saving patterns of different governments during booms. In good times some invest more while others invest less. A government's inability to invest in stabilisation or sovereign wealth funds during boom times might stem from the problem of a weak central government and a strong provincial government, particularly if the latter captures a majority of the oil revenues. Therefore, one should focus on fiscal reforms, instead of relying solely on monetary policy, which cannot be expected to deal with current account challenges. Fiscal reforms might also be beneficial for maintaining stability in the external sector, and especially for keeping sovereign spreads under control.

One of the panellists had commented that the government's response to the positive price shocks might not have been the most optimal since it had not saved adequately. This led one of the audience members to wonder whether monetary policy would have taken another direction had the fiscal adjustment during the boom been larger. In other words, the participant wondered whether the central bank had worked on quantifying the inefficiency of deviating from a possible optimal fiscal policy mix.

The next question was on the intervention of central banks in currency markets. The participant wondered about the objectives of central bank intervention and about which factors justify the use of this tool in some countries but not in others. Another participant asked whether intervention via foreign exchange swaps is undertaken to provide liquidity on the domestic interbank market, to smooth exchange rates, to increase revenues or to meet some other objective.

Replies from the Panellists

Concerning the comment regarding a commodities export tax during good times, one panellist responded using the example of the mining sector in the panellist's country. When company profits increase beyond a threshold, the authorities impose an additional 'windfall' tax that works as a buffer for bad times. The tax is proportional to profits and is therefore a better system as compared to a fixed tax. Another panellist mentioned that in this panellist's country most of the oil-related income accrues directly to the government, either through dividends from public oil companies or through taxes on multinationals. In this case, the stabilising charge takes the form of the savings decisions taken by the public sector; that is, those made through fiscal policy. The buffer can also be used to stabilise quantities rather than government revenues.

On the difference between savings patterns across countries during the boom, a panellist agreed that countries might now face problems due to insufficiently high savings during periods of high oil prices. This has been apparent as the credit default swap spreads rose disproportionately in response to monetary policy tightening by the Federal Reserve, which was the case in the country of one of the panellists. Regarding the distribution of oil revenues, the panellist added that a change to the Constitution has ensured that royalties are distributed to all regions in the country and not just the commodity-producing ones. As part of the same reform, the government set up a sovereign wealth fund aimed at saving a part of the royalties. The panellist clarified that the central bank has no current account deficit target, but since the country as a whole is facing a risk on external sustainability, monetary policy has been used to contain inflation risks and domestic expenditure simultaneously in recent years. There have been calls for more reliance on fiscal policy, since it may be better suit to deal with a large current account deficit caused by a persistent deterioration of national income.

Concerning the question about quantifying the inefficiency of deviation from an optimal policy mix during a boom, one panellist answered that these calculations have not been made. However, one option is to compare current account deficits between two countries and using this to back out the exchange rate that an optimal boom-time policy mix would have resulted in.

With respect to the question on central banks' intervention in foreign exchange markets, a panellist said that the central bank in that panellist's country has a rules-based way of thinking about intervention. The central bank intervenes when there is a short-term currency misalignment or a bout of illiquidity that may spike asset prices, or to keep international reserves at some 'minimum level'. Another panellist gave the example of the release of inflation data in the US. In some instances, currencies in emerging markets fluctuate considerably in response to such data, particularly if the release deviates from the consensus forecast. Central banks intervene to make sure that there is not much surprise volatility in the market. The previous panellist then replied that that is the reason a country has derivatives markets, to manage volatility. Short-term volatility is not necessarily bad, unless the financial system is dollarised, as it reduces pass through from the exchange rate to prices. The first panellist added that another reason to intervene is reserve accumulation. For commodity exporters that are dollarised, reserves are an important buffer to counter the cyclical component of commodity prices. The panellist also clarified that foreign exchange swaps are not a means of accumulating reserves. Given that there is no private derivative market in the economy, the central bank provides swaps.

5. Poster Session

5.1 COMMODITY PRICE BELIEFS, FINANCIAL FRICTIONS AND BUSINESS CYCLES

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— Bejarano, J., Hamann, F., Mendoza, E. G. and Rodríguez, D., "Commodity Price Beliefs, Financial Frictions and Business Cycles", in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 47–52.

Large international commodity price swings have been a source of instability in the global economy. In particular, commodity exporters have been shown to be vulnerable to commodity price cycles. Such economies enjoy the gains from the run-up and remain apparently strong during the good times but suffer and appear weak with the ensuing falls. How do commodity exporters react to changes in commodity prices? The conventional answer is that this depends on whether commodity price changes are known to be transitory or permanent. There is some degree of consensus that long-lasting changes in global conditions pose a different challenge for small, open and commodity-dependent economies. Persistent changes in oil prices tend to affect permanent income more than do short-lived ones, with potential effects on aggregate consumption and savings decisions, and have implications for resource allocations between tradable and non-tradable sectors, which show up in the real exchange rate, real wages and the country's net foreign asset (NFA) position in the long term. These long-lasting changes may have different macroeconomic consequences than do temporary shocks.

However, accurately identifying whether commodity price changes will be temporary or permanent is difficult in practice and agents have to learn over time. For instance, when oil prices collapsed in the second half of 2014, after five years of staying at historically high levels, some expected this change to last a few quarters (as it did in the previous collapse in 2008) while others expected a decade of low oil prices. These discrepancies highlight the uncertainty surrounding the persistence of commodity prices. In commodity exporting economies, an uncertain duration of commodity price shifts implies an uncertain duration of the good or the bad times. During the high price phase, optimism about the duration of the good times stimulates spending, widens the current account deficit (CAD) and increases net external indebtedness. Higher indebtedness becomes a key risk factor in the presence of borrowing constraints on foreign financing. Overconfidence about the duration of the good times leads to over-borrowing and increases the risk of a sharp macroeconomic adjustment.

The literature has documented that commodity exporters have experienced credit booms and busts that have been commonly associated with changes in the international environment, especially in commodity prices. For instance, many of the countries that enjoyed higher commodity prices increased national income, creating a surge in demand for tradable and non-tradable goods, inducing a real exchange rate appreciation and a shift of economic resources from the tradable sector to the non-tradable sector. Overall economic activity and demand booms move in tandem with asset prices. However, sharp commodity price reversals truncate this process and a reallocation of resources happens together with a collapse in asset prices and the currency (e.g. Chile, Colombia, Ecuador, Peru, Russia and Venezuela). Mendoza and Terrones (2012) document more systematically this boom–bust cycle. They find that 35 per cent of the credit booms observed in the 1960–2010 period across developed and emerging economies occurred after surges in capital flows, which are commonly driven by high commodity prices.

We conduct a quantitative assessment of the impact of commodity price fluctuations in a small, open and commodity-exporting economy. We proceed in two stages. In the first stage we present the model under rational expectations and perfect information. The use of these families of quantitative models in the international economic literature has its roots in Mendoza (1991) and is related to the emerging market business cycles literature including Mendoza (1995), Neumeyer and Perri (2005), Uribe and Yue (2006), Aguiar and Gopinath (2007) and Garcia-Cicco et al. (2010), among others. The dynamics of real exchange rate adjustment has been quantified in Mendoza and Uribe (2000). More recently, macroeconomic interaction with financial frictions has been investigated in Mendoza (2006) and Mendoza (2010). The main insights and lessons of this strand of the literature have been reviewed in Korinek and Mendoza (2014).

The rational expectations–perfect information set-up allows us to understand the basic mechanisms at work. Since commodity price changes bring about changes in the terms of trade, GDP and the associated equilibrium adjustment of the real exchange rate, this economy shares some features with those in which agents can borrow and lend in order to smooth random fluctuations in income. Differences between interest and discount rates and precautionary saving motives drive the determination of net foreign assets in the long run. However, we complement this framework by introducing a resource-extracting sector into the model. Unlike

the majority of models in the literature, resource extraction responds to economic incentives and the determination of natural wealth also plays a fundamental role in consumption and saving decisions. We model the resource sector as a dynamic optimal extracting problem as in Sickles (2001) and Pesaran (1990). The economy owns a natural resource and extracts the optimal portion of it to sell it in international, competitive commodity markets. Thus, optimal extraction rules depend on the stock of reserves of the natural resource, commodity prices, interest rates and the current and future marginal costs and the revenues gained from extraction. We calibrate this model to the Colombian data, taking oil as the natural resource for extraction.

In the second stage, we introduce imperfect information and learning. Following Boz and Mendoza (2014) we propose a model in which the true persistence of commodity prices can only be discovered with time, and this learning process interacts with an international borrowing constraint that limits the economy's external debt such that it does not exceed a fraction of GDP. The commodity price process is modelled as a two-state Markov chain: high price and low price. Agents in this small, open economy know that one of these two regimes can materialize in any given period: one in which high prices continue and one in which the price is lower. We assume that agents do not know the true probability of this new, lower-price regime, because they lack data with which to estimate accurately the switching probabilities across the two regimes (i.e. true commodity price persistence). We also assume that agents learn over time as they observe price realizations (Bayesian learning), and in the long-run their beliefs eventually converge to the true probabilities of the Markov chain. As in Boz and Mendoza (2014), in the long-run the model converges to the rational expectations–perfect information (REPI) solution. However, in the short-run optimal allocations deviate from the REPI equilibrium, because agents' beliefs that differ from those of the REPI solution lead to a misapprehension of the macroeconomic consequences of commodity price fluctuations. Here, since international financial markets are incomplete, this misappreciation leads to less precautionary saving with respect to the one that would be observed in the RE allocation, in the short-run. As a result, the small, open economy over-borrows in the short-run (with respect to the REPI allocation).

Our quantitative analysis points to two main findings about the long-run adjustment of a small, open economy in response to changes in international commodity prices. First, the natural response to high prices is to increase extraction and reduce the reserves of the commodity. The opposite happens during low prices. Thus, natural wealth matters for the determination of NFA in the short-run and in the long-run. The adjustment of a naturally rich economy to terms of trade shocks is different to that of an endowment economy, where the stock of the natural resource is irrelevant by assumption. Precautionary savings coupled with incomplete financial markets imply that uncertainty in the resource sector translates into the income uncertainty of the private agents, affecting their motives to spend, save and borrow, but also determining wealth in the long run. Moreover, the aggregate consequences of commodity price swings translate into domestic prices, like the price of non-tradable goods (the real exchange rate). In the presence of financial frictions, such as constraints on foreign borrowing, these swings relax or tighten the agents' ability to borrow abroad through different channels. Therefore, the share of the resource sector in the economy is important.

Second, the introduction of uncertainty with regard to the true persistence of commodity price fluctuations shows that the process of learning in the presence of foreign borrowing constraints leads to a period of booming activity, followed by a sharp, sudden collapse of consumption and a hike of the exchange rate. We conduct an experiment in this economy subject to informational and financial frictions, calibrated to Colombian data and taking the oil sector as the resource sector, in which we date the start of the high oil price regime in 2009Q2 and the beginning of the oil price reversal in 2014Q3. Hence, we assume that the economy experienced the high oil price regime during five years, followed by a switch to the low oil price regime in 2014Q2. We evaluate the quantitative predictions of the calibrated model. Here, however, we focus exclusively on the role of commodity prices affecting the economy's ability to borrow in an environment with imperfect information and incomplete and imperfect financial markets, because we aim to show how these frictions alone cause a sharp boom–bust business cycle in an oil exporting economy.

Also, at the core of the adjustment mechanism lies the external borrowing constraint that the economy faces in international financial markets. The presence of the borrowing constraint introduces a Fisherian amplification mechanism that interacts with the learning mechanism and the precautionary savings motive. For instance, a change in the commodity price regime from high to low has the direct effect of tightening the borrowing constraint because it reduces real GDP (in units of tradables) via the relative price of the commodity in units of the tradable goods. This financial amplification mechanism gets amplified even further due to the presence of learning. Periods of optimism about the persistence of the high price regime induce under-extraction of the commodity, over-consumption, over-borrowing and an overvalued real exchange rate (relative to the rational expectations–perfect information case), while the opposite happens during periods of pessimism; see figure 1. Yet the precautionary savings forces at work in these economies make sudden stops unlikely events because households in the commodity-exporting economy self-insure against them by maintaining lower levels of indebtedness in the long run.

We model learning following the approach proposed by Cogley and Sargent (2008) and applied to the 2008 US financial crisis by Boz and Mendoza (2014). The present paper primarily contributes to the strand of the literature in international macroeconomics that aims to explain the documented boom–bust pattern of business cycles in emerging economies. Our work is also closely related to Boz (2009) and Boz, Daude and Durdu (2011). These models explore the role of optimism in explaining key business cycle differences between emerging and developed economies. They highlight that uncertainty regarding the duration of structural breaks explains these differences. Boz (2009) models these changes in structural breaks by introducing a learning problem regarding persistent productivity shocks while Boz, Daude and Durdu (2011) does so by learning to decompose total factor productivity (TFP) into trend and cycle.

We provide an alternative explanation that also accounts for the observed relationship between commodity price fluctuations and the business cycle in commodity exporting economies. In this paper, our focus is not exogenous shifts in TFP but changes in commodity prices. Underappreciating the true process of commodity prices is natural given the lack of

data on the duration of the high/low price regimes, as well as the lack of knowledge about the true factors behind commodity price fundamentals. Natural resources are known to be affected by political instability, changes in their market structure, structural changes in the technology used to exploit them and shifts in global demand, among other factors. As a result, discovering the true process of commodity prices is a work in progress, as the academic debate around the true nature of oil price swings illustrates—see Hamilton (2003); Kilian (2009); and Kilian, Rebucci and Spatafora (2009), among others.

It is thus a natural extension to think that, with time, agents learn about the true process of commodity prices. Fornero, Kirchner and Yany (2015) examine quantitatively the widening of the current account through the lens of a large-scale, small, open economy monetary policy model with a commodity sector and the assumption that agents have imperfect information and learn about the persistence of commodity price shocks. They show that during a persistent copper price increase, agents believe at first that this increase is temporary but eventually revise their expectations upward as they are surprised by higher-than-expected price levels. Investment and production in the commodity sector (and in the overall economy) expands while domestic savings fall, worsening the current account.

Our main contribution is to show that commodity prices and the changes that they induce with regard to the incentives to exploit a natural resource interact with informational and financial frictions in the short and the long-run. As our model features precautionary savings by households, the long-run levels of the economy's assets are determined by the true properties of commodity prices. As time passes, the discovery of this process also determines the short-term dynamics of real and financial assets and the adjustment is very different with respect to the REPI case, because the extraction incentives are substantially different. In the REPI case a high realization of the price is expected to be followed by a lower price in the future, because the true process is mean reverting. Therefore, in a REPI economy extraction tends to be higher in the current period and lower in the future. The extraction pattern is crucially different in an optimistic, Bayesian learning environment (see figure 2). If there is optimism, a high realization of the price is expected to be followed by a high price in the future, because the agents are in the process of learning and remain optimists. Therefore, in a Bayesian learning economy extraction tends to be lower in the current period and higher in the future. The economy borrows more in the Bayesian learning allocation (relative to the REPI) because households are optimistic and the positive price effect (higher international prices) of the commodity revenues dominates the negative quantity effect (less extraction). When a negative realization of the commodity price hits the economy, agents become very pessimistic in the Bayesian learning economy and cut extraction dramatically, more than in the REPI economy, tightening even further the borrowing constraint. This process of over-borrowing (compared to the REPI allocation) puts the economy closer to the international borrowing constraint. So when commodity prices collapse, a sharp macroeconomic adjustment follows, because the constraint becomes suddenly binding not only because of commodity prices, but also because commodity extraction fails and the real exchange rate depreciates. A sharp consumption adjustment follows, reproducing the over-borrowing and the macroeconomic adjustment that follows the business cycles in emerging economies.

Figure 1: Conditional Forecast Functions—Exogenous Revenues Model

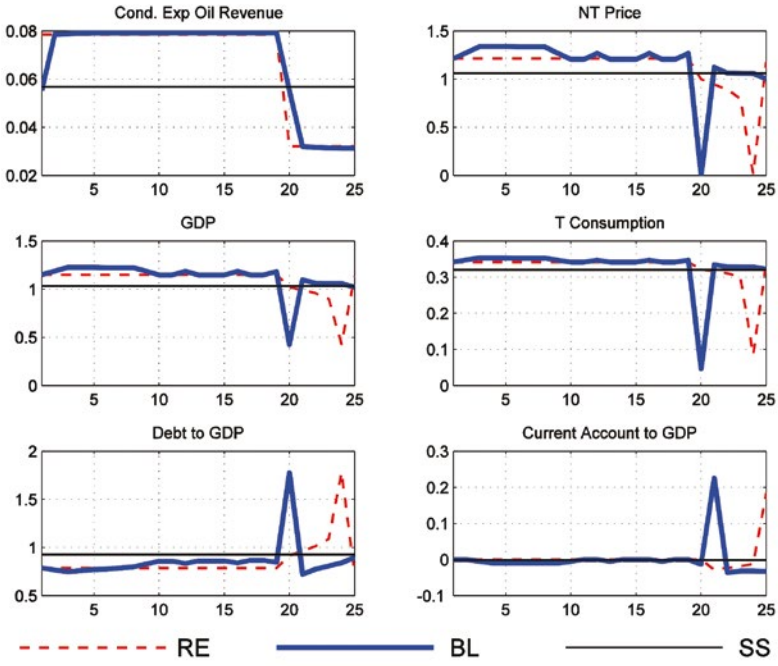
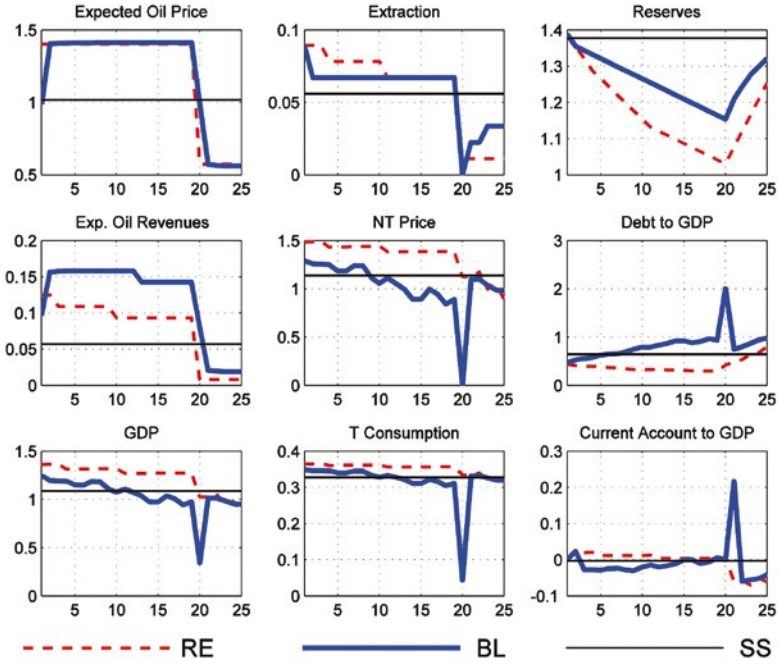
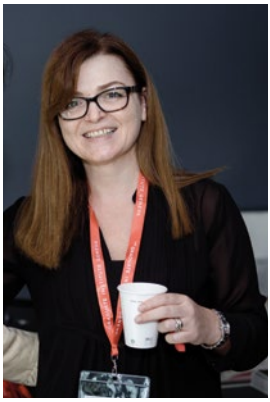


Figure 2: Conditional Forecast Functions—Endogenous Revenues Model



5.2 BANKING SYSTEM CONFIDENCE INDICATORS AND THE REAL ECONOMY: THE CASE OF ALBANIA

LINDITA VRIONI AND ESIDA ABAZAJ



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— Vrioni, L. and Abazaj, E., "Banking System Confidence Indicators and The Real Economy: The Case of Albania", in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 53–58.

Introduction

In conducting its monetary policy, the Bank of Albania (BoA) considers not only quantitative but also qualitative information about current economic conditions, such as surveys. The measurements obtained from these surveys help to shape the bank's decision-making by providing reliable, accurate and timely statistics on market expectations and public confidence, thus addressing the informational gap caused by the delay in the availability of official data and the inaccuracy of preliminary data.

Since 2006, the Bank of Albania has conducted a quarterly survey in order to assess commercial banks' perceptions and expectations regarding banking activity. There are different reasons why a central bank is interested in information obtained from banks' experts regarding current and expected banking activity. First, these expectations enable central banks' economists and forecasters to cross-check their own macroeconomic and financial projections, given that commercial banks' experts may possess valuable information that might not yet be reflected in aggregate economic variables.

Second, the CEOs of banks have the will and the power to take decisions on future banking activity, based on their judgments with regard to current conditions and their expectations with regard to future developments. In this way, they provide insights into future banking activity.

There has been considerable controversy regarding the causality between confidence measures and macroeconomic variables. At one extreme, confidence measures are shown to have both a predictive power and a role in understanding business cycle fluctuations. At the other extreme, some research concludes that the concept of confidence does not play any valuable role. Many economists think that the confidence measure is endogenous and a reflection of current macroeconomic conditions, whereas others argue that psychological factors that are not captured by economic variables can influence confidence measures.

In the case of Albania, there is no previous study that attempts to measure the informational content of the Bank's quarterly surveys. Similarly to the existing literature on the usefulness of confidence surveys in various countries, this study will explore how the banking confidence survey carried out by the Bank of Albania's Research Department performs in signalling future developments in loan growth and various macroeconomic measurements.

Overview of BoA's Survey on the Banking Activity Confidence Index

The questions used in the survey are designed in such a way that the answers are of a qualitative nature. The analysis employed in this paper is based on aggregate answers received from a sample of 16 banks over the period 2006Q1–2015Q2. The response rate of the survey has been 100 per cent for all rounds of interviews. The respondents of the survey (banks' CEOs) are asked to assess the development of their respective bank's activity in the current quarter in comparison with the previous one, and to form expectations for the forthcoming quarter's banking activity compared with the current one.

The survey's questions can be divided into two sets. The first set of questions relates to the assessment of actual developments in the current quarter compared to the previous one, regarding actual activity, number of employees, the amount of net income realised, the credit risk, employees' skills and the actual physical space where banking services occur.

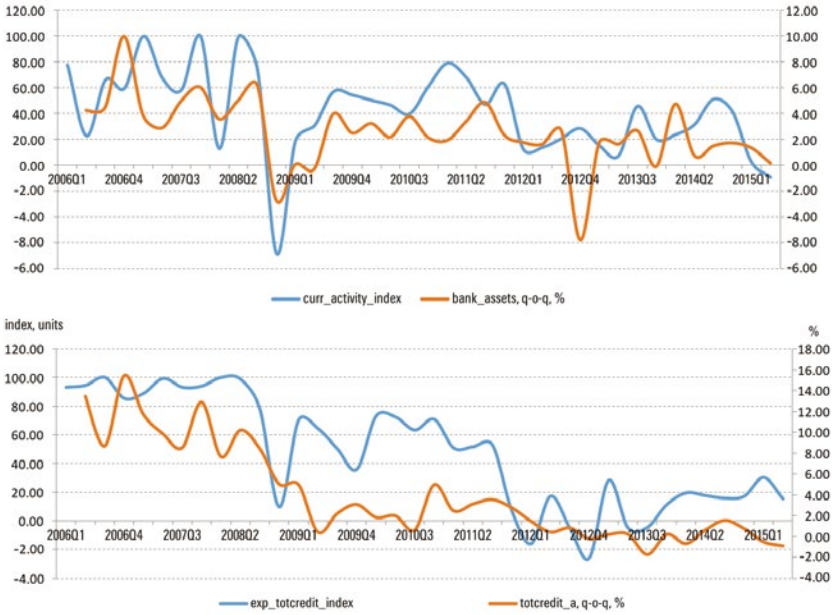
The second set of questions are regarding the evaluation of the expected activity for the next quarter compared to that of the current quarter. In addition to the questions from the first set, the second set comprises questions related to the expected level of a bank's liquidity and capitalisation. The rest of the questions attempt to extract information on banks' perception of expected demand for total credit and its subcategories: credit to businesses (small and medium enterprises (SMEs) and corporations), mortgage credit (issued to businesses or households) and consumers' credit. Lastly, the survey asks the respondents to state their expectations regarding the development of non-performing loans in the forthcoming quarter.

The survey asks participants to note the direction—if any—of changes in their evaluations or expectations, such as 'better', 'worse' or 'remains the same', but not the magnitude of such changes. A confidence index is constructed by calculating the difference between the percentage of positive responses and the percentage of negative responses. The percentage of positive (negative) responses is calculated as the ratio of banks (based on their asset share) that responded positively/negatively to the total number of banks (based on total assets) that participated in the survey, while disregarding the 'neutral' ('remains the same') responses. Accordingly, an increase in the value of the index should be interpreted as an improvement in banks' expectations, and vice versa.

Informational Content of the Banking Sector Survey

In figure 1, below, the graph on the left plots the change in the total assets of the banking system versus the performance of the current banking activity index.

Figure 1: Current Banking Activity Index Versus Quarterly Change in Total Banking Assets (top); Expected Total Credit Demand Index Versus Realised Quarterly Growth Rate of Total Credit (bottom)

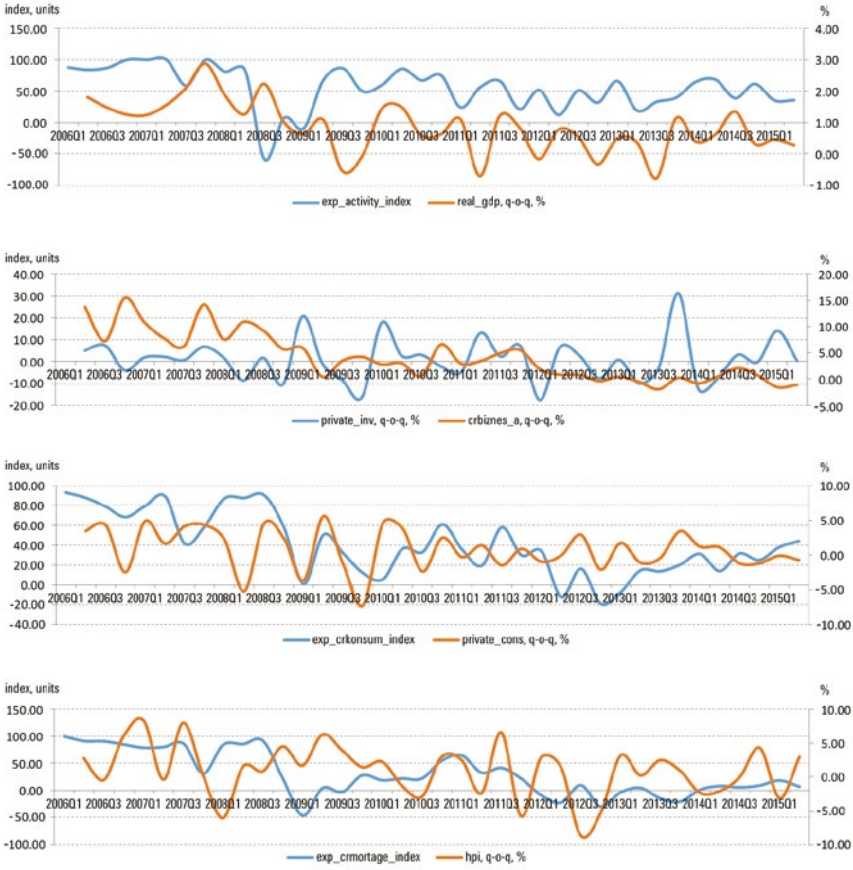


The banking activity confidence index is released three weeks prior to the release of the data on banking activity for the current quarter. A drop in the value of the index during the most recent crisis (2008–12) seems to be associated with a fall in total assets.

The graph on the right plots the expected total credit demand index against the quarterly growth rate of credit. The graph clearly suggests that movements in the index precede those in total credit.

A visual inspection of macroeconomic variables and surveys' indices shows that the expected banking activity index and the expected consumption credit demand index co-move, respectively, with the realised real GDP growth rate and the private consumption growth rate.

Figure 2: Surveys' Indices vs Macroeconomic Variables



Methodological Approach

The study attempts to address two main questions. First, does the survey provide reliable information on the growth of bank lending? Second, does the survey provide predictive information in terms of macroeconomic variables?

The strategy employed is quite straightforward. It consists in a series of causation regressions of the following form:

$$\Delta \log(X) = \alpha_0 + \beta * \text{survey's index}_{t-1} + \Delta \log(X_{t-1}) + \varepsilon_t \quad (1)$$

where X represents either one of the variables characterising the banking system indicators (various types of loans or banks' assets) or one of the macroeconomic variables (real gross domestic product (GDP), private consumption, private investment, retail trade index or house prices index). In a second step, the specification in equation (1) is augmented with a vector of control variables (Z), which will be represented by a measurement of changes in the shape of the yield curve (measured by the difference between the 12-month and the 3-month T-bill rate).

The empirical analysis shows that the qualitative information collected by the banking sector survey is useful in signalling future developments in loan growth (except those in the field of mortgage loans) and some of the main macroeconomic variables (especially private consumption and real GDP). The narrative of the descriptive graphs presented above is confirmed by regression analysis. Results show that survey indices related to the expected demand for loans are statistically significant in their signalling usefulness and carry the correct sign. The expected demand index for consumption loans shows the highest signalling ability: a 10-unit increase in this index would translate to an increase of 0.3 per cent in the loans issued for consumption purposes.

Table 1: Predictive Content of the Survey in Terms of Lending Growth

		α	Expected landing index	Current bank activity index	Expected bank activity index	Tagged value or realised lending growth rate	Adj. R-squared
Dependent variable	Total bank assets (q-o-q, %)	0.004854	-	0.000447***	-	0.044295	0.345275
	Total bank assets (q-o-q, %)	0.002073	-	-	0.000405***	0.011693	0.244391
	Total loans (q-o-q, %)	-0.003532	0.00342**	-	-	0.579200***	0.763838
	Loans to businesses (q-o-q, %)	-0.003549	0.000595***	-	-	0.350637**	0.735557
	Loans for consumption (q-o-q, %)	-0.006654	0.000795***	-	-	0.441767**	0.653824
	Mortgage loans (q-o-q, %)	0.039326***	0.000253**	-	-	-0.284989	0.150883

Note. *denotes significance at the 10% level of confidence, ** denotes significance at the 5% level of confidence and *** denotes significance at the 1% level of confidence.

The model's fit remains the same even when accounting for the control variable. Also, the first three indices from the surveys (the current banking activity index, the expected banking activity index and the expected demand for total credit index) do a good job in signalling future developments in real GDP (table 2). An increase of 10 units in the index of expected demand for total credit translates into an improvement of 0.13 per cent in real GDP.

Table 2: Predictive Content of the Survey in Terms of Macroeconomic Variables

		α	curr_ activity_ index	exp_ activity_ index	exp_ totcredit_ index	exp_ crbiznes_ index	exp_ crkonsum_ index	exp_ crmortgage_ index	lagged value of the dependent variable	Adj. R-squared
Dependent var., q-o-q, %	Real GDP	0.002637	0.000073*	-	-	-	-	-	0.295212*	0.221862
	Real GDP	0.000728	-	0.000089**	-	-	-	-	0.312317**	0.258939
	Real GDP	0.003619*	-	-	-	0.000071	-	-	0.174121	0.203082
	Real GDP	0.002443	-	-	0.000129***	-	-	-	-0.030639	0.355591
	Private cons	-0.003258	-	-	-	-	0.000335**	-	-0.319541*	0.170081
	Private cons	0.005937	-	-	-	0.000067	-	-	-0.281600	0.071226
	Private cons	-0.001665	-	-	0.000236*	-	-	-	-0.292273*	0.153185
	Private inv	0.010055	-	-	-	-0.0000933	-	-	-0.284528	0.081728
	Private inv	0.008541	-	-	-0.0000563	-	-	-	-0.27728	0.080999
	retail_index	0.011348	-	-	-	0.000103	-	-	-0.145078	0.026252
	HPI	0.004355	-	-	-	-	-	0.000179	-0.050052	0.030774

Note. *denotes significance at the 10% level of confidence, ** denotes significance at the 5% level of confidence and *** denotes significance at the 1% level of confidence.

Concluding Remarks

This article has shown that the qualitative information collected by the banking sector survey is useful in signalling future developments in loan growth (except in mortgage loans) and some of the main macroeconomic variables (private consumption and real GDP).

It is important to emphasise that these results should be approached with caution given the short history of the survey, which limited the choice of the empirical approach to be followed. A more rigorous and systematic analysis will be possible as more data are collected. A vector autoregression (VAR) analysis would be more appropriate in addressing the research questions of this study, as it would control for feedback when dealing with confidence indices, as survey respondents might change their expectations regarding future banking activity in response to past or present conditions of the economy. Another approach to tackle the short time span of the survey would be to employ panel data analysis for the 16 commercial banks operating in Albania.

5.3 COMMODITY PRICE FLUCTUATIONS, CORE INFLATION AND POLICY INTEREST RATES

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Central Bank of Colombia

— Gómez-Pineda, J., "Commodity Price Fluctuations, Core Inflation and Policy Interest Rates", in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 59–68.

Introduction

Commodity price fluctuations raise important questions for monetary policy. Should central banks react to consumer price index (CPI) inflation, thus adding variability to the economy? If central banks' target core inflation, what is the effect on core inflation of commodity price fluctuations? How strong are policy reactions to core inflation? What has been the record so far? The paper deals with the answers to the last three questions.

Among the papers dealing with the policy reaction to commodity price fluctuations two stand out. The first is De Gregorio (2012), in which a feedback central bank rule is defined with regards to CPI inflation to help tame the second-round effects of commodity price fluctuations. We, instead, define the feedback rule with regards to core inflation but incorporate the second-round effects as a reduced-form effect of non-core inflation on core inflation. The reason for this is that a central bank's reaction to non-core inflation adds variability to the economy; or, in other words, inflation targeting is the management of aggregate demand, supply-side shocks left aside. My set-up does not necessarily mean that central bank

1 The author thanks Liliana Muñoz for excellent research assistance.

targets should be defined with regards to core inflation. It only means that core inflation can help in the operation of monetary policy, by setting aside the supply shocks that sooner or later should fade away. De Gregorio also finds stronger second-round effects of food price fluctuations, compared to the second-round effect of oil price fluctuations. These results can be easily reconciled with my own, as I incorporate both oil and food commodity price fluctuations weighted by the shares of oil and food in the CPI.

The second paper that deals with the policy reaction to commodity price fluctuations is Gelos and Ustyugova (2012), in which the share of food in the CPI is shown to explain the extent of the effect of non-core inflation on core inflation. Their result is compatible with my definition of non-core inflation and the share of food in the CPI in the countries considered in the present study.

The Model

The model discussed in the paper is a simple but large central bank gap model;[2] it is a variant of the models in Gómez, Guillaume and Tanyeri (2015) (GGT) and Gómez and Julio (2016) (GT).

The model includes five systemic economies and one non-systemic economy: United States, Europe, Japan, China, the United Kingdom and Colombia. The set-up of the model enables us to study the effects of developments in each of the systemic economies on the world economy, on the systemic economies themselves, and on the non-systemic economy, Colombia. This relatively small number of economies accounts for 50 per cent of world output.

The focus of the paper is the transmission from commodity oil and food price fluctuations to country core inflation and the policy response. To this end, I add to the simple gap model a commodity prices channel. The channel has two strands. The first is the effect of oil prices on country energy prices and from country energy prices to country CPI inflation. The second strand is the effect of commodity food prices on country food prices and from country food prices to CPI inflation.

In the following section I describe the model, with a focus on the channels and equations that are relevant for the policy response to commodity price fluctuations. The remainder of the model's equations are described in more detail in GGT.[3]

Commodity Prices and Transmission to Country Inflation

To formalise the first strand of the commodity price channel, let the price of oil $\hat{q}_t^{oil}$ follow supply and demand factors.

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2 A central bank gap model is normally based on two transmission channels—an aggregate demand channel and an exchange rate channel. Besides these standard transmission channels in the small, open economy, the models in GGT and GJ include three global transmission channels: a systemic risk channel, a foreign aggregate demand channel and a foreign exchange rate channel.

3 The remaining equations include stochastic processes for latent prices, the UIP condition for bilateral real exchange rates, and the identities for the nominal and real multilateral exchange rates.

$$\hat{q}_t^{Oil} = \beta_1 \hat{q}_{t-1}^{Oil} + \beta_2 \hat{y}_t^{World} + \varepsilon_t^{\hat{q}^{Oil}} \text{ ①}$$

Supply is given by the error term $\varepsilon_t^{\hat{q}^{Oil}}$, a standard supply shock. Demand is given by the world output gap, $\hat{y}_t^{World}$. The price of oil is defined in real terms as $q_t^{Oil} \equiv p_t^{Oil} - p_t^{US}$ and enters equation ① in deviation form.

The latent price of oil follows

$$\tilde{q}_t^{Oil} = \tilde{q}_{t-1}^{Oil} + \tfrac{1}{4}\gamma_t^{\tilde{q}^{Oil}} + \varepsilon_t^{\tilde{q}^{Oil}} \text{ ②}$$

and

$$\gamma_t^{\tilde{q}^{Oil}} = \beta_3 \gamma_{t-1}^{\tilde{q}^{Oil}} + \varepsilon_t^{\gamma^{\hat{q}^{Oil}}} \text{ ③}$$

In the second strand, food commodity prices also follow supply $\varepsilon_t^{\hat{q}^{Food}}$ and demand $\hat{y}_t^{World}$ factors,

$$\hat{q}_t^{Food} = \beta_4 \hat{q}_{t-1}^{Food} + \beta_5 \hat{y}_t^{World} + \varepsilon_t^{\hat{q}^{Food}} \text{ ④}$$

Latent country energy and food prices follow processes similar to those of equations ② and ③ for the price of oil.

The transmission from the price of oil to domestic energy prices $\hat{q}_t^e$ follows

$$\hat{q}_t^e = \nu_7 \hat{q}_{t-1}^e + \nu_8 \hat{q}_t^{Oil} + \nu_{12} \hat{q}_t + \varepsilon_t^{\hat{q}^e} \text{ ⑤}$$

while the transmission from food commodity prices to country food prices $\hat{q}_t^f$ is given by

$$\hat{q}_t^f = \nu_{13} \hat{q}_{t-1}^f + \nu_5 \hat{q}_t^{Food} + \nu_4 \hat{q}_t + \varepsilon_t^{\hat{q}^f} \text{ ⑥}$$

where $\hat{q}_t$ is the real multilateral exchange rate.

It should be noted that $\hat{q}_t^e$ and $\hat{q}_t^f$ in equations ⑤ and ⑥ are real prices at the country level while $\hat{q}_t^{oil}$ and $\hat{q}_t^{food}$ are real prices at the world level.

As for the effect of these relative prices on inflation, inflation in the energy, food and overall CPI indexes are obtained with the identities

$$\pi_t^e \equiv \pi_t + 4(q_t^e - q_{t-1}^e) \text{ ⑦}$$

$$\pi_t^f \equiv \pi_t + 4(q_t^f - q_{t-1}^f) \text{ ⑧}$$

and

$$\pi_t \equiv \pi_t^c + \nu_f (q_t^f - q_{t-1}^f) + \nu_e (q_t^e - q_{t-1}^e) \text{ ⑨}$$

where π_t is CPI inflation, π_t^c is core inflation, $q_t^e \equiv p_t^e - p_t$ is the country real price of energy, $q_t^f \equiv p_t^f - p_t$ the country real price of food, and ν_f and ν_e are the weights of food and energy in the CPI.[4]

A measure of non-core relative prices is built as an aggregate of domestic energy and food prices relative to the CPI. In deviation form, this aggregate is

$$\hat{q}_t^{NC} = \frac{\nu_e}{1-\nu_x}\hat{q}_t^e + \frac{\nu_f}{1-\nu_x}\hat{q}_t^f \quad ⑩$$

where $\nu_x = 1 - \nu_f - \nu_e$. The first difference of this relative price, a proxy of non-core inflation, is approximately equal to the deviation of CPI inflation from core inflation. It is used here to account for the second-round effects of commodity price fluctuations on core inflation.

To make the second-round effects of commodity prices on core inflation clear, I add my proxy of non-core inflation at the right-hand side of the Phillips curve as follows:

$$\pi_t^c = (1 - \nu_1)\,\pi_{t+1|t} + \nu_1\pi_{t-1}^c + \nu_2\hat{y}_t + \nu_3\hat{q}_t^{RER} + 4\nu_{14}\,(\hat{q}_t^{NC} - \hat{q}_{t-1}^{NC}) + \varepsilon_t^{\pi^C} \quad ⑪$$

where $4(\hat{q}_t^{NC} - \hat{q}_{t-1}^{NC})$ is the first difference of non-core relative prices at an annual rate.

The Policy Rule

The nominal interest rate follows

$$i_t = \delta_1 i_{t-1} + (1 - \delta_1)\left[\bar{r}_t + \pi_{t+1|t}^c + \delta_2\,(\pi_{t+5|t}^c - \bar{\pi}_{t+5|t}) + \delta_3\hat{y}_t\right] + \varepsilon_t^i \quad ⑫$$

where π_t^c is core inflation or inflation excluding food and energy and $\bar{\pi}_t$ is the inflation target.

In the policy rule given by equation ⑫, the central bank reacts to core inflation. It reacts to non-core inflation only indirectly as the Phillips curve incorporates the second-round effects. The central bank does not operate with an eye on CPI inflation; instead it targets core inflation, including the second-round effects, and enables energy and food relative prices to adjust, as relative price changes should sooner or later fade away.

The Real Interest Rate

It is important to devote at least a separate section to the definition of the real interest rate. The definition $r_t \equiv i_t - \pi_t$ uses contemporaneous overall inflation. But a definition that uses expected inflation may better suit forward-looking consumption and investment decisions. In addition, a definition that uses core inflation is a more relevant measure of

[4] Following Caravenciov et al. (2013), an error term, ε_t^π, is added to equation ⑨, $\pi_t = \pi_t^\infty + \nu_f(q_t^f - q_{t-1}^f) + \nu_e(q_t^e - q_{t-1}^e) + \varepsilon_t^\pi$, to account for changes in ν_f and ν_e as the CPI basket changes over time. This error term is not economically meaningful; it merely ensures consistency in equation ⑨.

future inflation, as fluctuations in non-core inflation should sooner or later fade away. Hence, I define the real interest rate as

$$r_t \equiv i_t - \pi^c_{t+1|t} \quad (13)$$

where, again, $\pi^c_{t+1|t}$ is expected core inflation.

A look at equation (13) reveals that, under the hypothetical assumption of no second-round effects, commodity price fluctuations would have no effect on real interest rates.

The Data

Data are quarterly for the period 1996Q1–2016Q2. The source of stock market data is Bloomberg Financial Services. CPI indexes are taken from the World Bank commodity price database. The source of policy interest rate data is country central banks. The sources of country GDP and consumer price data are the OECD database and the country statistics departments.

Model Calibration and Estimation

The model was calibrated taking into account a set of indicators, such as impulse response functions, the evolution of latent variables, equation fit, error decompositions and model forecasting performance. The calibrated parameters appear in table 1. The backward-looking component of the output gap equations σ_2 was set at 0.7 mainly to help convergence in historical error decompositions. The interest rate smoothing parameter δ_3 was set at 0.5 as a compromise between model convergence and interest rate forecast performance. In general, most parameters were calibrated so as to obtain reasonable impulse responses and historical error decompositions.

The estimation dealt with those coefficients most relevant to the issues addressed in the paper. The coefficients related to the first-round effects are ν_5 and ν_8. The one related to the second-round effects is ν_{14}. Finally, the coefficient related to the policy reaction function is δ_2. The prior means of the coefficients found in the calibration of the model. Prior standard deviations were repeatedly reduced in a series of estimations seeking convergence in the likelihood function for each parameter.

The estimated parameters appear in table 2. The estimation of parameters ν_5 and ν_{14} confirms the quality of the calibrated parameters as the difference between the prior and posterior means is below a tenth of the prior mean in most parameters. The estimation of parameters ν_7 and δ_2 shows that the data brings useful information to the model as the differences between prior and posterior modes are large.

Results

The results of the paper deal with the effect of commodity price fluctuations on core inflation and with the policy response. The results are reported in impulse response functions and error decomposition exercises for the world economy (figure 1) and for the country economies (figures 2–5).

The response of core inflation to commodity price fluctuations depends on two factors: first, the transmission from commodity price fluctuations to country non-core inflation—that is to say, on the strength of the first-round effects; second, the transmission from country non-core inflation to country core inflation—that is to say, the extent of the second-round effects. In turn, the extent of the first-round effects depend on three factors: first, the size of the shocks to oil and food commodity prices; second, the response of country energy and food prices to oil and food commodity price fluctuations; and third, the share of energy and food in the CPI.

At the world level, a shock to the price of oil, with a standard deviation of 13.61 per cent, raises core inflation by one tenth of 1 per cent (figure 1, panel A). The rise in core inflation elicits an increase in interest rates by an order of magnitude slightly greater than a tenth of 1 per cent in interest rates (figure 1, panel B).[5] The rise in real interest rates causes a drop in output, of about the same order of magnitude (figure 1, panel C).

A shock to the commodity price of food, with a smaller standard deviation—7.55 per cent, causes responses in core inflation comparable to those of a shock to the price of oil because the share of food in the world CPI is larger. The share of food in the world CPI is 21.5 per cent while the share of energy is 6.9 per cent.[6]

The historical error decomposition exercises show that the second-round effects of commodity price shocks on core inflation followed two cycles (figure 1, panel D). The first cycle took place during the period 2008–09. The upward phase of the first cycle occurred in 2008 when core inflation rose with commodity prices; the downward phase occurred in 2009 when core inflation dropped along with commodity prices. The second cycle covered the period 2010–16. The upward phase of the second cycle occurred during the period 2010–11; the downward phase during the period 2012–16. Core inflation has dropped with commodity prices with particular strength since 2015–16 (figure 1, panel D).

Interest rates faced pressure from commodity prices in the two aforementioned cycles (figure 1, panel E). In particular, central banks have faced strong pressure to lower interest rates since 2015.

World output also has a response to commodity price fluctuations and that response is of a comparable magnitude—about a tenth of 1 per cent for a 10 percentage point change in commodity prices. The output gap responds to commodity price fluctuations through the monetary policy channels—that is to say, because interest rates respond to core inflation.

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5 The estimation of δ_2 is still a work in progress.

6 These are country shares weighted by the share of the respective countries in world GDP, where world GDP is measured as the GDP of the five systemic economies.

Regarding the country economies, the response of core inflation to oil price fluctuations is stronger in the United States, where the country price of energy reacts strongly to the commodity price of oil and the share of food in the CPI is small (figure 2). The policy response to food price fluctuations is stronger in Japan, China and Colombia, with a large share of food in the CPI, as well as in the United Kingdom, with a large response to commodity food prices (figure 2).

The historical error decomposition exercises display the two cycles of the effects of commodity price fluctuations on core inflation across countries. Commodity price shocks have tended to lower core inflation since 2015 in all countries (figure 4).

The policy response to commodity price fluctuations depends on the factors that affect core inflation as well as on the strength of the policy reaction. Given that the estimated policy response to core inflation was similar across countries, the policy response tends to follow the response of core inflation (figure 3).

The historical error decomposition exercises show that commodity price fluctuations have exerted important pressure on interest rate policy in the two previously mentioned cycles of expansion and contraction. The pressure to lower interest rates has been particularly strong since 2015 (figure 5).

Conclusions

The policy response to commodity price fluctuations depends on three factors: the extent of the first round effects, the extent of the second round effects and the strength of the policy response to the second round effects. In turn, the extent of the first round effects depend on three factors: the size of the shocks to oil and food commodity prices, the extent of the effect of commodity price fluctuations on the country's energy and food prices, and the share of energy and food in the CPI.

Shocks to oil prices have effects on core inflation at the world level that are comparable to those of commodity food prices because oil price shocks have a larger variance while food price inflation has a larger share in the CPI.

The second round effects of commodity price shocks on core inflation followed two cycles. The first cycle corresponds to the peak and trough in commodity prices in 2008 and 2009, respectively, before and after the Lehman Brothers bankruptcy. The second cycle started in 2010 and has exerted strong downward pressure on core inflation particularly since 2015.

The policy response to commodity price fluctuations has followed the effect of commodity price fluctuations on core inflation, given the set up of the model. The cycles in commodity prices have exerted pressure on interest rate policy, including particularly strong downward pressure since 2015.

A limitation of the paper is that the response to commodity price fluctuations may depend on the effect of commodity prices on the terms of trade. The systemic economies included in the model are currently oil importers, while the non-systemic economy is an oil exporter. I leave this topic for future research.

Table 1: Some Calibrated Parameters

$\nu_{(2,US)}$	0.100	$\nu_{(3,US)}$	0.027	$\nu_{(4,US)}$	-	$\delta_{(3,US)}$	0.516	β_1	0.500
$\nu_{(2,EU)}$	0.100	$\nu_{(3,EU)}$	0.056	$\nu_{(4,EU)}$	0.039	$\delta_{(3,EU)}$	0.509	β_2	3.000
$\nu_{(2,JA)}$	0.100	$\nu_{(3,JA)}$	0.024	$\nu_{(4,JA)}$	0.037	$\delta_{(3,JA)}$	0.576	β_4	0.700
$\nu_{(2,CH)}$	0.100	$\nu_{(3,CH)}$	0.068	$\nu_{(4,CH)}$	0.038	$\delta_{(3,CH)}$	0.570	β_5	0.500
$\nu_{(2,UK)}$	0.100	$\nu_{(3,UK)}$	0.035	$\nu_{(4,UK)}$	0.038	$\delta_{(3,UK)}$	0.516	δ_1	0.500
$\nu_{(2,CO)}$	0.100	$\nu_{(3,CO)}$	0.049	$\nu_{(4,CO)}$	0.040	$\delta_{(3,CO)}$	0.587		

Table 2: Estimated Parameters

Parameter	Prior mean	Posterior mean
$\nu_{(5,US)}$	0.020	0.019
$\nu_{(5,EU)}$	0.020	0.020
$\nu_{(5,JA)}$	0.050	0.024
$\nu_{(5,CH)}$	0.110	0.107
$\nu_{(5,UK)}$	0.090	0.088
$\nu_{(5,CO)}$	0.005	0.005
$\nu_{(8,US)}$	0.250	0.427
$\nu_{(8,EU)}$	0.120	0.016
$\nu_{(8,JA)}$	0.200	0.204
$\nu_{(8,CH)}$	0.080	0.043
$\nu_{(8,UK)}$	0.110	0.200
$\nu_{(8,CO)}$	0.005	0.005

Parameter	Prior mean	Posterior mean
$\nu_{(14,US)}$	0.020	0.028
$\nu_{(14,EU)}$	0.020	0.020
$\nu_{(14,JA)}$	0.035	0.035
$\nu_{(14,CH)}$	0.045	0.044
$\nu_{(14,UK)}$	0.030	0.029
$\nu_{(14,CO)}$	0.030	0.030
$\delta_{(2,US)}$	1.600	1.748
$\delta_{(2,EU)}$	1.600	0.745
$\delta_{(2,JA)}$	1.600	1.596
$\delta_{(2,CH)}$	1.600	1.952
$\delta_{(2,UK)}$	1.600	1.601
$\delta_{(2,CO)}$	1.600	0.665

Figure 1: World Core Inflation, Interest Rate and Output Gap

Impulse response functions are to a one standard deviation shock; historical error decompositions are in percentage points.

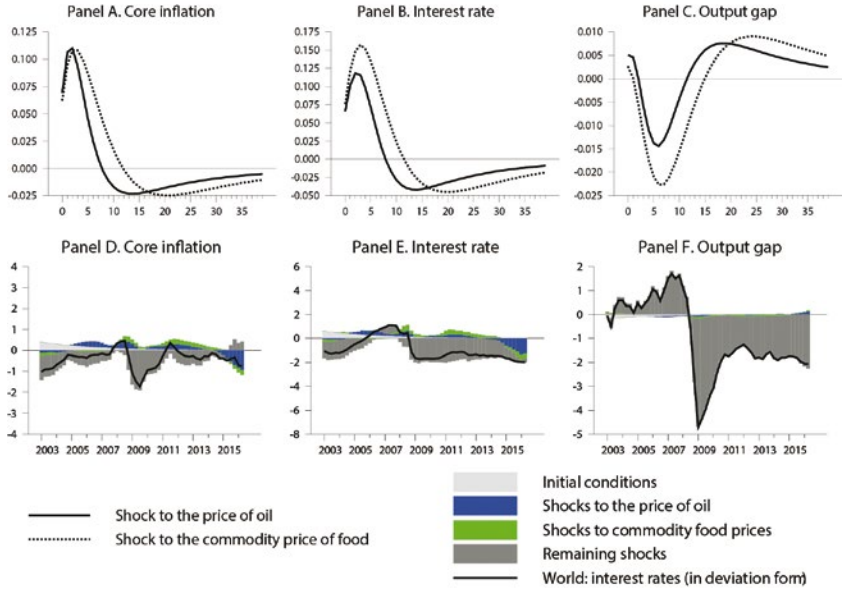


Figure 2: Response of Core Inflation to Fluctuations in Commodity Prices

Response to a one standard deviation shock.

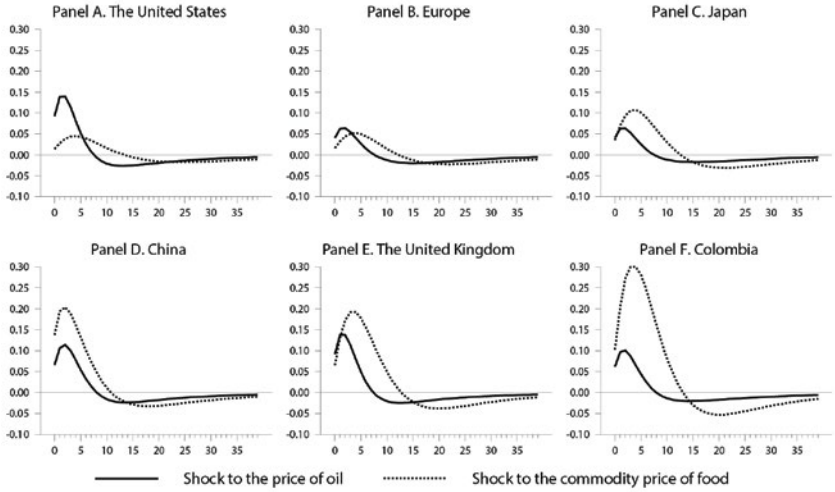


Figure 3: Policy Response to Commodity Price Fluctuations

Response to a one standard deviation shock.

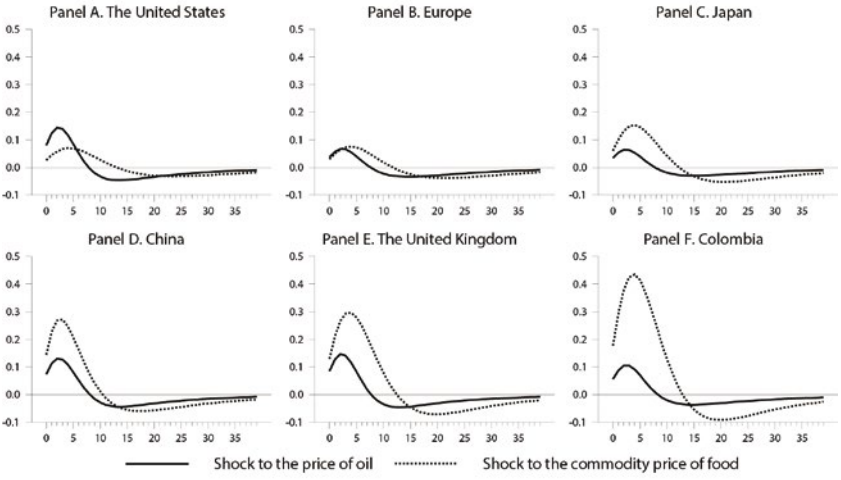


Figure 4: Country Core Inflation Rates

Historical error decompositions; contributions in percentage points.

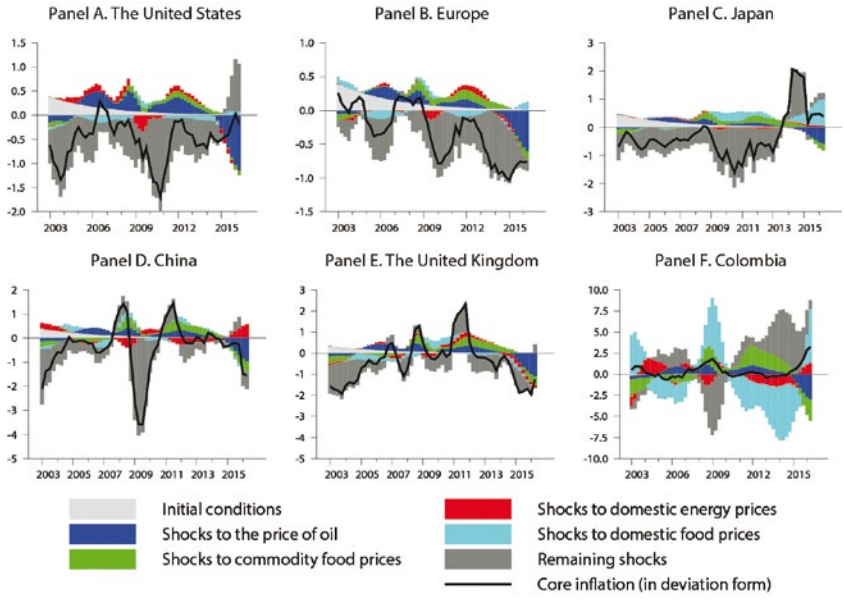
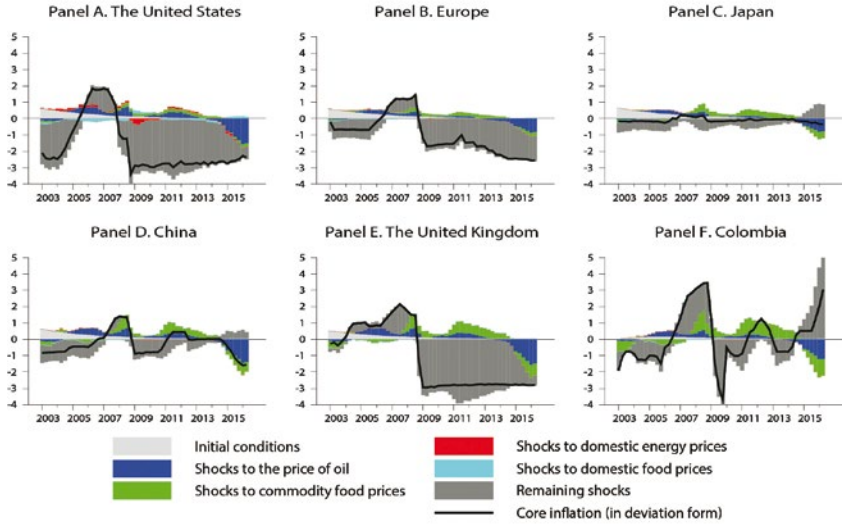


Figure 5: Country Interest Rates

Historical error decompositions; contributions in percentage points.



5.4 PRICE REGULATION AND INFLATION CONTROL IN VIETNAM

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Introduction

The past decade has witnessed both an unprecedented rise in commodity prices and inflationary consequences that have posed big challenges for monetary policy. However, in the socialist transitional economy of Vietnam, price regulation (so-called price control) is among the administration's top priorities, with the ultimate goal of price stability and inflation control. Accordingly, the Ministry of Finance frequently imposes 'stabilisation' measures and numerous forms of legislative actions to control domestic prices, if commodity prices rise faster than production costs. Since Vietnam's accession to the World Trade Organization (WTO) in 2007, price control has been relaxed. The liberalisation of domestic prices has affected a wide range of goods and commodities. State interventions focus only on certain types of essential and public goods and services, such as construction-grade steel, liquefied petroleum gas, commercial water, coal, chemical fertilisers, animal vaccines, salt, sugar, rice, dairy products, railway fares, medicine and health-care services and public education. In 2012, the government passed the Law on Price (LOP), which gives a legal framework to the new price-controls in order to ensure

price liberalisation commitments, and has led to continuous debate among economists and policymakers about the conflicting roles of the Ministry of Finance and the State Bank of Vietnam in price stability and inflation control.

There is an enormous literature that seeks convincing answers to the question of whether wage and price controls actually prevent inflation. The theory of price control developed by Galbraith (1952) emphasises the role of wartime price controls in preventing inflation from accelerating and allowing the economy to operate at a higher level of resource utilisation. However, most economists are sceptical of price controls as they produce shortages or surpluses and distort allocation of resources (Rockoff, 1992). According to Coyne and Coyne (2015), price controls cause significant welfare losses, a deterioration in product quality and reduction in investment, also encouraging black markets and illegal economic activity and, in the long run, higher prices. The empirical literature also provides inconsistent results with regard to the effects of price controls. Studies of price controls in developed countries find that there is a short-term effect of the expectation channel on price stabilisation, but they also provide evidence that price controls cannot prevent long-term inflation (Bourne, 2014; Feige & Pearce, 1973; Hansson, 1983; Whiteman, 1978). Fardmanesh (1996) shows that wage and price controls help to increase employment and output and to reduce the shortage of non-tradables in socialist transitional economies. Ghosh and Whalley (2004) find that rice price controls can be a useful revenue raising device in Vietnam—a low income economy with a large agricultural sector. In addition, a price control regime can have the effect of insulating a domestic market from stochastic external shocks.

The purpose of this study is to investigate structural effects of price regulation of wages, energy, medicine and healthcare services, and public education on inflation control in Vietnam. We will first analyse stylised facts of price regulation, and its effects on commodity price volatility following the Doi Moi policy, when Vietnam entered the transitional period that would lead to it becoming a market economy. We will then test the effects of price regulation on inflation controls to find out if regulating prices can attain the ultimate goal of price and inflation stability. In the last step, we will conduct market-based inflation forecasts for the period 2016–20, based on assumptions regarding different macroeconomic scenarios.

Wage and Price Controls in Vietnam: Some Stylised Facts

Before the 'Doi Moi' policy reform of 1986, the price structure in the centrally planned economy of Vietnam was completely rigid. Domestic prices were gradually liberalised when Vietnam entered the transitional period that would lead to it becoming a market-based economy. But this initial stage of liberalisation was characterised by strict control over producer prices and wage rates of state-owned enterprises (SOEs). Direct instruments, such as ceiling prices, floor prices, price brackets and state subsidies were key measures of market intervention. However, the country still faced frequent bouts of severe inflationary pressures during 1990s. Besides, the lack of market competition, particularly in markets

dominated by SOEs, such as gasoline, electricity, telecommunication and civil aviation, led to consumers having to suffer allegedly unreasonable prices set by players in those markets.

In the first years of the twenty-first century, the emergence of privately-owned enterprises and their significant contribution to the national economy encouraged the creation of a new legal framework to enhance price competition. The country's accession to the WTO in 2007 marked a shift in price controls, one that has been interpreted as a move to a more relaxed and flexible regime. State intervention aims to stabilise the prices of certain goods and services that are essential to production and human life, prescribed in two groups; namely, (a) raw materials, fuel, materials and services for production and circulation, and (b) goods and services that meet the basic needs of human sustenance. The enactment of the LOP in 2012 was a response to the public demand for an effective legal framework to control price manipulation practiced by dominant enterprises in fields such as gasoline and electricity. The LOP clearly limits the scope and manner of state intervention in the pricing decisions of businesses, and removes price stabilisation measures that are impractical and contravene WTO's requirements, such as subsidies for products produced by SOEs.

In order to capture the two different price-control regimes, we compute and compare the standard deviations of consumer price index (CPI) components between two regimes: 2000–07 (strict control) and 2008–15 (flexible regime). Table 1 reveals higher standard deviation of CPI and its components in the second period (2008–15). This is consistent with the relaxation of price controls after 2007, when prices were allowed to flexibly adjust to market conditions. Since 2007, the state is only allowed to implement stabilisation measures when the prices of goods and services found on the LOP list show abnormal fluctuations and affect economic and social stability. The LOP stipulates relatively specific methods with which to stabilise prices as well as the principles and basis for price valuations, which allows consumers and businesses to predict the adjustment measures employed by the state when prices fluctuate on the market.

Table 1: Standard Deviation of CPI and Components Between the Two Regimes

	CPI	Gasoline	Energy	Education	Medicine
2000–07	4.01	3.2	4.06	0.5	1.2
2008–15	7.47	6.8	4.44	1	2.2

Source: Calculated by the authors from Datastream

We also perform a Chow breakpoint test to identify structural breaks in the CPI series by running a dynamic regression of inflation, which is assumed to be dependent on its lag and on changes in domestic oil prices (Δoil), education services (Δedu), medicine and medical services (Δmed), and minimum wages ($\Delta minwage$). The structural breaks, if any, were assumed to happen between 2006Q1 to 2008Q1. The empirical result shows a significant break in 2007Q4, which confirms a regime shift in price controls for those goods and services that we consider.

Testing the Effect of Wage-Price Controls on Inflation

We test the effects of price regulation on inflation based on the approach of Whiteman (1978) and the methodology suggested by Sims and Zha (1995). Specifically, the structural vector-autoregression (SVAR) model for determining the rate of change in CPI is estimated on data between 2000–07 (the period of strict wage and price controls). The selection of variables in the SVAR is based on monetary theory and a traditional Keynesian approach to the causes of inflation, including the oil price (Δoil), output gap (gap), money supply (Δm), real effective exchange rate (REER) (Δe) and CPI (Δp) (where Δ represents first differences).

The standard form of SVAR can be expressed as follows:

$$AY_t = C + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \mu_t \quad ①$$

where Y_t is a $(n \times 1)$ vector of endogenous variables ($Y_t = (\Delta oilt, gapt, \Delta mt, \Delta et, \Delta pt)$); A is an invertible $(n \times n)$ matrix of coefficients of contemporaneous relations on the endogenous variables; A^{-1} are $(n \times n)$ matrices, which capture dynamic interactions between the k variables in the model; p is the number of lags; and μ_t is a $(n \times 1)$ vector of structural error terms. The SVAR model is useful for this study as it helps track and identify structural shocks with respect to underlying economic theory. However, it is necessary to impose relevant restrictions on the system of equations to retrieve the structural shocks of the model. Assuming that residuals are linearly related to structural shocks, denoted by ε_t, so that $\varepsilon_t = B\mu_t$ and B is a $(n \times n)$ matrix of structural coefficients representing the effects of structural shocks, we multiply equation ① with inverse matrix $A(A^{-1})$ as written below:

$$Y_t = \Gamma + A_1^* Y_{t-1} + A_2^* Y_{t-2} + \cdots + A_p^* Y_{t-p} + \varepsilon_t \quad ②$$

The matrix of restrictions on eq. ② is as follows:

$$B\mu = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 \\ b_{21} & b_{22} & 0 & 0 & 0 \\ b_{31} & b_{32} & b_{33} & 0 & 0 \\ b_{41} & b_{42} & b_{43} & b_{44} & b_{55} \end{pmatrix} \begin{pmatrix} \mu^{\Delta oil} \\ \mu^{gap} \\ \mu^{\Delta m} \\ \mu^{\Delta e} \\ \mu^{\Delta p} \end{pmatrix}$$

The model is estimated for the first control regime—2000–07—from which the estimated parameters are used to predict the rate of inflation for the second stage, 2008–14 (relaxed price controls). The difference between the actual and predicted rates of inflation provides an estimate of the effects of price controls. We use quarterly data from Datastream, Thomson Reuters, for the period 2000–14. The domestic oil price is collected from the statistics by the Ministry of Finance and Petrolimex. Minimum wages are generalised from Government announcements. All the data series are seasonally adjusted and expressed in first difference to be stationary as per the augmented Dickey-Fuller (ADF) test.

Figures 1 and 2 show the estimated results for price control measures. For the whole period 2008Q1–2015Q2, simulated CPI and inflation are lower for nine quarters but higher for 19 quarters. On average, simulated inflation is 0.3 per cent per quarter higher than actual inflation. The extremely high inflation in 2008 and 2011 may have been due to the global commodity price shock, extensive capital inflows associated with Vietnam's accession to the WTO in 2007, and the easing of monetary policy to contain contagion effects of the global crisis in 2010 (Bhattacharya, 2013). Moreover, actual prices were higher in 2008 than they would have been in the presence of price controls, which allude to a short-term effect via the expected inflation channel. Controls may have helped curb inflation temporarily but the effect clearly did not last very long. Prices rose faster after and ended up far above what they would have been in a regime of relaxed controls. Overall, the results imply that relaxed price controls have not necessarily increased inflation but have actually helped to stabilise prices and inflation.

Figure 1: Simulated and Actual CPI and Inflation

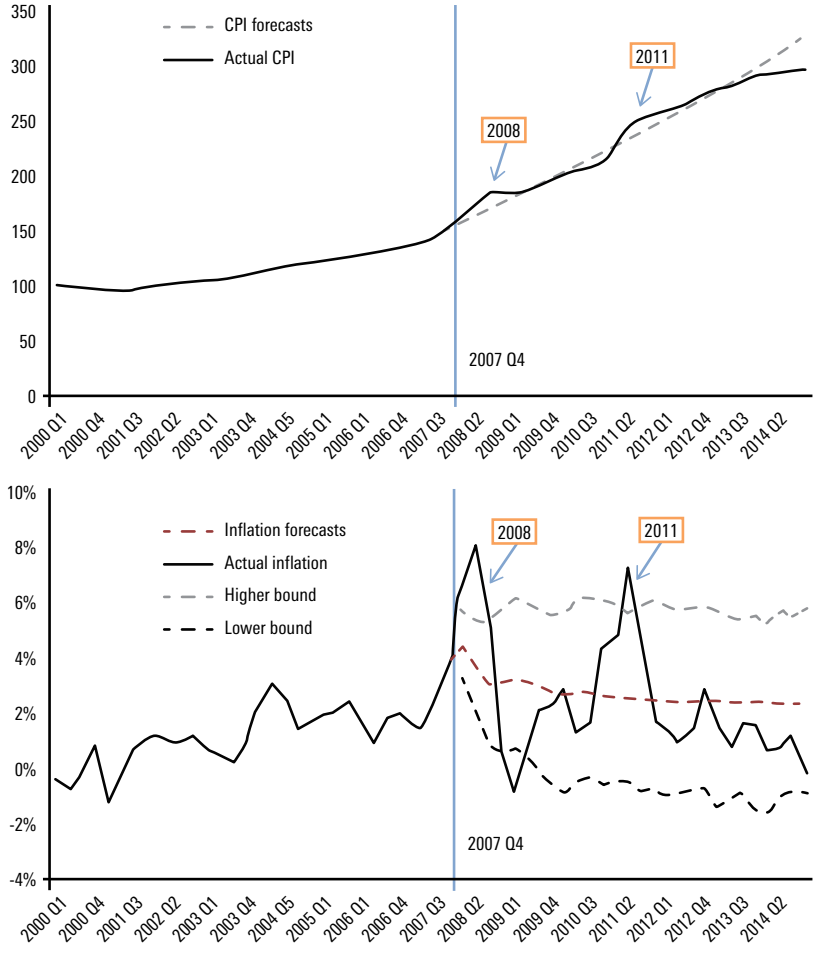
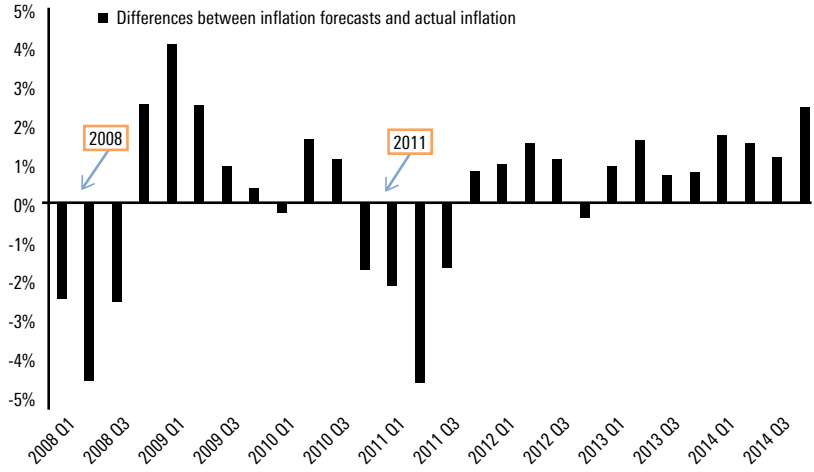


Figure 2: Differences between Forecasted and Actual Inflation



Forecasting Inflation With SVAR and Scenario Analysis

This section conducts inflation forecasting for the period 2016–20 from the SVAR developed in the first step: $Y_t = (\Delta oilt, gapt, \Delta mt, \Delta et, \Delta pt)'$ using quarterly data for the period 2000Q1–2015Q4. The forecasting process will be supported by different scenarios of macroeconomic conditions in the period 2000–15. A summary of the macroeconomic environment for the period 2000–15 is reported in table 2, which shows significant variation for different sub-periods. The period 2004–11 is characterised with overheating of economic growth, with positive output gap of 0.1 per cent, and especially high in 2008–11; the monetary aggregate (M2) over the same period 2004–11 shows an increase of 6.2 per cent. The percentage increases in nominal effective exchange rate (NEER) and oil prices are 1.4 per cent and 4.9 per cent, respectively. As a result, inflation is around 2.7 per cent per quarter; much higher than the average of the entire period 2000–15. Meanwhile, the period 2012–15 is characterised by a negative output gap (except in 2015) and the behaviour of macroeconomic variables appears to support an economy with low inflation.

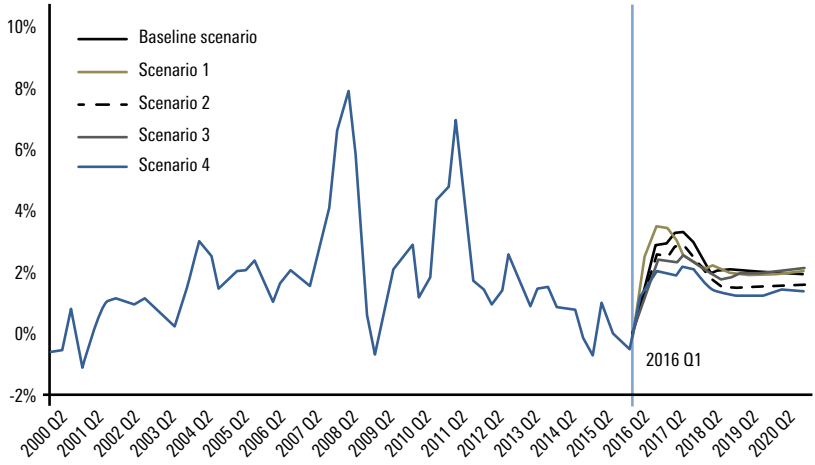
Table 2: Macroeconomic Overview, 2000–15

	2000–03	2004–07	2008–11	2004–11	2012–15
Inflation	0.50	2.00	3.30	2.70	0.90
Output gap	-1.00	0.00	0.20	0.10	-0.20
M2 (%⊗)	5.70	7.50	5.00	6.20	4.50
NEER	0.60	0.90	2.00	1.40	-0.20
Oil price	0.70	4.80	4.90	4.90	-3.10

Source: Calculated by the authors from the statistics of Petrolimex, the Ministry of Finance and Datastream

From the above macroeconomic review, we assume different scenarios for inflation forecasting. In the baseline scenario, it is assumed that economic growth is same as that of 2015, which results in an output gap of 0.2 per cent per quarter and gradually approaches the potential level for the period 2018–20. The oil price is estimated from World Bank's (WB) forecasting report for 2016–20. Accordingly, it is estimated that the oil price will fall in 2016 and rise the period after to grow at approximately 0.8 per cent per quarter for 2016–20. The simulated M2 and NEER are derived from SVAR estimation.

Figure 3: Forecasted Inflation for the Period 2016–20



In order to estimate the effect of the oil price, the price is assumed to increase by 0.8 per cent in scenario 1 rather than being based on the WB's forecast for the world oil price. Scenario 2 aims to test the effect of monetary policy by assuming a 1 percentage point increase in M2. In Scenario 3, we make the assumption that the government's target for economic growth in 2016–20 is exactly that of 2012–15, with the oil price being based on the WB's forecast. Finally, we allow a drop of 1 percentage point in M2 in Scenario 4 with the other variables remaining unchanged from scenario 3. The forecasted inflation for the period 2016–20 for different scenarios is presented in figure 4. Inflation is expected to increase in the period 2016–20 (around 1.5–2.1 per cent per quarter), reaching its highest level in 2017 and gradually decreasing in 2019 and 2020. The behaviour of inflation is likely to dependent on different macroeconomic scenarios. In the baseline scenario, overheating of economic growth by 0.2 per cent per quarter above the baseline is associated with high inflationary pressure. However, a conservative growth target and good management of M2, the monetary aggregate can help stabilise inflation.

Conclusions

This research adds to the literature with empirical evidence on the structural effects of price regulation in a socialist transitional economy. While wage and price controls serve important macroeconomic functions in Vietnam, there are no official statistics on, and there has been no research into, estimating the effects of price regulation on inflation control. The lack of convincing evidence on the impact of wage and price controls leads both to the state authorities' continuing strong focus on regulating prices and to their encouraging short-term outlook, while ignoring and/or undervaluing the important role of monetary policy in controlling inflation. Meanwhile, the unfavourable long-term effects of price regulation are hidden, which may generate adverse feedback by increasing commodity price volatility and severe inflation.

The empirical results from this study show two different regimes of price regulation policy in response to commodity price fluctuations in Vietnam, with the second regime being characterised by more flexible and relaxed price controls. There is no convincing evidence that regulating prices helps prevent commodity price volatility or accelerating inflation. Although short-term effects of price controls on inflation appear to be attractive via the expectations channel, in the long run controls may actually cause higher inflationary pressures. The forecasting process reveals that Vietnam may experience higher price fluctuations and increasing inflation in the period 2016–18. However, a conservative growth target and good management of the monetary aggregates may significantly stabilise prices and contain accelerating inflation.

6. Research Workshop

6.1 COMMODITY PRICES, INCOMPLETE MARKETS AND OPTIMAL MONETARY POLICY

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This paper deals with the question of how monetary policy should respond to commodity shocks in a small, open economy that (i) is endowed with commodities and (ii) features a domestic financial market in which heterogeneous domestic agents exchange only nominal, non-contingent financial claims.

The quantitative importance of commodity shocks as a driver of the business cycle is illustrated by the historical experience of commodity-producing emerging economies (EMs). At the same time, financial stability has gained significant prominence among the concerns of policymakers since the onset of the most recent financial crisis almost a decade ago. Specifically, central banks worldwide have recently set in motion a number of conventional and unconventional monetary policy strategies designed with the explicit objective of

1 The author is a junior researcher at the Banco de la República, Colombia. All views expressed here are the sole responsibility of the author and do not necessarily represent the official opinions of the Central Bank of Colombia or its board of directors.

guaranteeing the smooth functioning of financial markets and contributing to adequate risk-sharing within the economy.

These observations highlight the need for the design of appropriate (i.e. welfare maximising) policy responses to commodity shocks in small, open, commodity-producing economies, taking into account the important welfare implications of financial stability and risk-sharing when markets are incomplete.

This paper characterises optimal monetary policy responses to commodity shocks in open economies where financial markets are incomplete and, as a consequence, risk-sharing is generally suboptimal. In this context, monetary policy has a strong incentive to respond to shocks in a manner that takes into account, together with the standard considerations of output gap, inflation and terms of trade, the effect of policy choices on risk-sharing.

The paper builds a New Keynesian model of a small, open economy that is standard in the literature (see Corsetti et al., 2011; Obstfeld and Rogoff, 1995; McCallum and Nelson, 2001; Clarida et al., 2001; Corsetti and Pesenti, 2001; Fiore and Liu, 2005) except for the following three key features:

1. The model abandons the assumption of a representative household within the domestic economy in order to motivate a domestic financial market. Specifically, the model assumes that several risk-averse generations overlap within the domestic economy at every point in time. Given that different generations are in different stages of their life cycles, some generations are willing to borrow while other generations are willing to lend. All generations have a desire to smooth consumption across their lifetimes and are exposed differentially to aggregate uncertainty.
2. Building from the closed economy case of Sheedy (2013) and Pescatori (2007), the domestic financial market is incomplete in the sense that lending and borrowing only takes the form of a nominal, non-contingent debt instrument. This assumption seeks to capture the most important features of the vast majority of financial contracts available to households in the real world. The incompleteness of the domestic financial market has the well-known implication that, in general, risk is not efficiently shared across domestic agents: unexpected fluctuations in the real value of debt due to changes in domestic output and/or inflation fall disproportionately across generations.
3. The model incorporates an exogenous commodity endowment in the budget constraint of the domestic economy, following Gómez et al. (2015). Shocks to this endowment are meant to capture unexpected fluctuations in, for instance, the world price of commodities. Commodity shocks within the model are essentially wealth shocks to domestic agents, not shocks to the price of inputs or to production technology. This is intended to capture one of the main channels through which these shocks may affect a commodity-producing economy. Negative commodity shocks, insofar as they unleash negative wealth effects on domestic agents, are both deflationary and contractionary, unlike either shocks to technology or shocks to the price of inputs.

Optimal monetary policy in the face of commodity shocks is characterised analytically from the model by means of the linear-quadratic method, common to a great portion of the literature on optimal policy in New Keynesian models.[2]

The Model

The model follows closely the open economy structure of Corsetti et al. (2011) and Galí and Monacelli (2005) and the incomplete markets framework of Sheedy (2013). The model postulates a world economy populated by a continuum of countries of measure 1, each of them populated by a continuum of measure 1 of individuals. In what follows, the country of interest will be referred to as country H (Home). The model also assumes financial autarchy: although goods can be traded across borders, Home households can only trade financial claims among themselves.[3]

Households

Each of these households lives for three periods. In the first, second and third periods, the household is, respectively, young (indexed by y), middle-aged (m), and old (o). At any given time, three generations exist, each of which has a measure $\frac{1}{3}$. In each period, a new cohort of young households is born in a measure that exactly replaces the measure of old households that die. The problem faced by every new generation of young households consists of maximising the following lifetime utility:

$$U_t \equiv \left\{ \ln C_{y,t} - \alpha_y^{-\eta} \frac{H_{y,t}^{1+\eta}}{1+\eta} \right\} + \beta E_t \left\{ \ln C_{m,t+1} - \alpha_m^{-\eta} \frac{H_{m,t+1}^{1+\eta}}{1+\eta} \right\} + \beta^2 E_t \left\{ \ln C_{o,t+2} - \alpha_o^{-\eta} \frac{H_{o,t+2}^{1+\eta}}{1+\eta} \right\}$$

where $C_{i,t}$ represents the consumption at time t of a basket of Home and Foreign goods by a household at stage i of its life, $H_{i,t}$ is the individual supply of labour, and $\eta > 0$. The set of parameters α_i are related to the disutility of work for generation i and are specified in such a way that, in equilibrium, the profile of total income over the lifetime of an individual resembles a traditional life-cycle pattern (i.e. relatively low income when young and old, and relatively high income when middle-aged).

The consumption basket is defined by a Dixit–Stiglitz, CES-type standard, small, open economy aggregator, which combines the consumption of a composite of goods

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2 For more details, see Galí and Monacelli (2005), Paoli (2009) and Benigno and Benigno (2006).

3 This implies that domestic households will not be able to share risk with foreign households. In such a way, the model 'stacks the cards' against risk-sharing by domestic households. This assumption, however, goes against the results of the model, as eliminating it would only weaken the incentive of optimal monetary policy to be proactive in the promotion of risk-sharing across households if this had already been achieved by other means.

produced at Home ($C^H_{i,t}$) and Abroad ($C^F_{i,t}$), with elasticity of substitution ϕ and home bias. The consumption of these goods is itself a CES-type composite of infinite varieties produced at Home and in the continuum of foreign countries with a common elasticity of substitution (ϵ). The prices of the consumption basket P_t (that is, the CPI of the Home economy), of the composite good produced at Home (P^H_t) and of the composite good produced Abroad (P^F_t) follow standard results from CES-type aggregators of small, open economies with home bias. P^H_t and P^F_t are referred to in what follows as the producer price indices (PPI) of the Home and the set of foreign economies. Similarly, the allocation of the composite good demand produced in each country among each variety follows standard results from Dixit–Stiglitz aggregators.

The budget constraints faced by a household at each of the three stages of its life, expressed in units of the Home currency, are given by

$$P_t C_{y,t} + Q_t B_{y,t} + \frac{M_{y,t}}{1+i_t} = W_{y,t} H_{y,t} + \alpha_y J_t - P_t T_{y,t} + \alpha_y P_t O_t$$

$$P_t C_{m,t} + Q_t B_{m,t} + \frac{M_{m,t}}{1+i_t} = W_{m,t} H_{m,t} + \alpha_m J_t - P_t T_{m,t} + \alpha_m P_t O_t + B_{y,t-1} + M_{y,t-1}$$

$$P_t C_{o,t} = W_{o,t} H_{o,t} + \alpha_o J_t - P_t T_{o,t} + \alpha_o P_t O_t + B_{m,t-1} + M_{m,t-1}$$

These budget constraints incorporate the non-standard features included in this New Keynesian model of the small, open economy. Q_t is the price of a nominal, one period, non-contingent bond at time t. One unit of this bond purchased at t promises the bearer the payment of one unit of the Home currency at $t + 1$. The quantity of bonds purchased by a household is denoted by B. There is a Home central bank that produces money M. Households can deposit their holdings of money at the central bank at the riskless nominal interest rate i. Individuals are ex ante homogeneous in the sense of having the same preferences, the same life-cycle evolution of their endowment and the same (zero) initial wealth. $W_{i,t}$ is the nominal wage and α_i also represents the proportion of total profits received by individuals of generation i. J_t is the aggregate nominal profits of firms in the Home country and $T_{i,t}$ represents lump-sum levies charged on generation i by the government (in units of the composite good C). Finally, households have access to commodity revenues denominated in units of the composite good, O_t. These revenues take the form of an exogenous, stochastic endowment, and imply that commodity shocks in the Home economy are essentially equivalent to wealth shocks. This is different from a traditional interpretation of commodity shocks as shocks to technology or shocks to production costs, and the goal of this approach is to better capture shocks to commodity-producing countries where the commodity sector plays an important role in the total production of the economy.

Firms

A typical firm in the Home economy is standard in the sense that it operates in a monopolistically competitive environment and produces a differentiated good (j) with a linear technology in labour

$$Q_t(j) = N_t(j)$$

Following the literature on wage stickiness in New Keynesian models (in particular Erceg et al. (2000)), the demand for labour from different generations is aggregated using a Cobb–Douglas specification. Firms receive a proportional wage bill subsidy on labour costs. The firm solves a problem of allocating labour from different generations analogous to the one faced by the households when allocating components of a composite consumption basket. It is assumed that all firms set prices in the currency of the producer country (referred to in the literature as 'Producer Currency Pricing', PCP). Following a long tradition of nominal rigidities in general equilibrium models, this paper considers a form of price rigidity in which different firms have random access to the choice of making price changes (Calvo-style nominal rigidities). Specifically, every period a fraction, $1\text{-}\kappa$, of firms at Home are given the opportunity to make price changes if they desire to do so. The remaining κ fraction of firms must therefore keep their prices at the same level as the previous period. In these conditions, the problem of a firm is to maximise the flow of discounted, real, instantaneous profits during the expected lifetime of the chosen price.

Financial Autarchy

Given that the Home economy is not allowed to trade financial claims with the rest of the world, the exchange rate is determined from a zero net exports condition. Specifically, the total value of domestic production must be equal to the value of consumption (this also results from combining the budget constraints of the government and the household)

$$P_t C_t = \int_0^1 P_t(j) Q_t(j) dj + P_t O_t$$

where C_t is the aggregate consumption of the three generations and $P_t(j)$ is the price charged by the Home producer of variety j.

The Key Equation: Equilibrium Marginal Cost

The equilibrium allocation of the model is such that, given financial autarchy, borrowing in the young generation is equal to saving in the middle-aged generation $(B_{y,t} + B_{m,t} = 0)$. Combining the solutions of the optimisation problems of households and firms, an equilibrium condition emerges that is crucial to an understanding of the results with regard to optimal monetary policy. This equation characterises the real marginal cost of the Home economy (X_t) in equilibrium

$$X_t = C_{y,t}^{\frac{\alpha_y}{3}} C_{m,t}^{\frac{\alpha_m}{3}} C_{o,t}^{\frac{\alpha_o}{3}} Q_t^{\eta} Z_t^{-\eta}$$

where Q_t is the aggregate output of the Home economy and Z_t is a term related to price dispersion among firms in the Home economy. Crucially, the equilibrium real marginal cost depends on the distribution of consumption across generations, and not on aggregate consumption as in the standard version of the model. Therefore, any redistribution of consumption will have effects on inflation and, consequently, on the output gap. This observation has an important implication: in the context of incomplete markets, a benevolent policymaker has an incentive to improve risk-sharing by redistributing consumption across generations. However, this goal clashes with the standard objectives of inflation and output gap stabilisation. The introduction of heterogeneity and incomplete domestic financial markets implies an additional trade-off in the exercise of monetary policy in the face of commodity shocks: that between risk- sharing and macroeconomic stability. The solution to this trade-off is a quantitative matter, as is described next.

Optimal Monetary Policy

The optimal monetary policy strategy will result from a benevolent policymaker/central bank that attempts to maximise the following welfare function, which comprises the weighted sum of utilities of every generation living in the Home economy at all times:

$$W_0 = E_0\left[\frac{1}{3}\sum_{t=-2}^{\infty}\beta^t U_t\right]$$

This optimisation problem will be solved using the common approach in the New Keynesian literature, developed by Rotemberg and Woodford (1998) and Benigno and Woodford (2004), which consists in constructing a second order approximation of the welfare function using the original system of non-linear equilibrium conditions. It is possible to show that the problem of the policymaker is approximately equivalent to the minimisation of the following loss function:

$$L_0 = E_0 \sum_{t=0}^{\infty} \beta_t \left[\frac{1}{2}A\tilde{d}_t^2 + \frac{1}{2}B\hat{Q}_t^2 + \frac{1}{2}C(\tilde{\pi}_t^H)^2 + D\hat{Q}_t\tilde{O}_t\right]$$

where the symbol ~ over any variable denotes logarithmic distance from a steady state, d_t denotes the debt-to-GDP ratio, $\hat{Q}_t$ is the output gap (the logarithmic distance of output from its natural level), π_t^H is PPI Home inflation and A, B, C and D are combinations of parameters of the model. The loss function depends on the debt-to-GDP ratio of the economy precisely because this variable captures the degree of risk-sharing across generations: given that the young borrow from the middle-aged in the domestic financial market, an excessive debt-to-GDP ratio (relative to the steady state) implies that one generation is excessively exposed to risk under the incomplete market allocation. Optimal monetary policy is characterised by the first order conditions to the maximisation of the loss function subject to the set of constraints given by the Phillips curve and the equilibrium behaviour of the real interest rate and the ratio of debt to output.

Main Results

The main finding of this paper is that the introduction of heterogeneity and incomplete domestic financial markets adds a layer of complexity to the exercise of monetary policy in the face of commodity shocks. In the domestic economy, the existence of a domestic financial market allows a certain degree of risk-sharing among domestic households. However, risk-sharing is not perfect because there is not a full set of state-contingent debt instruments that domestic households could trade. Thus, together with the standard, small, open economy objectives of macroeconomic stability (price stability, output gap stability and terms of trade externalities), a benevolent policymaker has an incentive to improve risk-sharing across domestic households and contribute to consumption smoothing during their lifetimes.

The ability of monetary policy to steer the terms of trade and inflation in potentially different directions is related to its ability to control the real exchange rate and output. In principle, a negative commodity shock should trigger inflation, reducing the value of outstanding debt liabilities, and thus transferring wealth from creditors to debtors. However, the desire of the policymaker to improve on risk-sharing clashes with his or her objective of stabilising output and prices. In this sense, heterogeneity and market incompleteness introduce an additional trade-off for monetary policy, between risk-sharing and the standard macroeconomic objectives. The solution to such a trade-off is essentially a quantitative matter: under some circumstances, the incentive of the policymaker to concentrate on risk-sharing across domestic households can be strong enough to eliminate the optimality of an inflation-targeting rule, as found by Galí and Monacelli (2005).[4]

In order to better understand the properties of optimal monetary policy in the face of commodity shocks, it is possible to use the model to study the response of key variables of the model to negative productivity and endowment shocks under the optimal policy rule compared to a set of alternative policy regimes: producer price index (PPI) inflation targeting, consumer price index (CPI) inflation-targeting and an exchange rate peg.[5]

A negative commodity shock triggers a fall in the real interest rate in an attempt by the policymaker to stabilise the debt-to-GDP ratio and redistribute wealth from creditors to debtors with the goal of improving ex ante risk-sharing. In doing so, however, the policymaker does not achieve a significant improvement in risk-sharing across generations, as is evident from the fact that the debt-to-GDP ratio is not significantly more stable than in alternative regimes.

The fall in the real interest rate is brought about by an increase in the output gap, which necessarily implies a (relatively small) positive reaction of inflation through the Phillips curve.

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4 In a closed economy setting, for example, Sheedy (2013) demonstrates that the introduction of market incompleteness into an economy with heterogeneous agents may potentially render the strategy of inflation targeting suboptimal when compared to a nominal GDP-targeting rule. The reason for this is that a benevolent policymaker uses inflation as a mechanism to transfer wealth from creditors to debtors after a negative productivity shock. On the other hand, Schmitt-Grohe and Uribe (2004) introduce nominal rigidities into the otherwise classical framework of incomplete markets and optimal fiscal policy of Chari and Kehoe (1999). They discover that optimal monetary policy will not perform a great deal of ex post wealth redistribution between the government and households as this would imply extremely volatile inflation.

5 These regimes are also considered by Galí and Monacelli (2005).

The volatility of both the output gap and inflation is significantly smaller under the optimal policy rule than under alternative regimes. It is in this sense that the results indicate that the policymaker prefers to concentrate on the stabilisation of standard macroeconomic variables (the output gap and inflation) at the expense of not being active enough in boosting risk-sharing. The policymaker faces a trade-off between standard macroeconomic objectives and risk-sharing, and the latter proves to be very costly to undertake under a wide range of calibrations. In other words, the objective of stabilising the debt-to-GDP ratio would require a significant surprise in terms output and inflation, which the policymaker finds suboptimal.

For this reason, the optimal policy rule is closer to PPI-IT than to any other alternative regimes: the stabilisation of PPI inflation is approximately equivalent to the implementation of the flexible-price equilibrium in a context where only commodity shocks drive economic fluctuations. The stabilisation of PPI inflation gives priority to standard macroeconomic objectives (output gap and inflation volatility) over risk-sharing considerations.

The 'suboptimality' of CPI-IT and of an exchange rate peg is precisely related to the fact that these regimes create excessive volatility in output and inflation. Under the exchange rate peg, the fall in the real interest rate requires a very strong positive response of inflation, which is related to a strong positive response of output. CPI-IT allows some nominal appreciation and therefore reduces the response of inflation, but the dynamic behaviour imposed by CPI-IT on the nominal exchange rate interferes with the role of the latter in contributing to risk-sharing and creates higher volatility of inflation and output.

Concluding Comments

This paper has characterised optimal monetary and exchange rate policies for a small, open economy under incomplete markets at the local level and commodity shocks. Several conclusions arise from this effort.

The main finding of the paper is that the risk-sharing considerations that arise from market incompleteness introduce a new trade-off for monetary policy under financial autarchy. It is found that after a commodity shock, the variations in the real exchange rate and the real return required to replicate the complete markets allocation imply excessive volatility in the traditional macroeconomic objectives of output and inflation. Thus, optimal policy is more likely to resolve the risk-sharing vs macroeconomic stability trade-off in favour of the latter. This has two implications for monetary policy in the face of commodity shocks: on the one hand, the optimality of (some form of) inflation targeting is maintained even in the presence of risk-sharing considerations. On the other hand, the cost of 'not caring too much' about risk-sharing is an excessively volatile debt-to-GDP ratio and therefore imperfect risk-sharing across the different generations of the economy in the face of shocks[6].

[6] The results of this paper are therefore similar to those of Schmitt-Grohe and Uribe (2004) in the sense of monetary policy being relatively passive to risk-sharing considerations in order to avoid inflation variability, but in this paper tax smoothing plays no role; redistribution is made across households and the key to the desirability of risk-sharing is risk aversion on the side of the latter.

6.2 PREDICTING THE EFFECTS OF OIL PRICE- AND WEATHER-RELATED SHOCKS ON THE ANCHORING OF INFLATION[1]

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— Guarín, A., Hamann F. and Rodríguez D., "Predicting the Effects of Oil Price- and Weather-Related Shocks on the Anchoring of Inflation", Research Workshop, in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 85–88.

There exists a large body of literature in economics on the importance of long-term (LT) inflation expectations (IE) for monetary policy making (e.g. Autrup and Grothe, 2014; Nautz and Strohsal, 2015). There has also been a focus on assessing both central bank credibility as well as the degree of anchoring of inflation expectations towards long-run central bank targets (e.g. Gürkaynak et al., 2010; Strohsal and Winkelmann, 2015). Therefore, the understanding, tracking and assessment of the degree of inflation anchoring, and the correct identification of periods of anchoring and de-anchoring, are essential for central banks (see, e.g., Mehrotra and Yetman, 2014; Strohsal and Winkelmann, 2015; Antunes, 2015).

This paper proposes an empirical model with which to identify and predict periods of de-anchoring of IE for time horizons to 0, 3 and 6 months. This measurement is based on the prediction of

[1] The opinions, statements, findings and interpretations expressed in this paper are the responsibility of the authors and do not necessarily represent either those of the Banco de la República of Colombia or those of its board of directors. All errors and omissions in this work are the authors' responsibility.

the probability with which an episode of de-anchoring might occur. This is done using information from exogenous variables that have historically effected observed inflation. This probability is contrasted with a threshold over which our exercise provides warning signals. The probability is estimated using Bayesian model averaging (BMA) of logistic regressions. We apply this methodology to Colombian data with monthly frequency between January 2003 and April 2016.

Empirical Model

Let d_{t+h} denotes a dummy variable of the de-anchoring of LT IE for time $t = 1,...,T - h$ and forecasting horizon $h \geq 0$, such that

$$d_{t+h} = \begin{cases} 1 & \text{if } \tilde{\pi}^{LT}_{t+h} > \bar{\pi}^{+}_{t+h} \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

where $\tilde{\pi}^{LT}_{t+h}$ is the LT IE and $\bar{\pi}^{+}_{t+h}$ is the upper-bound of the inflation range at time t.

Following Guarín and Lozano (2016), the BMA posterior predictive probability of occurrence of a de-anchoring episode of LT IE at time $t+h$ is defined as

$$P^{BMA}(\hat{d}_{t+h} = 1|\mathcal{J}) = \sum_{k=1}^{K} \int_{\theta_k} P(\hat{d}_{t+h} = 1 \mid \theta_k, M_k, X_t)\, P(\theta_k, M_K \mid \mathcal{J}) d\theta_k \quad (2)$$

where $P(\hat{d}_{t+h} = 1 \mid \theta_k, M_k, X_t)$ corresponds to the predictive likelihood that $\hat{d}_{t+h} = 1$ conditioned on θ_k, M_K and evaluated on the set of explanatory variables X_t, and $P(\theta_k, M_K \mid \mathcal{J})$ is the joint posterior probability of θ_k and M_K. The variable $\hat{d}_{t+h}$ stands for the prediction or alternative realisation of $\hat{d}_{t+h}$ generated by the model.

The BMA estimation is performed through the well-known Metropolis–Hastings (MH) sampling algorithm along with the reversible-jump Markov chain Monte Carlo (RJMCMC) extension introduced by Green (1995) (see also Hoeting et al., 1999; Raftery et al., 2003; Green, 2003; Green and Hastie, 2009).

Following Guarín and Lozano (2016), we compute a cut-off probability $\tau \in [0,1]$ above which P^{BMA} provides a signal of the de-anchoring of IE, as

$$\underset{\tau \in [0,1]}{\text{Min}}\ \phi(\tau) \text{ subject to } \gamma(\tau) \leq \bar{\gamma} \quad (3)$$

where $\phi(\tau)$ and $\gamma(\tau)$ are the probabilities of false alarms and undetected episodes of de-anchoring, respectively, and $\bar{\gamma}$ is the maximum value of γ admitted by the policymaker.

Data

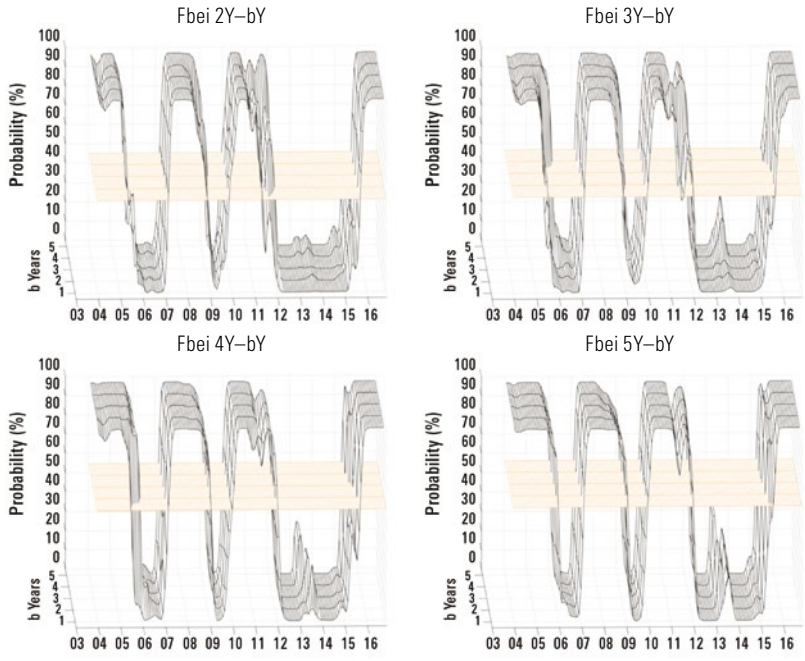
Our empirical exercises consider monthly data for Colombia between January 2003 and April 2016. Our data set includes two sets of information. The first involves the forward

break-even-inflation (Fbei) rate[2] expressed in annual terms as a proxy for $\tilde{\pi}^{LT}_{t+h}$, annual target inflation $\bar{\pi}_t$ and its range $[\bar{\pi}^-_t, \bar{\pi}^+_t]$, which are obtained from the Colombian Central Bank. The dummy of de-anchoring is computed as in equation ① and used as the dependent variable in equation ②. The second set of data considers explanatory variables, such as an international food price index, the Brent oil price and indexes for the climate phenomena 'Niño' and 'Niña'. We also include within the data set a dummy $D_{IT} = 1_{\{t<\text{Jan 2010}\}}$ for time periods before January 2010. Our explanatory variables take up to 6 lags of each variable.

Results

We carry out the BMA estimation of the probability $P^{BMA}(\hat{d}_{t+h} = 1 \mid \mathcal{I})$ in equation ② for the term structure of the Fbei rates 2Y–bY, 3Y–bY, 4Y–bY and 5Y–bY for all $b = \{1,2,3,4,5\}$. The set X_t considers the variables highlighted in the previous section. Once we have estimated all predictive probabilities, we compute the cut-off probability τ defined in equation ③ and set the estimated periods of the de-anchoring of IE as those time spans where $P^{BMA}(\hat{d}_{t+h} = 1 \mid \mathcal{I}) \geq \tau$. We perform prediction exercises for forecasting horizons $h = 0,3$ and 6 months. Figure 1 plots the predicted BMA probability of de-anchoring for $h = 6$ months ahead (black lines) and its cut-off probability (yellow hyper-plane).

Figure 1: Probability of De-Anchoring of Inflation Expectations (h=6 Months)



[2] The aY–bY Fbei rates provide high-frequency measurements of inflation compensation at specific time horizons.

Results show that our predicted probability anticipates most periods of de-anchoring. In particular, we are able to capture the period that started in the second half of 2015 as the result of both an abrupt fall in oil prices that depreciated the foreign exchange rate and a quick increase in domestic food prices due to an 'El Niño' shock.

Table 1: Predictive Probability of De-Anchoring of IE: Performance Evaluation

Prediction:	0 months ahead				3 months ahead				6 months ahead			
Term structure fbei	2Y-	3Y-	4Y-	5Y-	2Y-	3Y-	4Y-	5Y-	2Y-	3Y-	4Y-	5Y-
T (months)	775	775	775	775	760	760	760	760	745	745	745	745
De-anchoring (months)	385	420	452	473	370	405	437	458	355	390	422	443
Signalling analysis												
Cut-off probability	60.7	62.8	65.5	64.8	57.8	60.5	54.1	59.7	48.2	49.9	57.7	59.2
Missed de-anchoring events—EI	4.9	4.8	3.5	3,6	4,3	4.9	0.9	1.5	4.8	4.9	5	4.7
False alarms—EII	2.3	1.1	0	0	2,3	1.4	0	0	6.9	5.9	2.8	3.3
De-anchoring events correctly called	95.1	95.2	96.5	96.4	95.7	95.1	99.1	98.5	95.2	95.1	95	95.3
No false alarms	97.7	98.9	100	100	97.7	98.6	100	100	93.1	94.1	97.2	96.7
De-anchoring events given an alarm	97.6	99	100	100	97.5	98.7	100	100	92.6	94.6	97.8	97.7
False alarms of total alarms	2.4	1	0	0	2.5	1.3	0	0	7.4	5.4	2.2	2.3
De-anchoring events given no alarm	4.8	5.4	4.7	5.3	4	5,4	1.2	2.3	4.5	5.4	6.3	6.7
No de-anchoring events given no alarm	95.3	94.6	95.3	94.7	96	94,6	98.8	97.7	95.5	94.6	93.7	93.3
NtS (ratio %)	2.4	1.2	0	0	2.4	1.5	0	0	7.3	6.2	2.9	3.5

All values are defined as probabilities (%) unless otherwise stated in parentheses. EI and EII stand for type I error and type II error, respectively.

Table 1 evaluates the BMA predictions of episodes of de-anchoring with respect to those computed in Data using an approach based on signalling analysis (see Babecký et al., 2014; Christensen and Li, 2014). For each one of the term structures, the cut-off probabilities are very close and oscillating between 48 per cent and 65 per cent. The probability of both periods being correctly detected and no false alarms is for most cases over 95 per cent.

The relevant variables in the BMA prediction exercise and its lags depend on the forecasting horizon. Increases in the intensity of 'Niño' and in international food prices in all exercises lead to a higher probability of de-anchoring. The results of changes in Brent oil prices and the intensity of 'Niña' events are mixed and depend on the forecasting horizon. For $h = 0$ and 3, the oil price has a positive effect on the probability of de-anchoring through production costs, while for $h = 6$ the relationship is negative through its effects on the foreign exchange rate and its lagged transmission to inflation.

6.3 MONETARY POLICY RESPONSES TO DIFFERENT OIL PRICE SHOCKS: THE CASE OF VIETNAM[1]

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— Chu Khanh, L., "Monetary Policy Responses to Different Oil Price Shocks: The Case of Vietnam", Research Workshop, in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 89–96.

Introduction

The main objectives of this paper are to examine the impacts of oil price shocks on Vietnam's economy as well as the responses of Vietnamese monetary policy to oil supply and oil demand shocks. Oil is an important input for production activities and sharp oil price increases (decreases) are generally thought to make a major contribution to world business cycles. According to the classic supply-side effect channel, an unexpected increase in the oil price indicates a scarcity of energy. The lower availability of this input to production constrains economic growth and even slows productivity. If consumers expect a temporary oil price increase, they will save less and borrow more, forcing the real interest rate up. The fall in the real balance, given an unchanged money supply, leads to a higher inflation rate. On the other hand, the real balance effect channel explains that an oil price shock would lead to higher money demand as people adjust their portfolio towards liquidity. If the central bank refuses to adjust the money aggregate correspondingly, the interest rate

1 The opinions in this article are the sole responsibility of the author and do not represent those of the State Bank of Vietnam.

will rise and economic activity will slow down. The third channel, so-called income transfer, refers to the shift of income from oil-importing to oil-exporting countries when the oil price increases. An oil price increase can be viewed as a tax levied by oil-exporting countries on oil-importing households and firms. Although this payment to oil-exporting countries can be recycled back into the oil-importing ones when foreign consumers spend on goods and services, the negative effect is only partially offset. Overall, in net terms, the domestic demand of oil-importing countries decreases.

At the same time, there is the important question of how monetary policy makers should response to oil price fluctuations in order to achieve price and output stability. If a negative oil price shock occurs and the central banks focus on stabilising output, they would reduce the policy interest rate. This action could partly offset the decrease in output but can put more pressure on inflation. On the other hand, a central bank that pursues an inflation-targeting framework could raise the policy interest rate when the oil price increases unexpectedly, with negative impacts on production. Bohi (1991) and Bernanke, Gertler and Watson (1997) conclude that the Fed's systematic responses to oil price shocks are the main cause of the recession following the oil price shocks of the 1970s. If the Fed had not increased interest rates, the economic downturn could have been avoided. However, this conclusion has been challenged by Hamilton and Herrera (2004) and Kilian and Lewis (2011). Several studies suggest that monetary policy has a less than central role in transmitting oil price shocks (see Ferderer, 1996 and Brown and Yucel, 1999). And things become more complicated when one takes into consideration the assumption that policymakers should not respond to innovations in the oil price but directly to the underlying supply and demand shocks that drive this price (Kilian (2009) and Kilian and Lewis (2011)).

While rising oil prices led to high inflation and then partly contributed to a long-lasting global economic recession from 2008 on, the oil price plunge since mid-2014 has triggered an economic downturn in many oil-exporting countries. This has been true for the case of Vietnam. Oil price fluctuations have a significant impact on Vietnam's economy since the country not only imports various petroleum products from around the world, it also exploits, refines and exports oil. In 2008, the increase in global commodity prices, especially the increase in the oil price, together with expansionary monetary policy put significant pressure on domestic inflation. The State Bank of Vietnam (the SBV—the country's central bank) faced a huge challenge in curbing high inflation while maintaining economic growth rate targets (actually, the level of independence of the SBV from the government is not high). In contrast, falling oil prices since mid-2014 have put a squeeze on the state budget (it has shrunk significantly since 2008; in 2015, monies from oil exporting accounted for only 7 per cent of government revenue), constraining the government's ability to intervene in the economy and partly reducing the effectiveness of accommodative monetary measures to boost economic growth.

Methodology and Data

Methodology

To examine the responses of monetary policy to different oil price shocks, this research firstly disentangles oil price shocks into supply and demand shocks by following the methodology introduced by Kilian (2009). Kilian (2009) applies an identifying assumption to oil production, global economic activity and the oil price to classify oil price shocks into supply shocks (caused by disruptions in the supply of oil), aggregate demand shocks (caused by increases in the demand for oil due to strong global economic activity) and precautionary demand shocks (caused by increases in the demand for oil due to precautionary demand). Correspondingly, the structural vector auto-regression (SVAR) model comprises three variables: world oil production, a global economic activity index and the real oil price. This three-variable SVAR model allows us to decompose the real oil price into the three above-mentioned types of oil shocks.

In the next step, we measure the effects of three structural innovations (the exogenous error terms) generated from the aforementioned SVAR model on Vietnamese macroeconomic variables, such as real GDP growth and inflation. We also examine how the State Bank of Vietnam responds to oil price fluctuations, by assessing the response of monetary policy variables to such shocks, using a distributed-lag model. Specifically, effects of the three different oil price shocks on four macroeconomic variables take the following form:

The responses of the real GDP growth rate:

$$\Delta gdp_t = \gamma_t + \sum_{i=1}^{12} \delta_{jt}\, \hat{\varphi}_{jt-i} + \omega_{jt} \qquad j = 1, 2, 3 \text{ ③}$$

The response of the inflation rate:

$$inf_t = \vartheta_t + \sum_{i=1}^{12} \tau_{jt}\, \hat{\varphi}_{jt-i} + \nu_{jt} \qquad j = 1, 2, 3 \text{ ④}$$

The response of the money supply growth rate:

$$\Delta ms_t = \rho_t + \sum_{i=1}^{12} \lambda_{jt}\, \hat{\varphi}_{jt-i} + \xi_{jt} \qquad j = 1, 2, 3 \text{ ⑤}$$

The response of the policy rate:

$$pol_t = \zeta_t + \sum_{i=1}^{12} \kappa_{jt}\, \hat{\varphi}_{jt-i} + \psi_{jt} \qquad j = 1, 2, 3 \text{ ⑥}$$

In which $\hat{\varphi}_{jt}$ is quarterly structural shocks constructed by averaging the monthly structural innovations of the SVAR model. Quarterly averages are constructed because monthly data on the real GDP growth rate is not available and industrial production is not a good proxy for real GDP's response to oil shocks (Barsky and Kilian (2002)):

$$\hat{\varphi}_{jt} = \frac{1}{3} \sum_{i=1}^{3} \hat{\varepsilon}_{j,t,i} \qquad j = 1, 2, 3.$$

The coefficients δ_{jt}, τ_{jt}, λ_{jt}, κ_{jt} of equations ③ to ⑥ measure, respectively, the response of the following macroeconomic variables: the real GDP growth rate, the inflation rate, the money supply growth rate and the policy rate. The number of lags is determined by the maximum horizon of the impulse response function, which is set to twelve quarters. It seems plausible to assume that within a given quarter there is no feedback from the Vietnamese economy to oil price shocks as Vietnam is a small, open economy. To deal with the potential serial correlation of the residuals of equation ③ to ⑥, a block bootstrap method is employed.

Data

The sample period for the structural VAR model runs from 1973:2 to 2015:12. The data on world crude oil production is taken from the US Energy Information Administration and transformed into a percentage change. The index of global real economic activity is a measurement of the component of worldwide real economy activity that drives demand for industrial commodities in global markets (Kilian (2009)), rather than being a proxy for the global real value added. The third variable is the West Texas Immediate oil price deflated by the US consumer price index (CPI), which is taken from the Federal Reserve Bank of St. Louis.

To measure the impact of oil price shocks on Vietnamese macroeconomic variables, we use quarterly data from 1997Q1 to 2015Q4. The CPI, the money aggregate and the policy rate are taken from International Financial Statistics (IFS) of the International Monetary Fund (IMF). The money supply, which includes the money in circulation as well as bank deposits such as checking, time and savings accounts, is a proxy for the money aggregate. The policy rate is the refinancing rate, which is the price of a form of credit extension supplied by the SBV that aims to provide short-term loans and payment facilities for credit institutions. The real gross domestic product (GDP) data is collected from the General Statistics Office and transformed into the growth rate by taking difference of log.

To assess the unit root properties of time series, an augmented Dickey–Fuller test is employed. All data series, except for changes in oil production, the global real economic activity index, the real oil price and the policy rate, are non-stationary at 5 per cent and are transformed into first differenced form.

Empirical Results

Figure 1 shows the responses of the GDP and CPI to different structural oil shocks. All shocks have been normalised such that an innovation will tend to increase the oil price. An unexpected disruption in the supply of oil causes real activity and the price level to decline on impact. Although both the one- and two-standard error confidence intervals indicate that the responses are not significant, this can be evidence of stagflation as both output and the price level show contraction. In this case, the real balance sheet channel effect

is stronger than the supply-side channel's as reduced consumer purchasing power shifts the aggregate demand curve to the left more than the shift of the aggregate supply curve.

An unanticipated expansion of aggregate demand causes a significant increase in real GDP. The corresponding impact on the price level displays a similar pattern, although it is only statistically significant at 10 per cent. This demonstrates the dominance of a stronger global economy over the negative impact of the rising oil price on production.

Real activity responds positively to the oil-specific demand shock in the first quarter, but declines afterwards. As a small oil-producing and exporting country, Vietnam receives a very short-term positive effect from the rising oil price. However, this effect cannot last long due to the country's limited ability to increase production. At the same time, an oil-specific demand shock causes a significant increase in the price level within one and a half years, followed by a small decrease. Overall, this fits quite well with the conventional wisdom that an oil price increase without a lift in global demand will lead to lower output and higher price levels, especially for an energy intensive country like Vietnam.

Figure 2 shows the impulse response functions for the Vietnamese monetary variables to three different oil shocks. In response to lower real activity and price levels caused by an unanticipated disruption in the supply of oil, the central bank chooses to loosen monetary policy by increasing the money supply and reducing policy rates. In other words, the central bank's reaction function indicates that it considers the high oil price caused by the oil supply shock as an adverse demand shock.

The impulse response function is also evidence of monetary tightening following the positive oil-specific demand shock, which is done to curb inflation rather than to focus on the GDP growth target. The one-standard error confidence interval indicates that the response of monetary policy is statistically significant for both monetary variables.

In contrast to the conventional wisdom, the monetary authority reacts to rising oil price shocks caused by unexpected expansions in aggregate global demand by increasing the money supply and decreasing policy rates. Instead of implementing a tighter monetary policy to slow down the overheating economy (which is overheating due to unexpected stronger global demand), the central bank chooses the opposite action. This finding can be explained as follows. First, the central bank worries about the negative impact of higher oil prices on real activity because Vietnam's economic growth relies largely on imported oil products as inputs to production. However, as mentioned, the positive impact of an expansion in the global economy dominates such an expansion's negative impact on Vietnam's real activity. Second, price stability was not the top priority of monetary policy in the period before 2010 (before the *Law on State Bank of Vietnam's* organisation and operation was passed in 2010). As a multi-objective monetary policy was implemented, the central bank tended to implement expansionary monetary policies to foster economic growth. Both the structural shock and a historical decomposition analysis indicate that much of the oil price increase from the year 2006 to the year 2008 can be attributed to overheating global aggregate demand. In Vietnam, the expansionary fiscal and monetary policies that aimed to support economic growth had already led to high inflationary pressure on the economy. Therefore, increasing world commodity prices, especially oil, did contribute to the high price level.

Instead of implementing a contractionary monetary policy to slow the economy down, the high money supply growth rate that aimed to support economic growth (the interest rate was kept stable for nearly the entire year 2007) eventually led to a high rate of inflation for the year 2008. Similarly, this unwise practice contributed largely to the high inflation of 2011, when the government implemented stimulus policies to help the economy recover after the economic recession (see figure 3).

Overall, different oil price shocks have different impacts—in terms of both direction and magnitude—on Vietnam's economic growth and inflation rate. An oil price shock caused by oil specific demand depresses economic growth, but a shock caused by an unanticipated increase in aggregate demand does not. Correspondingly, the monetary authority's responses to different oil price shocks should not be similar. The inappropriate response of the monetary authority to the oil price increases of 2008 and 2011 caused many problems for the economy. In such periods, the SBV was forced to curb the high inflation rate while still maintaining the GDP growth rate. It seemed an impossible task and the central bank had to choose to lower its inflation target. Decreasing the money supply and the credit growth rate unexpectedly in order to control inflation, and reducing the inflation imported from world commodity prices (including the oil price), exerted a huge negative effect on the banking system in particular and economic enterprises in general.

I conduct two robustness checks of the above analysis. In the first check, I choose a different time period instead of using a data sample from 1997Q1 to 2015Q4. To separate the potential impact of the Asian financial crisis and to take into consideration the effect of a new Enterprise Law in 2000, a shorter sample period is chosen, only from 2001Q1 to 2015Q4. The second check uses the lending and deposit rates as indicators of the monetary policy stance. This is because in some periods of high economic instability the central bank directly levies the interest rate on deposits and loans (rather than using monetary policy tools to regulate them). None of these robustness checks (the results are not reported here but are available on request) generate significantly different results from the above analysis.

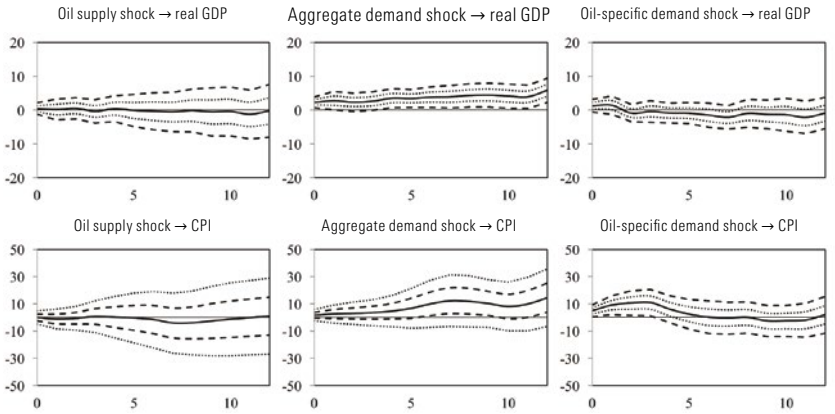
Concluding Remarks

This research examines the impact of structural oil price shocks on the Vietnamese economy and the responses of the monetary authority to different oil supply and demand shocks. By following the methodology of Kilian (2009), I disentangle global oil shocks into oil supply shocks, oil demand shocks driven by global economic activity and oil-specific demand shocks. These structural shocks are used to measure the shocks' effect on Vietnam's real GDP and price level for the period from 1997Q4 to 2015Q4. This leads to three main findings. First, an oil price increase caused by an unexpected disruption in the supply of oil can lead Vietnam's economy into a period of stagflation, although the confidence interval indicates no statistically significant impact. Second, real economic activity responds positively to an oil demand shock driven by global economic activity. Third, the real GDP growth rate

responds negatively to an oil-specific demand shock, while—at the same time—such a shock leads to a higher price level.

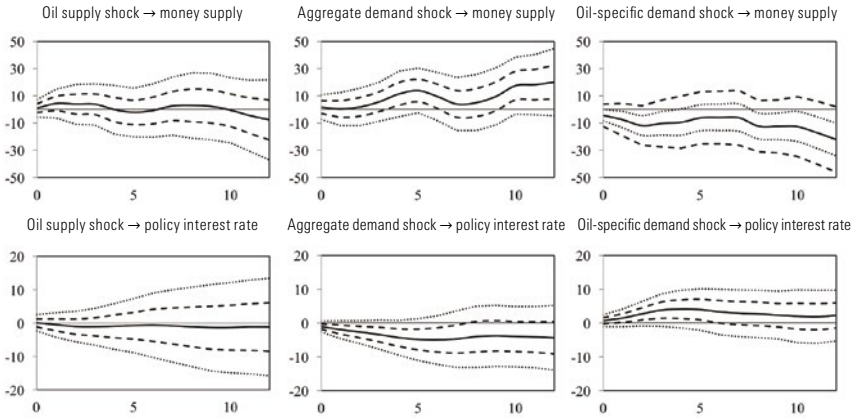
I also study how Vietnam's central bank responds to different oil price shocks. The main finding indicates that the SBV follows a prudential rule when oil price fluctuations are driven by oil supply and oil-specific demand shocks. However, the SBV chooses to implement an expansionary policy in response to oil price increases caused by unanticipated higher global demand. This response seems inappropriate given the impact of this oil demand shock on Vietnam's economy. Therefore, it is proposed that the SBV identifies the reasons behind oil price fluctuations and their impacts on output and prices, before selecting an appropriate monetary policy plan of action.

Figure 1: Responses of Vietnam Real GDP and CPI Level to Each Structural Shock



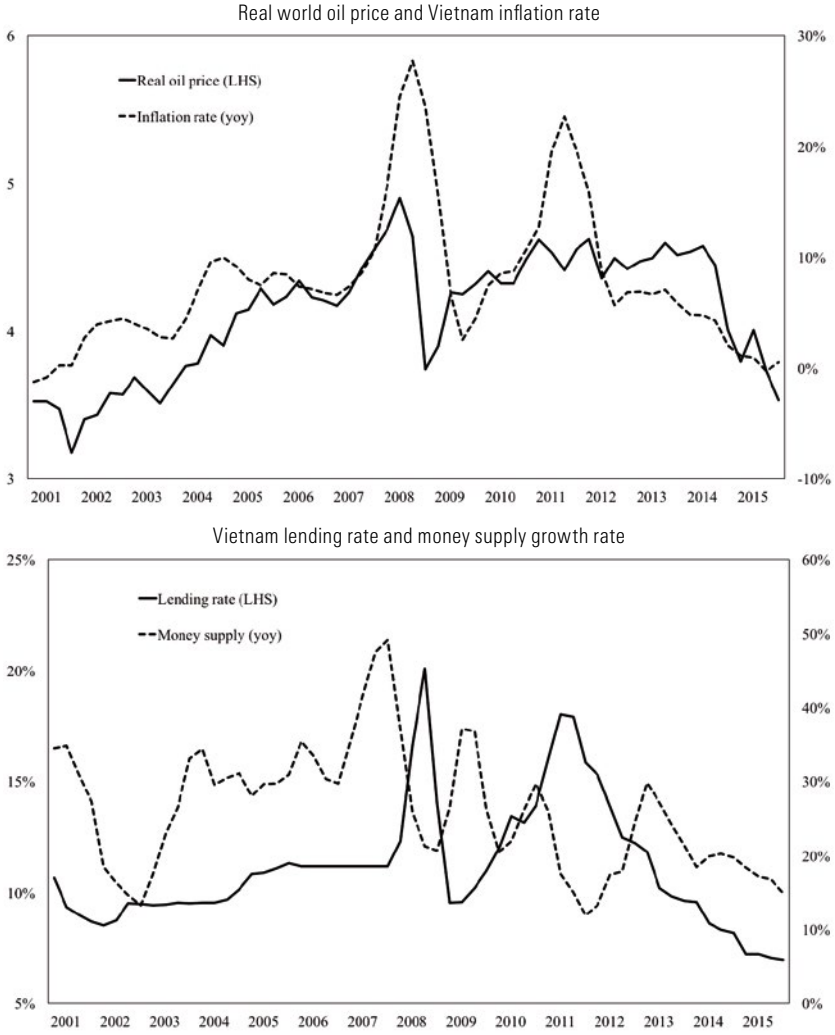
Notes: Solid black lines—point estimates; round dot and dash lines—one and two standard error bands.

Figure 2: Responses of Monetary Policy Variables to Each Structural Shock



Notes: Solid black lines—point estimates; round dot and dash lines—one and two standard error bands.

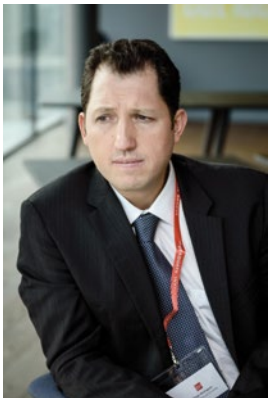
Figure 3: Oil Price and Macroeconomic Indicators



Source: International financial statistics, International Monetary Fund.

6.4 SHARING A RIDE ON THE COMMODITIES ROLLER COASTER: COMMON FACTORS IN BUSINESS CYCLES OF EMERGING ECONOMIES

ANDRÉS FERNÁNDEZ, ANDRÉS GONZÁLEZ AND DIEGO RODRÍGUEZ



DIEGO RODRÍGUEZ
Central Bank of Colombia

— Fernández A., González A. and Rodríguez, D., "Sharing a Ride on the Commodities Roller Coaster: Common Factors in the Business Cycles of Emerging Economies", Research Workshop, in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 97–102.

Fluctuations in commodity prices are an important driver of business cycles in small emerging market economies (EMEs). We document how these fluctuations correlate strongly with the business cycle in EMEs. We then embed a commodity sector into a multi-country EME's business cycle model where exogenous fluctuations in commodity prices follow a common dynamic factor structure and coexist with other driving forces. The estimated model assigns to commodity shocks 42 per cent of the variance in income, of which a considerable part is linked to the common factor. A further amplification mechanism is a 'spillover' effect from commodity prices to the risk premium.

Introduction

In recent times, the world economy has witnessed large swings in the prices of commodity goods traded in international markets. These swings have been observed across distinct types of commodities, from agricultural products to fuels and metals. What have been the macroeconomic consequences of these swings for small emerging market economies (EMEs) that export these goods? EMEs, often portrayed as being vulnerable to external forces and price takers in commodity markets, may have been subject to more macroeconomic volatility through these fluctuations in the prices of the commodity goods that they export. Thus, an important open question in international macroeconomics is what are the main channels by which commodities price fluctuations affect business cycles in EMEs and how much have they mattered in practice.

A first look at the recent historical account of commodity prices and EMEs' business cycles suggests that fluctuations in the price of the commodity goods—easily comparable to a wild roller-coaster ride; hence the title of our work—may be a key driver of such economies' business cycles. This paper explores this hypothesis formally. It does so by using data and economic theory. First, we explore how much commodities matter in the average EME and then document the 'co-movement' between the international prices of these commodities and several macroeconomic variables across a pool of EMEs. We then build a structural, small, open economy model that allows us to articulate a simple and tractable theory of how fluctuations in the commodity goods that these economies export can be the drivers of business cycles. Lastly, we estimate the structural model to assess how important such drivers have historically been through the lens of this theory.

On the empirical front, we document three stylised facts. First, the typical EME is a commodity exporter: the share of commodities in total exports in the average EME is more than double that of advanced economies. This is important insofar as the business cycle models of EMEs have largely abstracted from this intrinsic characteristic of these economies. Second, the country-specific commodity prices in the EMEs that we build exhibit strong co-movement with other macro variables throughout the business cycle. They are procyclical and lead the cycle of production, consumption and investment. In addition, they are countercyclical to real exchange rates and measurements of external risk premia—that is to say, periods in which commodity prices soar are accompanied by a real appreciation of the exchange rate and cheaper access to foreign capital markets. Lastly, we uncover the preponderant role of common factors when accounting for the dynamics of the country-specific commodity price indices that we build for several of the EMEs. This extends also to the dynamics of the real gross domestic product (GDP). Such co-movement does not come from EMEs exporting the same types of goods but is rather associated with different commodity good prices being driven by global forces.

The estimation of the structural model gives commodity price shocks a paramount role when accounting for aggregate dynamics in EMEs. The median share of the forecast error variance in output accounted for by these shocks is 42 per cent. Importantly, the bulk of the action from commodity prices is recovered by the model in the form of common shocks across economies. This common factor exhibits a marked increase in its volatility in the

post-2005 period. Furthermore, it allows us to bring the model much closer to the data in terms of business cycle co-movement across EMEs, as well as other more traditional second moments addressed in previous studies. For instance, the model predicts that real exchange rates are countercyclical, as observed unconditionally in the data. Fluctuations in commodity prices have not always amplified the business cycle, though. A historical decomposition of the output gap reveals that they have, sometimes, acted as cushion devices against what the model identifies as domestic forces. This was particularly the case of the fast recovery after the world financial crisis when commodity prices rebounded and helped counterbalance negative domestic shocks in some EMEs.

Stylised Facts

The first empirical task that we set out to carry out is to assess the size of the share of commodity exports in a typical EME. The share of commodities in total exports in the average EME is more than double that of advanced economies: while the median export share in EMEs is 25.7 per cent, that of advanced economies is 11.2 per cent.

We also explore the 'cyclicality' of commodity prices. The country-specific commodity prices in EMEs are procyclical and lead the cycle of output, consumption and investment. In addition, they are countercyclical to real exchange rates and measurements of external risk premia. The average contemporaneous correlation between the commodity price index and real GDP is about 0.5, and is slightly higher when the index is lagged by one quarter.

A last dimension that we explore empirically is the presence of common factors in our measurements of commodity price indices across EMEs. There is a preponderant role of common factors when accounting for the dynamics of commodity price indices across EMEs. This also extends to the dynamics of the real GDP. Principal component analysis further corroborates this: the first principal component accounts for as much as 78 per cent of the variance in the indices across these EMEs.

Taken together, the stylised facts presented contribute to further improving the understanding of the main patterns exhibited by EMEs' business cycles. On one hand they shed light on the strong co-movement between aggregate macro variables in these economies and the prices of the commodities that they export. In addition, because the relative share of these commodities is shown to be large in these economies and movements in their prices are largely exogenous, they can be regarded as an important driver of EMEs' business cycles.

Model

We then build a dynamic general equilibrium model guided by the stylised facts discussed, where we formally articulate a mechanism by which exogenous changes in commodity prices turn into fluctuations in real economic activity.

The set-up of our model is a multi-country version of the small, open economy framework first developed by Mendoza (1991), and further analysed by Schmitt-Grohe and Uribe (2003). We make five departures from such a framework. First, we add a country-specific commodity sector that faces fluctuations in the price of the good it sells in international markets. These fluctuations are exogenous, as we assume that the countries are small players in these markets. The commodity good is an endowment that is entirely sold abroad and the income generated accrues directly to the households who own the sector. Second, there are foreign and (country-specific) home goods, which are imperfect substitutes when consuming them or using them to produce investment goods. Home goods are produced domestically using capital, labour and domestic productivity. Productivity is subject to a random shock. Foreign goods are imported from the rest of the world. Third, there is a sector that produces investment goods using home and foreign goods as inputs. As in the standard framework, households in each EME can issue non-state-contingent, one-period bonds in international financial markets. Such bonds will pay a premium over the world interest rate. Both the premia and the world interest rate are exogenous and stochastic, acting as two additional driving forces. The structure with which we model commodity prices constitutes a fourth novelty of our framework. We model them with a dynamic factor structure that incorporates a latent common factor in addition to idiosyncratic shocks. This structure is intended to capture the strong co-movement across EMEs in the data documented in the previous section. Fifth, the multi-country structure of our framework comes from jointly modelling a collection of EMEs that interact with the rest of the world as small, open economies. The sole source of co-movement across these EME comes from shocks to the common factor in the prices of the commodity goods that they sell in international markets.

There are four agents in each EME considered in the model: households, firms, investment goods producers and the rest of the world (which does not include the other EMEs in the model). Households consume final goods, defined as a bundle of home and foreign goods; decide how much labour and capital to supply to domestic firms; and issue bonds in foreign markets. They also purchase investment goods to replace depreciated capital and increase the net stock of capital for which they face capital adjustment costs. Besides income from the commodity sector, they receive profits from firms, as well as capital and labour income. Firms maximise profits, defined as the revenue from selling home goods net of the costs of renting labour and capital from households. Home goods are produced with a standard neoclassical technology and sold to households, to investment goods producers or to the rest of the world. Investment goods producers use a technology that combines home and foreign goods. They later sell these goods to households for capital accumulation purposes. The fourth agent is the rest of the world. It provides funding for households at a stochastic premium over the world interest rate. It also demands home goods for its own consumption as a function of both their relative price and a price elasticity, as well as exogenous external demand shocks. Finally, it provides (foreign) goods that are imported by households for their own consumption or used as inputs by investment goods producers.

Taking the Model to the Data

Next we take this model to the data of emerging economies with the main goal of quantitatively assessing the strength of this mechanism by which commodity price shocks lead to movements in real economic activity and we compare it with alternative driving forces of the business cycle in these economies.

We pick a sample of four EMEs to estimate the model: Brazil, Chile, Colombia and Peru. This pool of only four economies is, nonetheless, representative of the type of economies modelled in our theoretical framework. The four countries are all well-known commodity exporters, with a median commodity export share of 35.4 per cent.

There is also strong evidence in favour of common factors affecting the macro dynamics in these four countries. The first principal component explains 81 and 67 per cent of the variance in the commodity price indices and real output across the four economies, respectively.

When assigning values to the parameters in the model, we follow a strategy that uses both calibration and formal estimation methods. A subset of the parameters in the model, in particular those that determine the steady state of the model, are either taken from previous studies or calibrated so as to match certain long-run ratios in the data. The latter is an important prerequisite to disciplining the quantitative exercise.

The remaining subset of parameters is estimated using Bayesian techniques. These parameters do not govern the model's steady state, but do govern the short-run dynamics of the model—namely, the persistence of the driving forces, the standard deviation of their shocks, the loading factors in the dynamic common factor, and those that determine the cost of adjusting the capital stock.

The estimation uses as observables quarterly time series data on seven variables from each of the four countries considered that have a direct mapping onto the variables in the structural model: real private consumption, real income, real investment, the trade balance-to-GDP ratio, the EMBIG spread, the real effective exchange rate and the commodity price index. Two additional observables are the three-month real US Treasury bills rate and United States real GDP, as proxies for the world interest rate and foreign aggregate demand, respectively. The model is estimated on a balanced panel that covers the period 2000Q1 to 2014Q3. In the measurement equations, the data are expressed in log-deviations from the Hodrick–Prescott trend and are measured as percentages. Interest rates and EMBI are measured in logs of gross rates.

Estimation Results

We use the estimated model to document the main business cycle drivers. Our first tool with which to accomplish this, is the forecast error variance decomposition (FEVD) of real income across the four countries and at various forecast horizons. Commodity price shocks play a large role, only comparable to that of productivity shocks. Their share in the unconditional forecast error variance decomposition (FEVD) of income displays a median of

42 per cent, ranging from 27.5 per cent in Brazil up to 77.1 per cent in Chile, with Colombia (43.5 per cent) and Peru (40.4 per cent) in between the two. Moreover, in all four countries a considerable amount of this share is related to the common factor in commodity prices. The remaining three external shocks to foreign demand, the world interest rate and spreads do not account for a large share of output's unconditional FEVD, with the exception of Brazil where interest rate shocks do play a role. This last point is related to the considerably large stock of external debt that Brazil has, relative to that in the other countries.

Concluding Remarks

This paper has shed light on the nature and relative importance of external forces as drivers of aggregate fluctuations in emerging market economies with a special focus on commodity prices. It has involved both a careful study of the stylised facts in the data and an attempt to structurally identify these external forces by estimating a dynamic, stochastic equilibrium model. We have found support for the view that these external forces are relevant and that their sources can mostly be traced back to exogenous changes in the prices of the commodity goods that these economies export, which are viewed through the lens of the theory as large income shocks. A salient characteristic of these movements—easily comparable to a wild roller-coaster ride—is that they share a common factor. The latter cannot be solely attributed to these economies exporting similar commodity goods. Indeed, the common factor arises also because there is a marked tendency for the prices of different commodity goods to move in tandem. Furthermore, the real effects generated by the fluctuations in the prices of these commodity goods can be amplified by the fact that they are often accompanied by movements in interest rates in opposite direction. Lastly, while movements in these relative prices have most often amplified the business cycle of EMEs, there are instances where they have served as cushion devices against other forces. This was the case during the recovery after the world financial crisis when a rapid reversal of commodity prices helped to counterbalance negative shocks from domestic and external sources.

The simplicity of the theoretical framework with which we have looked into the data has served us well for the kind of question that we set out to answer. However, that same simplicity has also left aside important issues that are worth exploring in subsequent work. One such important topic is to try to uncover the role of government in the mechanism through which changes in commodity prices affect the real economy. Also worth exploring is the type of optimal fiscal and monetary policies that may be implemented to counteract the effect of these shocks.

6.5 COMMENTS BY CÉDRIC TILLE AND JOSHUA AIZENMAN

CÉDRIC TILLE (LEFT) *The Graduate Institute, Geneva*
JOSHUA AIZENMAN (RIGHT) *University of Southern California and the NBER*

— Tille, C. and Aizenman, J., "Comments by Cédric Tille and Joshua Aizenman", Research Workshop, in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 103–111.

- *Workshop Panel 1: Aggregate Effects and Monetary Policy*

Gyrations in commodity prices present policymakers in emerging economies, and beyond, with a broad range of challenges. The four papers in this panel consider complementary angles on this broad issue. Osorio focuses on the heterogeneous effect of commodity price movements and their distributional implications. Guarín, Hamann and Rodríguez consider how inflation expectations at different horizons are affected. Chu Khanh points out that the policy response to movements in prices needs to take account of the underlying shock. Finally, Fernández, González and Rodríguez assess the impact on the business cycle beyond the commodity-producing sector. In my remarks, I provide comments on each paper before drawing some general conclusions.

The analysis by Osorio, "Optimal Monetary Policy and Risk Sharing under Commodity Shocks", presents an open-economy model of a country with a fluctuating endowment of commodities. The central feature is to depart from a representative-agent approach to show the distributional consequences of commodity price movements. The paper carefully analyses an overlapping generation model with young,

middle-aged and old agents. The model is calibrated to ensure that agents borrow when young and save for retirement when they are middle-aged. Financial markets are limited: there is no financial integration with the rest of the world and agents can only trade a bond domestically. This implies that the uneven impact of commodity prices across generations cannot be handled through contingent assets or insurance contracts. As monetary policy also has a different impact across generations, it can be used to improve the pattern of risk-sharing. The author shows that taking this into account, the optimal policy is similar to a stabilisation of producer prices (excluding commodity prices), but differs from a stabilisation of consumer prices.

The paper raises an interesting point by showing how a central bank can affect risk sharing across agents in the country. While a similar point has been made in the literature, this paper focuses on international risk sharing across countries that are each inhabited by a representative agent. These results raise the question of whether the central bank, which is an aggregate actor, should be concerned with the heterogeneity of the impact of its policy. I think that one can make a case in the context of *international* risk sharing as there is no other policymaker taking the aspect into account. The case is harder to make for *intra-national* risk sharing however as other tools, such as fiscal policy, are available. One could thus argue that the central bank should keep a focus on aggregate variables and not be concerned about the heterogeneity within the country.

The modelling framework implies that all economic shocks have a distributional impact as national income is not evenly spread across the population. The movements in commodity prices are one particular illustration, but we can expect other forms of volatility (technology shocks, government spending shocks) to have a similar effect. It would be interesting to assess whether commodity price movements have a particularly pronounced distributional impact compared to other sources of economic fluctuations.

The work by Guarín, Hamann and Rodríguez, "The Effects of Oil Price- and Weather-Related Shocks on the Anchoring of Inflation Expectations: The Colombian Case (A Brief Summary)", provides a thorough and careful analysis of how movements in oil shocks and commodity prices more generally affect inflation expectations. The authors measure inflation expectations using the spread in yields between inflation-indexed government bonds and standard government bonds of a similar maturity, an approach that is standard in the literature. Instead of relying only on one horizon, the authors compute a broad range of expectations for different durations starting at different points in the future. They then contrast their measurements with the official inflation target and identify times of de-anchoring when expectations exceed the target range. A thorough econometric analysis allows them to identify that weather events that impact food prices and oil prices help predict de-anchoring episodes. The impact is quite homogeneous at all maturities, as inflation expectations do not become de-anchored only over the next two years, but also at longer horizons.

The analysis uses a standard approach in the literature of inferring inflation expectations from yields in different types of bonds. However, it has long been recognised that

even in mature markets, such as the one for US treasury bonds, this spread moves for reasons other than inflation expectations, for instance reflecting the different liquidity of the various types of bonds. The high volatility of spreads seen in the data thus may not reflect true movements in expectations. After all, I would expect long-term inflation expectation to be quite inertial, with sharp moves being clearly attributable to a change of policy regime. I thus think that the paper should take the time to make a clear case that the spread in yields can confidently be interpreted as a measurement of inflation expectations.

The analysis shows that expectations are de-anchored most of the time. Should we interpret this as the policy framework profoundly lacking credibility? Another possibility is that the level of expectations should be approached with caution, as—for instance—in many countries surveys of consumers' expectations can show an average level that appears at odds with the country's experience. The paper's approach also focuses on a binary characterisation of expectation being anchored or de-anchored. I think that undertaking the analysis on the actual value of expectations would be also useful, as this allows for a more continuous assessment than the binary framework. A complementary approach is to consider whether the persistence of inflation movements is affected, as the literature has shown that policy regimes with a clear focus on inflation lead to limited persistence as any movement in inflation is quickly followed by a convergence to the policy target.

Chu Khanh's paper, "Monetary Policy Responses to Different Oil Price Shocks: The Case of Vietnam", provides an empirical assessment of the impact of oil shocks on growth, inflation and the interest rate in Vietnam. The paper emphasises that one should control for the exact cause of movements in oil prices. Specifically, the analysis uses a VAR approach on world variables to distinguish between supply shocks, general demand shocks and shocks specific to demand for oil. This approach replicates the earlier analysis by Killian (2009).

The response of the Vietnamese economy to movements in oil prices is quite different depending on the source of shock. Supply shocks have little effect, and generate little policy movement. Oil-specific demand shocks lead to a temporary increase in inflation, a policy tightening and somewhat lower growth. General demand shocks raise growth and inflation, and are associated with an easing of monetary policy.

The analysis raises the question of whether policymakers can improve their response to shocks. The response seems appropriate in the case of supply and oil-specific demand shocks, as policy leans against imported inflation following adverse terms-of-trade movements. The situation is more contrasted in the case of general demand shocks, as policy seems to lean into the wind. However, this could reflect constrained, rather than mistaken, policy. Specifically, a boom in world demand raises the oil price and the demand for Vietnamese exports. It also can lead to a surge of capital inflows. In response to this surge the central bank can choose to lower the interest rate to discourage inflows, but this policy is in tension with the domestic business cycle as it can allow inflation to increase. I thus recommend extending the

analysis to the exchange rate and the current account, as this would capture any impact through international capital flows.

In the fourth paper of the panel, "Ride on the Commodities Roller Coaster: Common Factors in the Business Cycles of Emerging Economies", Fernández, González and Rodríguez assess the relevance of commodity prices for business cycles in emerging economies. They first show that the business cycle is closely correlated with prices across a large range of countries. They find that the commodity price cycle displays a substantial global component. It leads the business cycle, appreciates the currency and lowers the risk premium. The authors then build a calibrated theoretical model to assess the linkages. An important element is to treat commodity production as an endowment, so the analysis focuses on the business cycle in the sectors of the economy that do not produce commodities. The model shows that higher commodity prices raise consumption through a wealth effect, raise investment and lower other exports because of a loss of competitiveness. Growth movements are driven by productivity and commodity shocks to a large extent, with interest rate and premium shocks having only a minor impact.

The limited role of world interest rates and risk premium shocks is a puzzling aspect that warrants further investigation. A growing literature argues that the global financial cycle has grown more relevant in recent years, which in the context of the model would translate into a large role for exchange rate premium shocks. This suggests that commodity price shocks in the model could proxy for the global financial cycle. Specifically, a global risk-appetite cycle could drive both financial returns *and* commodity prices, and thus the commodity shocks can really be interpreted as financial market shocks. The paper also finds a sizable contribution of productivity shocks, which raises the usual issue of how to interpret the Solow residuals as these can proxy for other aspects, such as a varying intensity of use of inputs.

Overall the four papers in the panel clearly show that commodity cycles drive growth, impact expectations and raise policy challenges. The source of movements in commodity prices is an important aspect. In particular, an increase due to an expansionary phase of the global financial cycle, which raises all asset prices, is likely to have a very different impact from an increase due to a tightening of supply.

The papers also show that the distributional consequences of commodity prices can be acute. It nonetheless remains to be clearly assessed whether this dimension should be a concern for the central bank or whether it should be left to other policymakers.

The papers also suggest that emerging economies, being particularly exposed to commodities, could need an inflation-targeting regime that is more stringent than that implemented in advanced economies in order to stabilise inflation expectations. In that respect, it is worth remembering that commodity exporting countries such as Australia and New Zealand were at the forefront of the development of the inflation-targeting framework.

- *Optimal Monetary Policy and Risk Sharing under Commodity Shocks*
  Daniel Osorio

This paper characterises optimal monetary policy responses to commodity shocks in a small, open, commodity-producing economy where financial markets are incomplete and, as a consequence, risk-sharing is suboptimal. A benevolent monetary authority has an incentive to mitigate the deflationary effects of a negative commodity shock in order to improve on risk-sharing and financial stability. The optimal monetary policy rule arises from a trade-off between the stabilisation of the debt-to-output ratio and the traditional objectives of inflation and output stabilisation. Optimal policy in the face of commodity shocks is found to be closer to producer price inflation (PPI) targeting than to consumer price inflation (CPI) targeting or an exchange rate peg.

Is a commodity shock mostly a wealth shock, as is presumed in this paper? Frequently, adverse commodity shocks induce debt deflation, raising the probability of defaults on loans funding past commodity-related investment, and of higher defaults on consumer loans. Adverse commodity shocks also tend to reduce investment in exploration, and lead to a fall in maintenance of the existing production capacity.

Should monetary policy be burdened with risk-sharing? Chances are that fiscal-cum-transfer policy has a comparative advantage in dealing with these issues. A commodity-producing country may also benefit from having, and actively managing, a sovereign wealth fund (SWF), and following a countercyclical fiscal rule.

Should monetary policy be burdened with financial stability? Maybe, though the first best policy mix should include prudential regulation (leverage regulation, reserve ratios, etc.)

The focus of this paper is on risk-sharing across generations, assuming a representative agent for each generation. This presumes efficient risk-sharing among agents in each generation, an assumption that better fits Scandinavian countries than emerging market economies (EMEs).

The paper does not model the banking system, presuming no access to risky instruments and to foreign borrowing. It would be useful to analyse the role of the financial exposure associated with external debt. This issue may be pertinent for Colombia—its current account deficit doubled from 3 per cent of GDP in 2007 to 6.5 per cent in 2015. This trend led the Economist Intelligence Unit (EIU) to comment, 'The sovereign rating [of Colombia] was downgraded to BB in our May 2016 report, owing to a collapse in oil prices that has triggered deterioration in fiscal and external balances, and slower economic growth. Commodities exports generate a large share of foreign earnings and fiscal revenue, sustaining the economy's vulnerability to external shocks. A persistent current-account deficit and fiscal rigidities also weigh on the rating. However, Colombia has never defaulted, which underpins its creditworthiness.' See *http://country.eiu.com/article.aspx?articleid=654524849&Country=Colombia&topic=Risk&subtopic=Credit+risk&subsubtopic=Overview*.

The paper's main result: 'Optimal policy in the face of commodity shocks is found to be closest to Producer Price Inflation Targeting than to Consumer Price Inflation Targeting or an Exchange Rate Peg' is in line with other papers, which reach this conclusion independently of intergenerational risk-sharing motives (Frankel, J., 'A comparison of product price targeting and other monetary anchor options for commodity exporters in Latin America'. *Economia* (2011), and 'Product Price Targeting—A New Improved Way of Inflation Targeting'. *MAS Monetary Review*, (2012)).

- *The Effects of Oil Price- and Weather-Related Shocks on the Anchoring of Inflation Expectations*
  Alexander Guarín, Franz Hamann and Diego Rodríguez

This paper outlines an empirical model to predict periods of de-anchoring of inflation expectations for several forecasting horizons based on the probability of the occurrence of such episodes. The paper applies this methodology to Colombian data with monthly frequency between January 2003 and April 2016 and forecasting horizons, h to 0, 3 and 6 months. Increases in the intensity of 'Niño' and in international food prices lead to a higher probability of de-anchoring, while changes in Brent oil prices and the intensity of 'Niña' events lead to mixed results and depend on the forecasting horizon. The non-linear exercises show that the probability of de-anchoring is extremely high when the 'Niño' phenomenon displays high intensities.

Why should we care about short-run CPI fluctuations if most of the shocks are real shocks, with limited and time varying persistence? Suppose that weather doubles the price of food items, but this process has a mean reverting component. Should the central bank (CB) tighten short-run policy interest rates due to higher short-run inflation?

Not according to the practice of the US Federal Reserve (Fed). The Fed closely tracks other inflation measures as well, including the CPI and PPI. Because inflation numbers can vary erratically from month to month, policymakers generally consider average inflation over longer periods of time, ranging from a few months to a year or longer. Policymakers examine sub-categories of CPI and PPI to determine if a rise in inflation can be attributed to price changes that are likely to be temporary or unique events. Since the Fed's policy works with a lag, it must adopt policy based on its best forecast of inflation. Therefore, the Fed must try to determine if an inflation development is likely to persist or not. Policymakers examine a variety of 'core' inflation measures to help identify inflation trends. The most common type of core inflation measures exclude items that tend to go up and down in price dramatically or often, like food and energy items. For those items, a large price change in one period does not necessarily tend to be followed by another large change in the same direction in the following period. Although food and energy make up an important part of the budget for most households—and policymakers ultimately seek to stabilise overall consumer

prices—core inflation measures that leave out items with volatile prices can be useful in assessing inflation trends. See *http://www.federalreserve.gov/faqs/economy_14419.htm* for further details.

A too orthodox view of inflation targeting would imply that the Fed needed to contract its policies in 2012. Luckily, the Fed knew better. Similar advice may apply to Colombia.

A suggestion—focus on filtering the CPI inflation into core and non-core inflation. Relate the core and non-core inflation to the 'expected intermediate-run inflation,' to gauge the factors contributing to the possible de-anchoring of inflation. There is no obvious reason why the central bank should react to real shocks that are viewed as transitory. Similarly, there are no obvious reasons why, or answers how, the CB should react to real shocks that are viewed as permanent. As long as the CB is not compelled to fund the adverse fiscal implications of real shocks by 'printing money,' it should focus more on targeting core inflation, and less on the short-run inflationary trends induced by commodity shocks.

- *Monetary Policy Responses to Different Oil Price Shocks: The Case of Vietnam*
  Lan Chu Khanh

This paper assessed the impact of oil price fluctuations on the Vietnamese economy and the responses of monetary policy. Unexpected oil supply disruption can lead to stagflation in Vietnam's economy. With regard to the responses of monetary policy, the State Bank of Vietnam (SBV) follows the price stability target when an oil price fluctuation is caused by oil supply and oil-specific demand shocks. However, it chooses to implement an expansionary policy in response to oil price increases driven by unanticipated higher global demand, and this contributed to the build-up of inflation in 2008 and 2011.

This is a case study documenting the pro-cyclicality of monetary and fiscal policy in Vietnam. It suggests that Vietnam may benefit from institutional reforms.

The author notes, 'falling oil prices since mid-2014 have put a squeeze on the state budget (it has shrunk significantly since 2008; in 2015, monies from oil exporting accounted for only 7 per cent of government revenue), constraining the government's ability to intervene in the economy and partly reducing the effectiveness of accommodative monetary measures to boost economic growth.' 'only 7 per cent'?—7 per cent of government fiscal revenue is a significant share. Countercyclical fiscal policy can help.

The history of Latin America suggests that the prime role of the central bank lies in taming inflation and bolstering financial stability. CB attempts to 'support growth' may destabilise inflation over time.

The author notes, the central bank worries about the negative impact of higher oil prices on real activity because Vietnam's economic growth relies largely on imported oil products as inputs to production.' It would be useful to verify the impact of higher oil

prices on the commodity terms of trade of Vietnam, and how monetary policy can deal with this.

Tell us more about the management of the exchange rate regime: was it part of the problem?

- *Sharing a Ride on the Commodities Roller Coaster: Common Factors in the Business Cycles of Emerging Economies*
  Andrés Fernández, Andrés González and Diego Rodríguez

This paper documents how fluctuations in commodity prices correlate strongly with the business cycle in EMEs. The paper embeds a commodity sector into a multi-country EME business cycle model, where exogenous fluctuations in commodity prices follow a common dynamic factor structure and coexist with other driving forces. The estimated model assigns to commodity shocks 42 per cent of the variance in income, of which a considerable part is linked to the common factor. A further amplification mechanism is a 'spillover' effect from commodity prices to risk premia.

A missing key variable—The commodity terms of trade (CTT) of a country is a useful variable for evaluating a country's exposure to commodity shocks. Specifically, the CTT of a country that exports (x) commodity c and imports (m) commodity o is defined by: $\mathrm{CTT} = \frac{(\mathrm{P_c})^{\mathrm{s_{xc}}}}{(\mathrm{P_o})^{\mathrm{s_{mo}}}}$, where $\mathrm{s_{xc}}$ and $\mathrm{s_{m0}}$ are the GDP share of exports of c and imports of o respectively, and $\mathrm{P_c}$, $\mathrm{P_o}$ are the commodity prices. A commodity terms of trade shock increase country's income by about $\mathrm{dlog(CTT)} = \mathrm{s_{xc}} * \mathrm{dlog(P_c)} - \mathrm{s_{mo}} * \mathrm{dlog(P_o)}$ (measured as a fraction of GDP). This definition can be readily generalised to a vector of exports and imports. For further details, see Spatafora, N. and I. Tytell (2009), *Commodity Terms of Trade: The History of Booms and Busts*, IMF WP/09/205. This paper does not control for changes in the CTT, and may thereby overstate the role of the 'common commodity factor'.

Various simplifying assumptions used in the model overlook important aspects of EMEs:

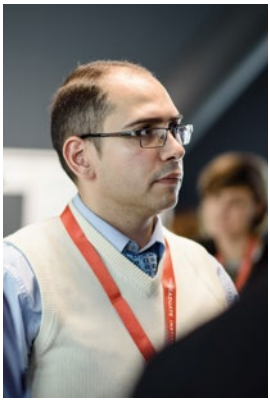
- Households borrow and save at the same interest rate, equal to the 'gross external real interest rate'; this assumption negates any role for domestic banks, financial intermediation risk, and the like;
- The paper assumes that, 'default decisions are modelled assuming that private domestic lenders always pay their obligation in full but that in each period there is a probability that the local government will confiscate all the interest payments going from local borrowers to foreign lenders.' Therefore, a default is modelled as a transfer to the local government. Yet, the paper does not model the role of local governments, and the possible use (or misuse) of resources transferred from the private sector to the government;
- External defaults are correlated with domestic banking crises, impacting households, yet not modelled; and,

- The paper's presumption that, '[t]he commodity good is an endowment' does not match the facts. Extracting commodities requires maintenance and the investment needed to deal with depreciation.

The model does not tell us about the role of active buffer policies, and the way they may be integrated with exchange rates and monetary policy.

The representative agent model, with access to the global financial market subject to an exogenous stochastic risk premium, does not fit well most non-OECD commodity-producing countries. A sizable share of households are employed in the informal sector, without access to the capital market and to the formal banking system. Without modelling the differential access of household and firms to the financial system, the DSGE model applied in this paper misses important factors accounting for the business cycles of commodity-producing countries. For a recent overview of these challenges and of models that go beyond the representative agent model, see Dou, W.W., A.W. Lo and A. Muley (2015), *Macroeconomic Models for Monetary Policies: A Critical Review from a Finance Perspective*.

6.6 PERMANENT AND TEMPORARY OIL PRICE SHOCKS, MACROECONOMIC POLICY AND TRADABLE NON-OIL SECTOR: CASE OF AZERBAIJAN, KAZAKHSTAN AND RUSSIA



RAMIZ RAHMANOV
Central Bank of the Republic of Azerbaijan

— Rahmanov, R., "Permanent and Temporary Oil Price Shocks, Macroeconomic Policy and Tradable Non-oil Sector: Case of Azerbaijan, Kazakhstan and Russia", Research Workshop, in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 113–120.

Introduction

In the last two years, the oil market experienced a series of negative price developments. Brent crude oil prices had declined from the peak of USD 111.6 in June 2014 to the trough of USD 30.7 in January 2016. The fall in oil prices observed this time around fundamentally differs from the drop that occurred during the most recent financial crisis. The latter decline resulted from market anxiety surrounding liquidity problems provoked by the insolvency of Lehman Brothers, while the former fall was rather engendered by structural changes in demand and supply.

In the former Soviet Union, there are three major oil exporting countries: Azerbaijan, Kazakhstan and Russia. These countries are characterised by a high dependence on oil in trade and fiscal accounts. When the negative oil price shock hit the oil market, the inflow of petrodollars slowed down, which in turn put pressure on national currencies. To prevent foreign exchange reserves from falling to critical levels, the central banks in these countries had to devalue their

currencies and change exchange rate regimes. Additionally, the governments of these countries started optimising their spending and suspending low priority projects.

Numerous studies have examined the relationship between changes in oil prices and macroeconomic variables in oil exporting countries. One strand of the literature assumes that economies respond symmetrically to negative and positive shocks (Rautava, 2004; Ito, 2008). Another strand instead argues that economies respond differently to negative and positive oil price shocks and therefore distinguishes these two kinds of shocks (Rahmanov, 2009; Koh, 2016). A third strand, along with estimating the impact of either symmetric or asymmetric oil price shocks aims to determine the nature of the shocks using structural vector autoregression (SVAR) models (Kose and Baimaganbetov, 2012; Karimli et al., 2016). Despite the diversity of approaches, there exists a consensus about the existence of a significant positive relationship in oil exporting countries between oil prices on the one side and output and fiscal spending on the other.

In this paper, following the permanent income hypothesis (PIH) of Friedman (1957), which proposes that consumption responds to permanent changes in income rather than temporary changes, I argue that fiscal spending in oil exporting countries responds only to permanent oil price changes. To test the proposition, I estimate a five-variable vector autoregression model with two exogenous variables (VARX)—permanent and temporary oil price shocks—for Azerbaijan, Kazakhstan and Russia using quarterly data over the period 2003–15. The results for Azerbaijan and Kazakhstan support the PIH, while the result for Russia, that real budget expenditure responds to a temporary oil price shock, contradicts the PIH. Such a counter-intuitive reaction of fiscal spending in Russia can be explained by the rule used to manage oil revenues. As regards the presence of the symptoms of the Dutch Disease, the results indicate only one symptom—appreciation of the national currency.

Methodology

In this paper, to investigate the impact of permanent and temporary oil price shocks on the real economy, I use a quarterly VARX with five endogenous and two exogenous variables. The endogenous variables considered in this model are the following: real short-term interest rate, real effective exchange rate, real budget expenditure, real imports and real tradable non-oil GDP. The set of exogenous variables includes a nominal permanent oil price shock and a nominal temporary oil price shock. Here I use the assumption that the oil price is an exogenous factor for these economies. For the analysis of the reactions of the economic variables to permanent and temporary oil price shocks, I estimate impulse responses functions (IRFs).

The composition of the endogenous variables is motivated by both the propagation mechanism of the oil price shocks and the interest of the paper in examining the impact of the oil price shocks on macroeconomic policy and the tradable non-oil sector. Changes in oil prices affect budget revenues and therefore the spending capacity of the government.

Expenditures in turn have a significant effect on demand, which can be met through either higher imports or domestic production. Fluctuations in the inflow of petrodollars also

affect the supply of the foreign currency into the country and therefore affect the value of the national currency. Changes in the value of the national currency, in turn, affect its purchasing power and can influence country imports. Additionally, the variable set includes a real short-term interest rate to capture the reaction of the monetary sector to inflationary pressures coming from increased demand.

The vector auto regression (VAR) model contains real permanent and temporary oil price shocks to test the PIH, which states that only changes in permanent income have an influence on consumption. Following the logic of this hypothesis, one can suggest that the fiscal spending in oil exporting countries has to react only to permanent oil price shocks because only permanent changes in oil prices will cause permanent changes in oil revenues. Besides, the analysis of the VAR model will allow us to test whether these countries have the symptoms of the Dutch Disease. The Dutch Disease theory predicts that a large inflow of petrodollars into the economy has to lead to the appreciation of the domestic currencies, a decline in manufacturing, an increase in wages, and fast growth of the non-tradable sector (Esfahani et al., 2013; Mohaddesand Pesaran, 2013). In this VAR specification, it will be possible only to test the impact of oil price shocks only on the real exchange rate and tradable non-oil sector.

Data

The sample period is almost the same for all countries; it runs from 2003Q1 to 2015Q4 for Azerbaijan and Kazakhstan and from 2003Q4to 2015Q4 for Russia. The oil price is defined as the spot price of the Brent brand of crude oil in USD. The real short-term interest rate is the nominal short-term lending rate adjusted for inflation. For Azerbaijan and Kazakhstan, the short-term lending rate is an average rate on credits up to one month charged from individuals and firms; for Russia, it is an average rate on credits up to one year charged from firms. The real budget expenditure represents the expenditure of the consolidated budget in the national currency deflated by the CPI. The real non-oil tradable GDP stands for the total real value of production in agriculture and manufacturing expressed in the national currency. All variables except real interest rates are expressed in logs.

As the purpose of the analysis is to determine the impact of permanent and temporary oil price shocks, one should extract permanent and temporary components from the oil price series. To decompose the oil price series into permanent and temporary components, I use the Kalman filter. A permanent oil price shock series is defined as a growth rate of the permanent component of the oil price series, and a temporary oil price shock series is defined as a growth rate of the temporary component of the oil price series.

The time series properties of the variables were assessed by the augmented Dickey Fuller and Kwiatkowski–Phillips–Schmidt–Shin tests. For Azerbaijan, all variables are found to be first-difference stationary series. For Kazakhstan and Russia, the real short-term interest rate is determined to be a stationary process and the other series are determined to be first-difference stationary processes.

Empirical Results

In the VAR estimation the lag order selection is an important issue. As the sample sizes are relatively small, to select the lag order this paper uses a Schwarz criterion (SC) because of its parsimony setting the maximum lag order to five. The SC indicates that for all country VARX models the optimal lag order is one. Figures1–3 show the responses of macroeconomic variables to temporary and permanent positive oil price shocks for 20 quarters together with their 68 per cent error bands for Azerbaijan, Kazakhstan and Russia.

The PIH implies that government budget expenditures have to respond only to permanent oil price shocks. However, the IRF analysis shows that the PIH holds for Azerbaijan and Kazakhstan but not for Russia. The reason why the hypothesis does not hold for Russia is that the way that oil revenues enter the budget in Russia differs from that in Azerbaijan and Kazakhstan. In Russia, every year Parliament determines the amount of transfers to be made to the budget for the next fiscal year from oil revenues formed by hydrocarbon production taxes and hydrocarbon export duties. In normal times, the amount cannot exceed 3.7 per cent of the forecasted GDP of that year. After the oil transfer to the budget is made, the remaining part of the oil revenues goes to the stabilisation fund, whose objective is to help maintain spending of a social character during a downturn. The amount of the transfers to the stabilisation fund cannot exceed 10 per cent of the forecasted GDP of that year. Any amount above 10 per cent of forecasted GDP goes to the National Welfare Fund, whose objective is to co-finance the deficit of the Pension Fund. However, from 2010 these quantitative rules have not been applied and all oil revenues go to the federal budget. This description of the Russian oil revenue usage policy shows that even during periods in which the quantitative rules were applied, the government did not distinguish between permanent and temporary fluctuations in oil revenues. In such circumstances, it is not surprising to observe that budget spending in Russia responds to both permanent and temporary oil price shocks. In Azerbaijan and Kazakhstan, the procedure for the management of oil revenues is different. There, most oil revenues are directly accumulated in wealth funds. Then, for each fiscal year, the respective governments, together with the respective parliaments, decide on the amount of transfers to be made from the stock of the funds. Such a discretionary policy allows policymakers and lawmakers to consider their expectations with regard to developments in the oil market before they make a decision on the amount to be transferred, and thereby to some extent makes the oil revenue transfers secure from the effects of short-term price fluctuations.

In all three countries, real imports respond positively to both types of oil price shock. In fact, one expects that imports will not respond to temporary oil price shocks because imports are a part of consumption and therefore, according to the PIH, imports need to respond only to permanent shocks. Although a positive and significant response to temporary oil price shocks for Russia is not surprising (as a temporary oil price shock significantly affects budget spending), it is an unexpected result for Azerbaijan and Kazakhstan. In fact, imports usually

grow if either income increases or the exchange rate appreciates, or both movements occur. Therefore, it is likely that temporary oil price shocks affect imports through real exchange rate appreciation.

The IRFs show that real effective exchange rates in Azerbaijan and Russia appreciate when either temporary or permanent oil price shocks hit, while, in Kazakhstan, the real effective exchange rate responds only to temporary oil price shocks. Any positive oil price shock for oil exporting countries implies an increase in export revenues and thereby should lead to the appreciation of domestic currencies. However, the way oil price shocks affect the exchange rate is largely predetermined by the exchange rate regimes in place. During 2003–15, Azerbaijan and Kazakhstan maintained an exchange rate anchor to the US dollar. Until recently the Russian exchange rate was anchored to US dollar; however, now Russia is gradually moving to an inflation-targeting framework. This implies that generally, during the study period, Azerbaijan, Kazakhstan and Russia (for almost all periods) stuck to peg-type exchange rate regimes; therefore, the variation in the real effective exchange rates in these countries is explained by the variation in the exchange rates of the US dollar vis-à-vis the currencies of the trading partners and the variation in relative prices. A positive oil price shock leads to depreciation of the currencies of the trading partners, the majority of which are oil importers, and increases domestic price levels. These two factors in combination lead to the appreciation of the real effective exchange rates in these oil-rich countries. As exchange rate appreciation is one of the symptoms of the Dutch Disease, this result implies that this disease also affected Azerbaijan, Kazakhstan and Russia.

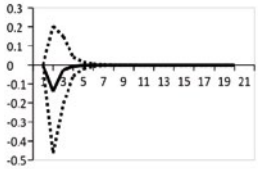
Along with the appreciation of the national currency, the Dutch Disease is supposed to lead to a decline in the tradable non-resource sector. However, the IRF analysis shows that, in fact, in Azerbaijan permanent oil price shocks, in Kazakhstan temporary oil price shocks, and in Russia both kinds of shocks have a positive effect on tradable non-oil output. Thus, the inflow of oil revenues does not hamper the other tradable sectors but instead promotes their development. Such an outcome is indebted to the policies of the governments concerned, which have set as their aim the development of the non-oil sector, in order to avoid the Dutch Disease.

The IRFs also show that the effects of oil price shocks last a short time. Esfahani et al. (2013) suggest that the quick adjustment to shocks can be explained by the low development of the financial sectors concerned, which offer a limited set of opportunities to smooth expenditure, therefore forcing economic actors to respond quickly as the circumstances change.

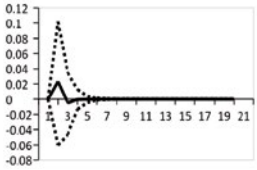
The other interesting finding is that the real interest rate in Azerbaijan does not respond to either permanent or temporary oil price shocks, while in Kazakhstan the real interest rate reacts to both kinds of shocks and in Russia the real interest rate responds only to permanent oil price shocks. This result shows that, in fact, the banking sector in Azerbaijan is isolated from the effects of developments in the main sector of the economy.

Figure 1: Responses to Positive One Unit Innovations With 68 Per Cent Bootstrapped Confidence Bounds—the Azerbaijani Case

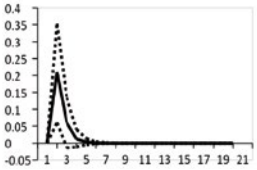
Response of the *real short-term interest rate* to a permanent oil price shock



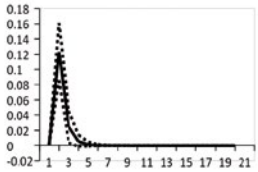
Response of the *real short-term interest rate* to a temporary oil price shock



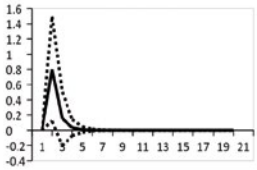
Response of *REER* to a permanent oil price shock



Response of *REER* to a permanent oil price shock



Response of real *budget expenditure* to a permanent oil price shock



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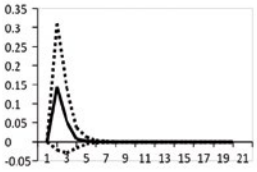
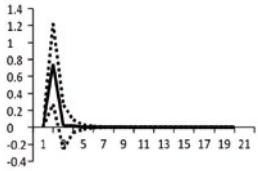
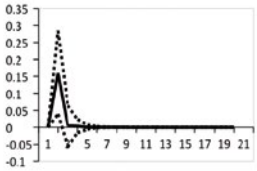


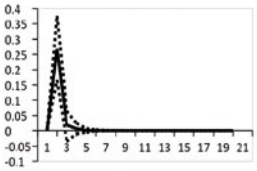
Response of *real imports* to a permanent oil price shock



Response of *real imports* to a permanent oil price shock



Response of *real tradable non-oil production* to a permanent oil price shock



Response of *real tradable non-oil production* to a permanent oil price shock

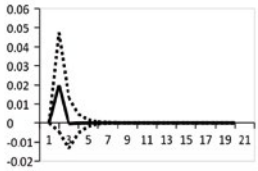
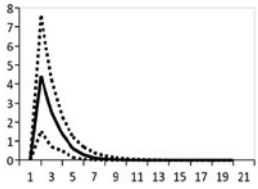
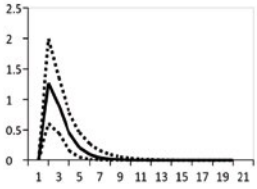


Figure 2: Responses to Positive One Unit Innovations With 68 Per Cent Bootstrapped Confidence Bounds—the Kazakh Case

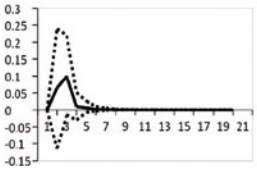
Response of the *real short-term interest rate* to a permanent oil price shock



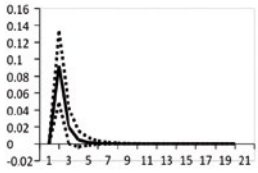
Response of the *real short-term interest rate* to a temporary oil price shock



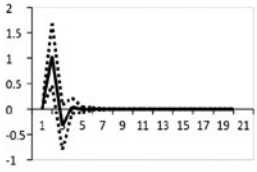
Response of *REER* to a permanent oil price shock



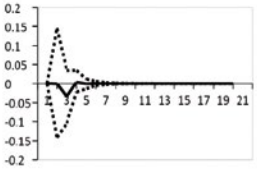
Response of *REER* to a permanent oil price shock



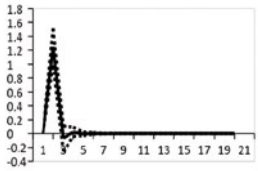
Response of real *budget expenditure* to a permanent oil price shock



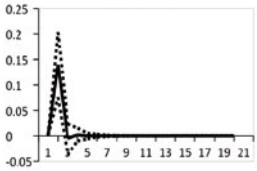
Response of real *budget expenditure* to a permanent oil price shock



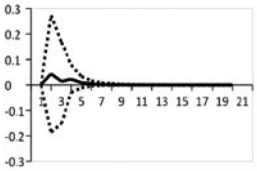
Response of *real imports* to a permanent oil price shock



Response of *real imports* to a permanent oil price shock



Response of *real tradable non-oil production* to a permanent oil price shock



Response of *real tradable non-oil production* to a permanent oil price shock

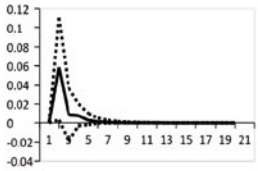
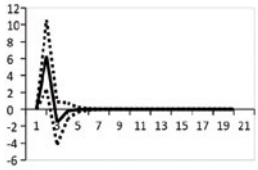
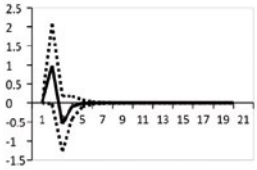


Figure 3: Responses to Positive One Unit Innovations With 68 Per Cent Bootstrapped Confidence Bounds—the Russian Case

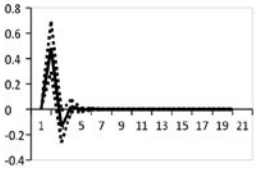
Response of the *real short-term interest rate* to a permanent oil price shock



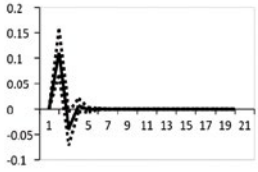
Response of the *real short-term interest rate* to a temporary oil price shock



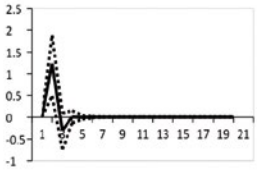
Response of *REER* to a permanent oil price shock



Response of *REER* to a permanent oil price shock



Response of real *budget expenditure* to a permanent oil price shock



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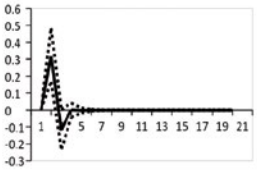
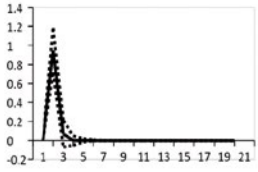


Response of *real imports* to a permanent oil price shock



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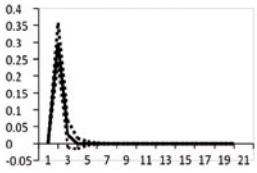
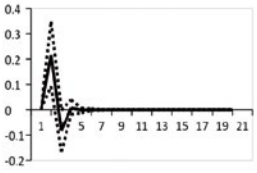
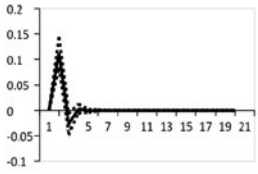


Response of *real tradable non-oil production* to a permanent oil price shock



Response of *real tradable non-oil production* to a permanent oil price shock



Policy Implications

The finding that a temporary oil price shock stimulates growth in the budget expenditure of Russia is the consequence of a fiscal rule that does not adjust the amount of the oil transfer to the budget for temporary fluctuations in oil prices. In Azerbaijan and Kazakhstan, there is no specific rule, but it seems that when the respective governments and parliaments decide on the transfer from the wealth funds to the budget they take into consideration the nature of changes in oil prices. In practice, the failure to distinguish between permanent and temporary changes can lead to undesirable consequences. If there is a temporary positive oil price shock and the government decides to increase social spending, which is irreversible, then after the positive temporary shock quickly decays the government can find it problematic to find the resources with which to fulfil increased social obligations. Therefore, the authorities need to design fiscal rules that account for the nature of oil price shocks.

The IRFs show that these countries have only one symptom of the Dutch Disease—real exchange rate appreciation. No evidence was found that an increase in oil prices leads to a decline in the tradable non-oil sector. Such a counterintuitive outcome is the result of the efforts of the governments of these countries to develop their non-oil sectors in order to avoid the Dutch Disease. Now, when oil prices experience a negative shock, the scale of the financial support of the government to the non-oil sector and domestic demand for the goods of the non-oil sector will drop, and this in turn will lead to a downturn in the tradable non-oil sectors. To minimise the negative effect of a fall in oil prices on the tradable non-oil sector, the authorities should assist firms in finding new markets to compensate for the decline in domestic demand.

6.7 TERMS OF TRADE, REAL EXCHANGE RATE AND NON-TRADITIONAL PERUVIAN EXPORTS

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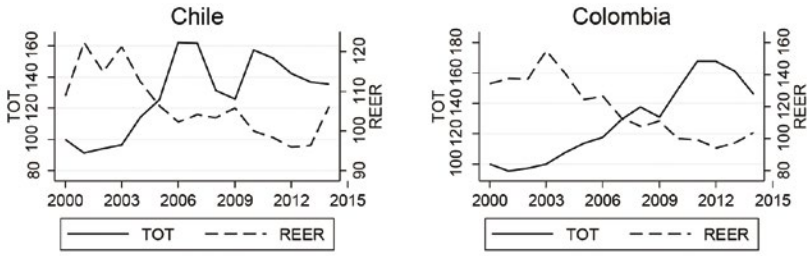
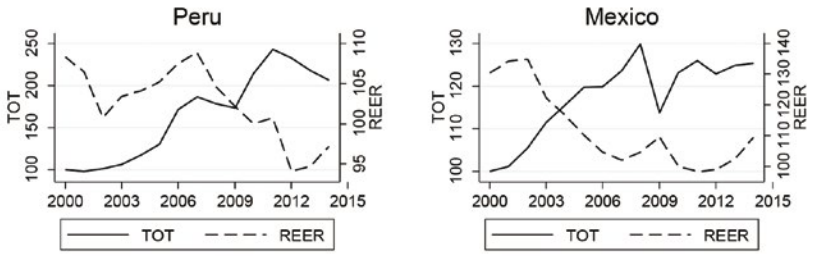
— Castellares, R., "Terms of Trade, Real Exchange Rate and Non-Traditional Peruvian Exports", Research Workshop, in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 121–130.

Latin American commodity exporters such as Chile, Colombia and Peru experienced a significant increase in their terms of trade from 2003 to the beginning of this decade. These episodes were characterised by current account surpluses, capital inflows and a significant appreciation of the real exchange rate (RER). A common concern among policymakers during these episodes has been the loss of competitiveness of manufacturing exports after an RER appreciation. Figure 1 depicts the recent evolution of the terms of trade and the RERs of Chile, Colombia and Peru. In all three cases, the inverse relationship between these variables is straightforward.

Figure 1: Terms of Trade and Real Effective Rate





In this work, we estimate the impact of the RER on Peruvian non-traditional exports (NTX), those which exclude commodity products from total exports, from 2007 to 2014.[1] During this period, both the terms of trade and the RER experienced significant ups and downs. The use of real exchange rates rather than terms of trade allows us to calculate bilateral real exchange rates (BRER) to exploit the variability across Peru's trade partners. Different from previous studies for Peru, we use firm size heterogeneity to evaluate the differentiated effects of RER movements on non-traditional exports.

This work follows closely the empirical strategy of Berman et al. (2012) and Berthou et al. (2015), who evaluate the impact of the RER on export prices and volumes and on the value of exports, respectively. Nevertheless, departing from the approach employed by these papers, we also analyse the impact of the RERs of Peru's competitors (CRERs) on NTX. Velásquez (2015), using Cuba and Ferreyra's (2011) measure of the RERs of Peru's competitors, find that the negative impact of the CRERs on Peruvian exports is smaller when competitors' productivity is higher. Different from Velásquez (2015), we evaluate the heterogeneous impacts of the RERs of Peru's competitors depending on Peruvian firms' productivity. Also, different from Berthou et al. (2015), we exploit detailed data on exports by destination at 8-digit product level from 2007 to 2014.

There are different theories that explain the heterogeneous effect of the real exchange rate on exporting firms' markups and prices. Berman et al. (2012) introduce heterogeneous firms to the model by Corsetti and Dedola (2005). In this model, the margin increases in response to a real exchange depreciation, but the effect is proportionally larger on more productive firms.[2] As a second extension, Berman et al. (2012) introduce real exchange rates on Melitz and Ottaviano's (2008) model. In this setup, the price expressed in exporter (importer) currency increases (decreases) more (less) in more productive firms when the RER increases. This is due to more productive firms having a less elastic demand.[3] This also implies that the number of units sold increases more in less productive firms. Based on this model, Castellares (2016) shows that the export value–RER elasticity is positive and larger in less productive firms.[4]

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1 Non-traditional exports' share of total exports is around 35 per cent.

2 Berman et al. (2012) also propose a model that includes firms producing goods with different levels of quality.

3 The demand function faced by firms is linear in this model, and more productive firms sell their product varieties at lower prices. This implies that the point elasticity is lower when firms' productivity is higher.

4 Berman et al. (2012) estimate the effects of real exchange rates on export prices and volumes, which respectively have opposite effects. They conclude that the overall effect on the export value is undetermined. However, Castellares 2016 shows that the overall impact of the real exchange rate on firms' export value is decreasing in firms' productivity.

There is empirical evidence of a heterogeneous effect of RER variations on firms' exports. Berthou et al., (2015), using information on aggregated exports by sector at the firm level for 11 countries from 2001 to 2008, find that the real exchange rate elasticity is two or three times larger for less productive firms. In the case of Peru, Barco et al., (2008), using firm-level data on Peruvian exporters from 2002 to 2007, do not find evidence that the real exchange rate affects exports significantly, with the exceptions of fishing and basic metals sectors.[5] We, also using firm-level information on Peruvian exports, find initial evidence that less productive firms are more sensitive to the BRER.

Specification

We estimate the following equation to calculate the heterogeneous impact of the BRER on non-traditional exports

$$\mathrm{Ln}(\mathrm{Exports}_{\mathrm{fpdt}}) = \alpha_1 \ln(\mathrm{BRER}_{\mathrm{dt}}) + \alpha_2 \ln(\mathrm{BRER}_{\mathrm{dt}}) \times \mathrm{FirmSize}_{\mathrm{f}} + \beta_1 \Gamma_{\mathrm{dt}} + \beta_2 \Upsilon_{\mathrm{fdt}} + \delta_{\mathrm{fpd}} + \delta_{\mathrm{t}} + e_{\mathrm{fpd}} \quad (1)$$

where $\mathrm{Exports}_{\mathrm{fpdt}}$ represents the value of product p exported by firm f to destination d in year t. The $\mathrm{BRER}_{\mathrm{dt}}$ is the bilateral real exchange rate index between Peru and its trade partner, which is defined as follows

$$\mathrm{BRER}_{\mathrm{dt}} = (\mathrm{CPI}_{\mathrm{dt}} \times \mathrm{ERI}_{\mathrm{dt}}) / \mathrm{CPI}_{\mathrm{Peru,t}}$$

where $\mathrm{ERI}_{\mathrm{dt}}$ is the nominal exchange rate index of Peru's and its trade partner's (destination country) currencies, $\mathrm{CPI}_{\mathrm{dt}}$ is the destination country's consumer price index, and $\mathrm{CPI}_{\mathrm{Peru,t}}$ is Peru's consumer price index. $\mathrm{FirmSize}_{\mathrm{f}}$ is our proxy for firms' productivity. We calculate this variable using firms' total exports and it is expressed in logs. According to the theory discussed previously, a higher $\mathrm{BRER}_{\mathrm{dt}}$ increases firms' exports ($\alpha_1 > 0$), although this effect is proportionally lower as firms' productivity increases ($\alpha_2 < 0$).

Otherwise, Γ_{dt} includes the usual controls such as the destination country's GDP, $\mathrm{GDP}_{\mathrm{dt}}$ and $\mathrm{Trade\ Agreement}_{\mathrm{dt}}$, which takes the value of 1 if Peru has a free trade agreement with the destination country and 0 if not. Υ_{fdt} includes the total intermediate inputs imported by firm f from the destination country d in period t. We include this variable to capture the fact that an increase in the real exchange rate of Peru and the destination country d makes firm f's exports in destination country d cheaper; however it also raises firms' intermediate input costs from that country. Therefore, we expect the positive effect of a real exchange rate depreciation on exports to be lower for those firms that also import inputs from the

5 Barco et al., (2008) construct a measurement of the real effective exchange rate by firm, using firms' exports by destination as weights for the bilateral real exchange rates of Peru and each of its trade partners.

same destination country. Finally, δ_{fpd} and δ_t are fixed effects, which control for unobserved heterogeneity at the firm-product-destination level, and year, respectively.

Data

We use information on the exports and imports of Peruvian firms provided by the Peruvian Tax Agency (known in Spanish as Superintendencia Nacional de Administracion Tributaria (SUNAT)). Each observation in the raw data contains information on the exporting/importing firm and the f.o.b. value by product and the destination country at 8-digit level at Nandina Classification and at the 6-digit level of the Harmonized System (HS).[6] The export values are deflated by the export price index of each sector (agriculture, fishing, textiles, non-metallic mining, chemicals and base metals).[7] Intermediate inputs are deflated using the import price index. Country information on the consumer price index, exchange rates and gross domestic product is taken from the World Development Indicators (WDI) and the World Economic Outlook (WEO) databases. Finally, information on regional and bilateral agreements is taken from De Sousa (2012).

Peruvian Non-Traditional Exports

Peru's trade policy of subscribing to free trade agreements (FTA), which began over a decade ago, and the introduction of new products and firms to export markets enabled the country to increase significantly its non-traditional exports (Mincentur, 2015).[8] In fact, Peruvian non-traditional exports increased on average by 5.6 per cent per year from 2007 to 2014, reaching USD 11 billion in 2014. The number of firms and products increased by 16 and 30 per cent, respectively, in the same period. The agriculture, fishing and chemical sectors made the most important contributions to NTX growth. In contrast, the textile products sector suffered a contraction during the same period mainly due to tougher competition from Asia and Central America.

Firms' Productivity Proxy

Product per worker and total factor productivity (TFP) are typical measurements of productivity in the literature. Olley and Pakes (1996) develop one of the most standard methodologies for calculating firms' TFP. Unfortunately, our data only contains information on exports and imports by firm, so we cannot use any of these common measurements of productivity. However, previous studies report evidence that more productive firms usually export more products to

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6 We exclude from the data any reported export/import value that is lower than USD 5,000.

7 Those products that could not be categorised into any sector were deflated using the export price index of non-traditional exports.

8 Peru signed free trade agreements with more than 40 countries from 2006 to 2014, including agreements with the US, China and the European Union.

more countries and have higher revenues (Bernard and Jensen, 2004; Bernard et al., 2011). Thus we use information on total exports by firm as a proxy for firms' productivity.

Results

Table 1 reports the estimates of equation ①. As can be seen from column (1), the elasticity of non-traditional exports to the bilateral real exchange rate is positive, but decreases as firms' productivity increases. This result is consistent with Berman et al., (2012) for export volumes, and Berthou et al. (2015) for export values. Similarly, the positive effect of the BRER on exports is smaller on firms that source inputs from the same country that they export to. In such a case, an exchange rate depreciation increases the cost of inputs in the domestic currency, reducing the positive effect of the depreciation. Finally, usual controls, including the destination country's GDP and having subscribed to an FTA, have the expected positive signs.[9]

Table 1: Bilateral Real Exchange Rate Impact on Non-Traditional Exports
Dependent Variable: Value of Exports (logs)

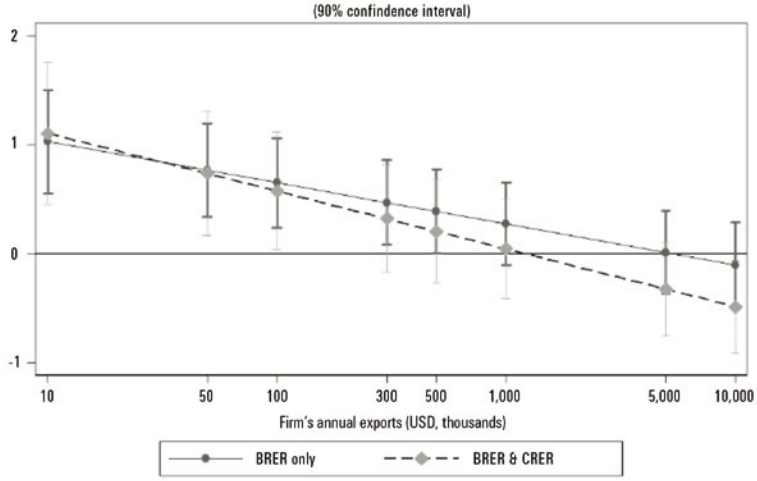
	(1)	(2)	(3)	(4)
$BRER_{dt}$ (ln)	2.531*** (0.453)	2.012*** (0.516)	3.220*** (0.639)	2.526*** (0.770)
$BRER_{dt}$ (ln) × Firm $size_{f}$	-0.163*** (0.029)		-0.230*** (0.038)	
$BRER_{dt}$ (ln) × Firm $size_{f\,t-1}$		-0.126*** (0.031)		-0.172*** (0.045)
Competitors RER_{pdt} (ln)			-1.294** (0.547)	-1.137* (0.626)
Competitors RER_{pdt} (ln) × Firm $size_{f}$			0.106*** (0.035)	
Competitors RER_{pdt} (ln) × Firm $size_{f\,t-1}$				0.086** (0.039)
$BRER_{dt}$ (ln) × Imports of int. $inputs_{f\,pdt}$ (ln)	-0.280* (0.161)	-0.244 (0.155)	-0.286* (0.156)	-0.253* (0.152)
Imports of int. $inputs_{pdt}$ (ln)	1.414* (0.735)	1.232* (0.701)	1.439** (0.712)	1.267* (0.688)
Destination country's GDP_{dt} (ln)	0.561*** (0.116)	0.496*** (0.108)	0.570*** (0.115)	0.506*** (0.107)
FTA_{dt}	0.044 (0.029)	0.045* (0.027)	0.041 (0.029)	0.043 (0.027)
Observations	77,543	76,472	77,543	76,472
R-squared	0.822	0.825	0.822	0.825
Destination—Product—Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Notes: Clustered standard errors by year and destination in parentheses in columns (1) and (2) and multi-clustered standard errors by destination and year; product, destination and year in columns (3) and (4).***, **, * denote significance levels at 1%, 5%, 10%, respectively.

9 The use of non-deflated total exports as a dependent variable, controlling for year or year-sector fixed effects, does not change the results significantly.

The continuous line in figure 2 plots the estimates reported in table 1 to show the estimated BRER elasticity for different firm sizes. In addition, we calculate the proportion of firms whose BRER elasticities are positive and statistically different from zero. As seen in figure 2, firms that export more than USD 500,000 do not respond to BRER fluctuations.

Figure 2: Non-Traditional Exports–BRER Elasticity



We then calculate the proportion of firm–product pairs and their share of the non-traditional exports of those firms that are sensitive to BRER changes. Table 2 indicates that, conditional on the destination country, around 35 to 46 per cent of firm–product pairs are sensitive to BRER fluctuations. However, the exports of these firms explain only 5 to 11 per cent of the non-traditional exports of 2014 and around 1.7–3.3 per cent of total exports.

Table 2

Peruvian exports to:	China	USA	Spain	Ecuador	Colombia
% of firm–product pairs	36.6%	40.2%	30.8%	45.9%	35.5%
% of export value	5.7%	5.3%	5.9%	11.2%	6.0%

Bilateral Real Exchange Rates of Competitors

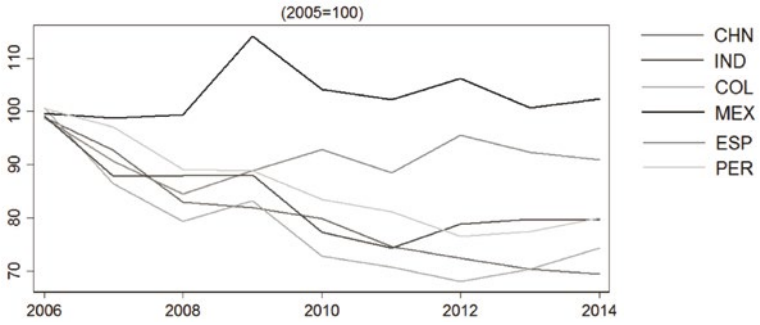
In order to compare the level of competitiveness of Peruvian products with those exported by other countries to the same destination markets, Cuba and Ferreyra (2011) propose an index of the real exchange rates of Peru's competitors (CRERs). This index is the weighted average of the bilateral real exchange rate of each country competing with Peruvian exporters. The use of this variable as a determinant of Peruvian non-traditional exports considers that the demand for Peruvian products depends not only on the relative prices of Peru and the destination country, but also on the price of the same product that is imported to the

destination country from other countries. An increase of the CRERs increases the demand, in terms of quantities, for those products exported by competing countries, reducing the demand for the Peruvian versions of these products. Velásquez (2015) finds that higher CRERs reduce Peruvian exports and this effect is larger when competing countries' productivity is lower. Different from Velásquez (2015), we evaluate the heterogeneous impact of the CRERs, considering differences in Peruvian exporters' productivity levels.

For our empirical procedure, the set of competing countries varies by product and destination country. This set is made up of countries that export product $\mathbf{p}$ to destination $\mathbf{d}$ and whose price is 'close' to the median price of the same product exported from Peru to the same destination.[10] To do this, we calculate the price deviation of each country with respect to the average Peruvian price (by product and destination), classifying as competing countries all those whose deviations are in the closest 75 percentile of those deviations. Countries that are outside of that percentile are not considered competitors for product $\mathbf{p}$ and destination $\mathbf{d}$. In addition, we also exclude competitors whose price deviations are greater than one standard deviation of the price of product $\mathbf{p}$ in destination $\mathbf{d}$. As a robustness check we use the 25th and 50th percentiles and the results do not change significantly. To calculate the CRERs we use information from COMTRADE, which contains export values and quantities at the 6-digit level of the Harmonized System (HS).

Once we have defined the set of competing countries by product, we use the share of total imports of product p in destination country d of each competing country to weight each competitor's bilateral real exchange rate with respect to the destination country.[11] Figure 3 shows the bilateral real exchange rates of some competitors of Peruvian exporters in the US. As noted, some countries, such as China and Colombia, experienced deeper real exchange rate appreciations than Peru during the sample period. Conversely, Mexico's BRER with the US increased during that time.

Figure 3: Bilateral RERs of Competitors of Peruvian Exports in the United States



10 We calculate the median price for each product, destination and exporting country from 2007 to 2014 to avoid outliers and to keep constant the set of competitors for each product–destination pair.

11 We exclude Peru's exports to each destination when we calculate the market share of each competitor.

Columns (3) and (4) of table 1 report the estimated elasticity of the CRERs of Peruvian exporters with respect to non-traditional exports. The results confirm a negative, but decreasing in firms' productivity, impact of CRERs on exports. According to these estimates, the CRERs' elasticity is not statistically different from zero for firms that export more than USD 10,000 worth of products. In addition, figure 2 depicts that introducing CRERs as an additional regressor in equation ① reduces slightly the BRER estimates.

Probability of Continuing Exporting

As a final exercise, we estimate the impact of the BRER on firms' probability of continuing exporting. In Berman et al.'s (2012) extension of Melitz and Ottaviano's (2008) model, only firms whose productivity level is greater than the minimum productivity threshold are able to export. In this model, a lower BRER increases the minimum productivity threshold, forcing less productive firms to stop exporting. To test this hypothesis we estimate the following equation using a linear probability model:

$$\mathrm{Ln}(\mathrm{Continue\ Exporting}_{fpdt}) = \alpha_1 \ln(\mathrm{BRER}_{dt}) + \alpha_2 \ln(\mathrm{BRER}_{dt}) \times \mathrm{FirmSize}_f + \beta_1 \Gamma_{dt} + \beta_2 \Upsilon_{fdt} + \delta_{fpd} + \delta_t + e_{fpd} \quad ②$$

where the variable $\mathrm{Continue\ Exporting}_{fpdt}$ takes the value of 1 if the firm f continues exporting product p to destination d in year t, and 0 otherwise. In addition to the BRER and the interaction of the BRER with firm size, we also include the set of controls we use in the estimation of equation ①, Γ_{dt} and Υ_{fdt}; and δ_{fpd} and δ_t fixed effects.

The results reported in table 3 confirm that less productive firms—those for which exports are low—are more sensitive to real exchange rate fluctuations. The results also confirm a negative, but decreasing in firm's productivity, impact of the CRER on the firm's probability of continuing exporting.

Table 3: Impact of BRER on Continuing Exporting Probability Dependent Variable: Continuing Exporting = 1 Stop Exporting = 0

	(1)	(2)	(3)
$BRER_{dt}$ (ln)	3.395*** (0.599)	4.670*** (0.549)	4.618*** (0.561)
$BRER_{dt}$ (ln) × Firm $size_f$	-0.213*** (0.036)	-0.309*** (0.035)	-0.306*** (0.036)
Competitors RER_{pdt} (ln)		-2.040*** (0.458)	-2.050*** (0.462)
Competitors RER_{pdt} (ln) × Firm $size_f$		0.146*** (0.028)	0.147*** (0.028)
Imports of int. $inputs_{pdt}$ (ln)	0.061* (0.033)	0.059* (0.034)	0.665* (0.353)
$BRER_{dt}$ (ln) × Imports of int. $inputs_{f\,pdt}$ (ln)			-0.134* (0.077)
Destination country's GDP_{dt} (ln)	0.074 (0.138)	0.084 (0.138)	0.085 (0.138)
FTA_{dt}	-0.019 (0.032)	-0.019 (0.032)	-0.019 (0.032)
Observations	65,657	65,657	65,657
R-squared	0.383	0.384	0.384
Destination—Product—Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Notes: Multi-clustered standard errors by destination and year; product, destination and year in parentheses.***, **, * denote significance levels at 1%, 5%, 10%, respectively.

Table 4 shows the percentage of firm–product pairs that are significantly affected by a 10 per cent real exchange rate appreciation in the top five destination countries of Peruvian NTX. Approximately 3–5 per cent of firm–product pairs would stop being sold in these countries. Nevertheless, these products represent only around 0.6–1.1 per cent of Peruvian NTX in these countries.

Table 4: Extensive Margin—Effect of a 10% RER Depreciation on the Prob. of Continuing Exporting

	China	USA	Spain	Ecuador	Colombia
% of firm–product pairs	3.6%	4.0%	3.0%	3.5%	4.6%
% of export value	0.6%	0.6%	0.6%	0.6%	1.1%

Conclusions

This paper reports evidence of the heterogeneous effects of the real exchange rate on non-traditional Peruvian exports. Using detailed information on exports at the firm-level from 2007 to 2014, we find that less productive firms are more sensitive to bilateral RER

fluctuations. Particularly, the total value of exports that is sensitive to RER fluctuations represents less than 6 per cent of total non-traditional exports and 2 per cent of total exports in the year 2014. However, we must emphasise that this does not imply that firms' markups are not affected significantly by RER fluctuations.

In addition, we also find evidence that the real exchange rates of Peruvian exporters' competitors (CRERs) reduce firms' exports in a heterogeneous way. Less productive firms are proportionally more affected than more productive firms when CRERs increase. The omission of this variable in regressions that evaluate the effect of bilateral RERs on exports causes a slight overestimation of RER elasticity.

6.8 COMMODITY PRICE SHOCKS & CURRENT ACCOUNT DYNAMICS IN MINING & NON-MINING EXPORTERS[1]

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— Pérez Forero F.J. and Serván, S., "Commodity Price Shocks & Current Account Dynamics in Mining & Non-Mining Exporters", Research Workshop, in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 131–137.

Introduction

By the beginning of the last decade, the global economy had begun to experience the positive effects of an expansionary phase of the business cycle. This triggered a significant increase in the terms of trade of many commodity exporting economies. In fact, according to the World Bank, commodity prices increased by 135 per cent from 2003 to 2007. This was the largest increase recorded in a single five-year period since the 1960s. Overall, this improvement in prices has had a significant impact on current accounts and the aggregate GDPs of commodity exporting economies.

Among the commodities that experienced a significant increase in their price, the case of metals deserves particular attention. Thus, the current account dynamics of countries such as Australia, Canada, Chile, Peru and South Africa, economies that export mainly metals like copper

1 The views expressed are those of the authors and do not necessarily reflect those of the Central Bank of Peru. Any remaining errors are those of the authors.

and gold, have been of particular interest. Fornero et al. (2016) show that in these countries current account deficits or reversals are associated with the response of investment, mainly in the mining sector, which is highly correlated with the price of metals. Moreover, this investment reaction depends on the temporal nature of the price shocks—that is to say, transitory shocks do not generate a huge increase in commodity sector investments, whereas permanent shocks have a significant impact. Therefore, transitory shocks tend to be associated with current account surpluses, while persistent shocks are highly correlated with significant current account deficits.

In order to assess the impact of commodity price fluctuations, this paper uses quarterly data for a group of commodity exporting countries (Australia, Brazil, Canada, Chile, Colombia, Mexico, New Zealand, Norway, Peru and South Africa). In particular, we evaluate the individual responses of the current account to a global commodity price shock, where we focus our attention on metal prices. The data sample ranges from 1996 to 2015 in order to include the latest episode of price increases. Unlike Fornero et al. (2016), who estimate individual VARs for each country, we employ a panel VAR approach in the spirit of Canova and Ciccarelli (2009).[2] This latter methodology allows us to capture cross-country, lagged interdependencies and incorporate common, country-specific and variable-specific indicators summarising spillover effects across countries and variables. In addition, we allow for time variation in order to explore the impulse responses at different dates, making the distinction between periods before and after the commodity boom. Additionally, by comparing the effects on mining countries to those on non-mining countries, it may be possible to extract the differentiated effect of commodity price shocks and different monetary policy responses.

This paper is organised as follows: section 2 describes the econometric model, section 3 discusses the main results and section 4 concludes.

The Multi-Country Panel VAR Model

This section closely follows Canova and Ciccarelli (2009). We specify a multi-country model with lagged inter-dependencies and time-varying parameters. We abstract from the possible presence of stochastic volatility, since the current setup is already computationally demanding.[3]

The Setup

The statistical model employed in this paper has the following form

$$y_{it} = D_{it}(L)Y_{t-1} + F_{it}(L)Z_t + c_{it} + e_{it} \quad ①$$

[2] See also Canova and Ciccarelli (2003).

[3] See also Canova et al. (2007), Canova and Ciccarelli (2012) and Canova et al. (2012).

where $i=1,...,N$ refers to countries and $t=1,...,T$ refers to time periods. In addition, y_{it} is an $M\times1$ vector of endogenous variables for each country i and $Y_t = (y'_{1t},y'_{2t},...,y'_{Nt})'$, and $D_{it,}$ and $F_{it,}$ are matrices of dimensions $M\times NM$ and $M\times M_2$, respectively for each lag. Moreover, Z_t is an $M_2\times1$ vector of exogenous variables common to all countries, c_{it} is an $M\times1$ vector of intercepts and e_{it} is an $M\times1$ vector of random disturbances.

Notice that cross-unit lagged inter-dependencies are allowed whenever the $NM\times NM$ matrix $D_t(L) = [D_{1t}(L),D_{2t}(L),...,D_{Nt}(L)]'$ is not block diagonal. Notice also that coefficients in ① are allowed to vary over time and that dynamic relationships are unit-specific. All these features add realism to the econometric model. However, this comes at the cost of having an extremely large number of parameters to estimate. For this reason, we specify a more parsimonious representation of the model in order to proceed to the estimation.

Equation ① can be rewritten in a compact form as

$$Y_t = W_t\delta_t + E_t, \qquad E_t \sim N(0, \Omega) \text{ ②}$$

where $W_t = I_{NM}\otimes X'_t$; $X'_t = (Y'_{t-1}, Y'_{t-2},..., Y'_{t-p}, Z'_t, Z_{t-1},...,Z'_{t-q}, 1)$; $\delta_t = (\delta'_{1,t}, \delta'_{2,t},..., \delta'_{N,t})'$; and δ_{it} are $Mk\times1$ vectors containing, stacked, the M rows of matrix D_{it} and $F_{it'}$ while Y_t and E_t are $NM\times1$ vectors. Notice that since δ_t varies with cross-sectional units in different time periods, it is impossible to estimate it using classical methods. Even in the case of constant coefficients, the number of degrees of freedom needed to conduct proper inference is tremendously large. For that reason, Canova and Ciccarelli (2009) suggest reducing the dimensionality of this problem as follows

$$\delta_t = \Xi_1\theta_{1t} + \Xi_2\theta_{2t} + \Xi_3\theta_{3t} + \Xi_4\theta_{4t} + u_t \text{ ③}$$

where Ξ_1, Ξ_2, Ξ_3, Ξ_4 are matrices of dimensions $NMk\times1$, $NMk\times N$, $NMk\times M$ and $NMk\times1$, respectively. θ_{1t} captures movements in coefficients that are common across countries and variables, θ_{2t} captures movements in coefficients that are common across countries, θ_{3t} captures movements in coefficients that are common across variables and θ_{4t} captures movements in coefficients that are common across exogenous variables. Finally, u_t captures all the un-modelled features of the coefficient vector.[4]

The factorisation ③ significantly reduces the number of parameters to be estimated. In other words, it transforms an over-parametrized panel VAR into a parsimonious SUR model, where the regressors are averages of certain right-hand side variables. In fact, substituting ③ in ② we have

$$Y_t = \sum_{i=1}^{4} W_{it}\theta_{it} + v_t$$

4 See details in Canova and Ciccarelli (2009).

where $W_{it} = W_t \Xi_i$ capture, respectively, common, country-specific, variable-specific and exogenous-specific information present in the data, and $v_t = E_t + W_t u_t$, and to complete the model, we specify $\theta_t = (\theta'_{1t}, \theta'_{2t}, \theta'_{3t}, \theta'_{4t})'$ such that it follows a random walk process.

In summary, the empirical model has the state-space form

$$Y_t = (W_t \Xi)\, \theta_t + v_t \quad ④$$

$$\theta_t = \theta_{t-1} + \eta_t \quad ⑤$$

where $v_t \sim N(0, \sigma_t)$; $\sigma_t = (1 + \sigma^2 X'_t X_t)$; and $\eta_t \sim N(0, B_t)$. To compute the posterior distributions, we need prior densities for the parameters $(\Omega, \sigma^2, \bar{B}, \theta_0)$.

Priors

Following various references in the literature we set conjugated priors—that is to say, priors such that the posterior distribution has the same shape as the likelihood function. In particular, given the normality assumption for the shocks, the variance and covariance parameters have an inverse gamma distribution[5] or an inverse Wishart distribution for the multivariate case. In addition, since we are going to use the Kalman filter and smoother for simulating the posterior distribution of latent factors, it is reasonable to assume the initial point as normally distributed.

Results

Data and Variable Selection

For each country we use year-to-year growth rates of GDP, the consumer price index, terms of trade and exchange rates. As in Canova et al. (2012), we include domestic price indexes in order to control for variations in nominal variables. We also include the current account surplus (as a percentage of GDP) and the domestic interbank rate. As exogenous variables, we include the annual growth rate of US GDP, the growth rate of West Texas Intermediate (WTI) oil prices and a commodity price index, the growth rate of prices of metals, fuel and non-fuel commodity prices. Our main data sources are the International Financial Statistics (IFS) from the International Monetary Fund (IMF), Federal Reserve Economic Data (FRED), the Inter-America Development Bank (IDB), the Organisation for Economic Co-operation and Development (OECD) and domestic central banks. The sample covers the period 1997Q1–2015Q4. Following the literature, data is demeaned and standardised. We estimate our model considering one lag for domestic and exogenous variables.

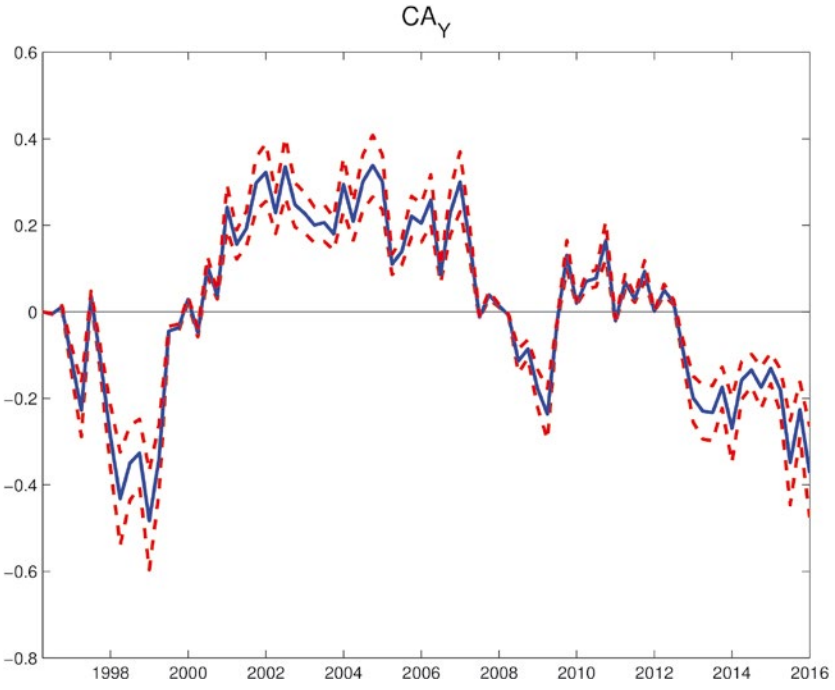
5 See, e.g., Zellner (1971) and Koop (2003).

We also include a common component, a country-specific component, a variable-specific component and an exogenous component.

Analysis of the Commodity Exporting Current Account

Based in our methodology we are able to construct a common current account indicator for the whole sample of countries. This indicator, following Canova et al. (2012), corresponds to the posterior distribution of W_{3t} multiplied by the estimated θ_{3t} and is shown in figure 1.

Figure 1: Posterior Distribution of the Current Account Indicator



One important thing to notice is that our indicator shows the average ups and downs of current account balances for the countries in our sample, which should be correlated with the dynamic behaviour of the commodity price index. In fact, between 2000 and 2008 we see a current account surplus and this period coincides with a high increase in the commodity price index (commodity prices increased by 106.6 per cent). After 2008, commodity prices experienced a sharp decline, which is also reflected in our current account indicator.

Finally, from the second quarter of 2011 on, commodity prices entered a downturn, declining by almost 52 per cent by the end of 2015. As a consequence, current account balances deteriorated, which for most countries meant an increase in their deficits (figure 1 shows a common current account deficit for the same period).

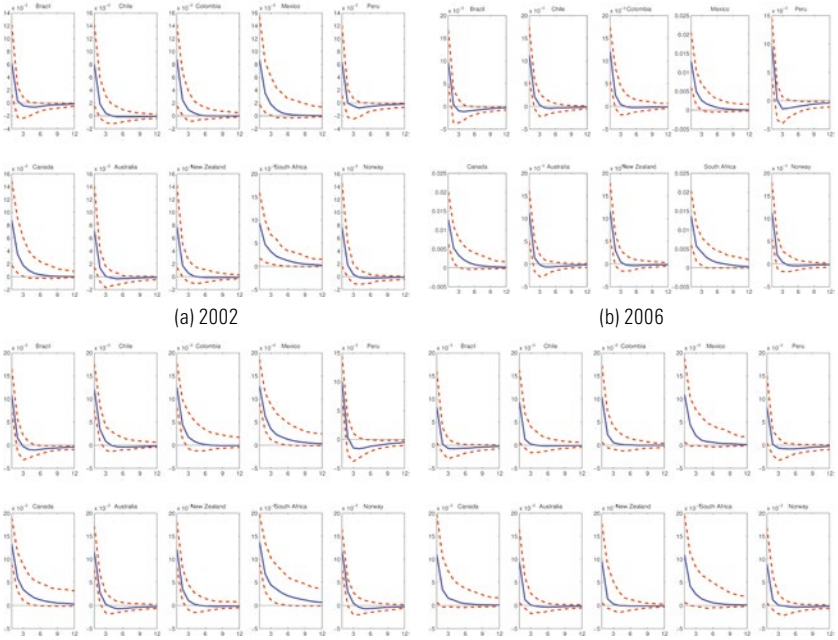
The Transmission of Distinct Commodity Price Shocks Across Commodity Exporting Countries

The previous section gave an overall picture of the impact of commodity price changes on current account balances. Although the commodity price index we are using is a good starting point, some commodities deserve special attention. In particular, we focus our analysis on fuel and metal prices.

We compute the impulse response functions for a fuel and metal unit shock so we can analyse the heterogeneity in responses across countries and for different time periods, which is one of the most important outputs that can be obtained using the panel VAR methodology.

We first present the results for a fuel shock (figure 2). Although we find a positive impact across countries and in different time periods for the first few quarters following a shock, most impulse response functions turn out to be not significant. Nonetheless, it is worth mentioning that for Peru we found a significant negative impact after three or four quarters in line with the expected behaviour of an oil importing economy.

Figure 2: Response of Current Accounts to a Unit Shock to Fuel Prices; Median Value and 68 Per Cent Bands



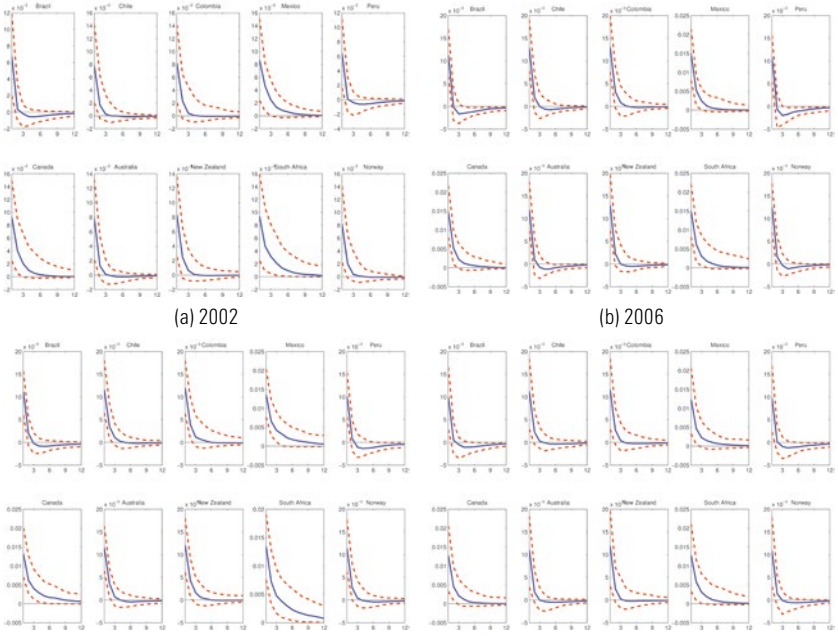
(a) 2002 (b) 2006

(c) 2010 (d) 2014

The results for the metal price shock are shown in figure 3. This analysis allows us to reach two important conclusions. First, the dynamic response of current accounts has changed along the sample. For all countries, metal price shocks had, quantitatively, a more important impact in 2014 compared to 2002. Second, the higher impact was experienced by metal

exporting countries like Australia, Chile, Peru and South Africa. However, the impact in the case of Peru seems to be less persistent and lasts, on average, less than three quarters.

Figure 3: Response of Current Accounts to a Unit Shock to Metal Prices; Median Value and 68 Per Cent Bands



(a) 2002 (b) 2006

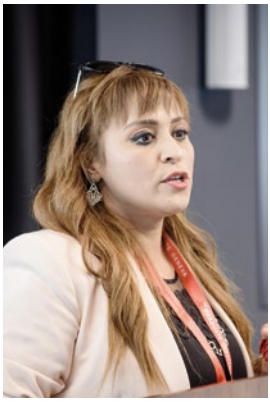
(c) 2010 (d) 2014

Concluding Remarks

We have estimated a panel VAR with dynamic interdependencies and time-varying parameters for ten commodity exporting countries (Brazil, Chile, Colombia, Mexico, Peru, Canada, Australia, New Zealand, South Africa and Norway). Within this framework, we build an average current account indicator and study the response of individual current account balances to shocks to fuel and metal prices. We found that our common indicator for the current account follows closely the dynamic pattern of the commodity price index—that is to say, surpluses (deficits) are usually associated with increases (decreases) in commodity prices. At the country level, by comparing the impulse response functions, we found that commodity price shocks have a similar effect across countries, although their magnitude differs. In general, our results suggest that the impact on current account balances have increased since 2002. In the case of a fuel shock, we do not find significant current account responses. However, the evidence for a metal shock is more robust, with higher responses in the case of the metal exporting countries.

Although we have included domestic interest rates, most of the literature has emphasised the effect of commodity prices on credit and other financial variables. In this regard, the future research agenda should include the response of financial variables to an external shock such as a commodity price shock.

6.9 TIME-VARYING IMPULSE RESPONSES TO THE OIL PRICE SHOCK ON CORE INFLATION: STRUCTURAL AND CYCLICAL EFFECTS (THE CASE OF TUNISIA)



HAJER BEN ROMDHANE
Central Bank of Tunisia

— Ben Romdhane, H., "Time-Varying Impulse Responses to the Oil Price Shock on Core Inflation: Structural and Cyclical Effects (the Case of Tunisia).", Research Workshop, in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 139–143.

Some Stylised Facts

The Central Bank of Tunisia (CBT) has recently pursued an accommodative monetary policy. In fact, the slowdown in private sector credit, a widening output gap (2.5 per cent in 2015) and a downward trend in inflation led the CBT to lower its policy rate by 50 basis points in October 2015. Nevertheless, when confronted with an oil price shock, central bankers have faced a fundamental trade-off depending on their monetary policy strategy: whether to try to counter real effects with expansionary measures, or to fight inflationary effects with tightening measures.

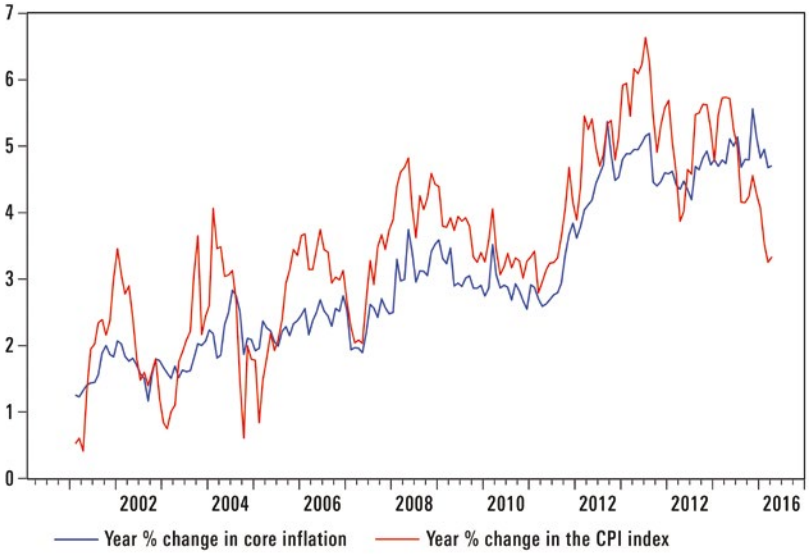
To anchor inflation expectations, the CBT plan to gradually move towards a credible inflation-targeting framework in the medium term. Despite price liberalisation, administered prices remain important.[1] The prices of about 32 per cent of the basket are still administered:

1 The government fixes the administered prices. Even if the BCT coordinates with the government, the mechanism for adjusting administered prices introduces a fiscal bias into the control of inflation.

some sectors (such as transport and health) are heavily administered; others (such as food, housing and services) are partially liberalised; and clothing is fully liberalised.

Energy prices too are administered. The 56 per cent decline in global oil prices since the beginning of 2014 has not been passed on to domestic consumers. Domestic prices, for certain products, are 30–50 per cent higher than international levels. The IMF has supported the authorities' efforts to transform the asymmetric formula for the automatic adjustment of fuel prices—to an automatic balancing formula that smoothes strong fluctuations in international prices and guarantees a full cost recovery and a proper collection of taxes.

Figure 1: Evolution of Core Inflation and CPI Index



Core inflation is characterised by less noticeable volatility and a cyclical profile. Given the important proportion of administered prices, any unexpected adjustment in commodity prices is likely to cause a budgetary bias in the control of inflation and to reduce the impact of interest rates in the transmission of monetary policy impulses.

Model

We model the behaviour of quarterly real oil price inflation, $\Delta \ln PO$; the quarterly growth rate of TU real GDP, $\Delta \ln y_{TU}$; and quarterly TU CPI core inflation,[2] π_{TU}. An analysis of the stationarity of our quarterly series precedes the estimation process. Our sample includes

[2] The best measurement of the core inflation is based on excluding the most volatile CPI components (tobacco and cigarettes, care and treatment, common transport and sugar). The measurement that excludes administered prices has a major shortcoming in that it is not operational at a relatively high level of aggregation.

the period 1980Q1–2015Q4. The augmented Dickey–Fuller unit root test results show that non-stationarity is rejected at 1 per cent significance level for quarterly inflation.

Specifically, we consider the following reduced-form time-varying parameter (TVP) VAR:

$$Y_t = c_t + \sum_{j=1}^{p} \beta_{j,t} Y_{t-j} + v_t$$

$$E(v_t' v_t) = R_t$$

$$E(v_t' v_s) = 0 \text{ if } t \neq s$$

$$\beta_t = \mu + F\beta_{t-1} + e_t \qquad VAR(e_t) = Q$$

where Y_t is a 3×1 vector $(\Delta \ln PO \; \Delta \ln y_{TU} \; \pi_{TU})'$; v_t is a vector of reduced-form errors; c_t is a vector of constants and the $\beta_{j,t}$s are matrices of coefficients. We assume that Tunisia is 'small' in the sense that movements in TU variables have no effect on world variables. The Gibbs sampling algorithm can be discerned by noticing that if the time-varying coefficients β_t are known, the conditional posterior distribution of R is inverse Wishart. Similarly, conditional on β_t the distribution of Q is inverse Wishart. Conditional on R and Q and with the assumption that $\mu = 0$ and $F = 1$, the model is a linear Gaussian state space model. A Gibbs sampling algorithm is used to estimate the time-varying coefficients for this model.

The next step consists in determining whether oil price-related fluctuations in core inflation are structural or cyclical in nature. To do this, we apply a Markov switching chain on time series estimated elasticity. The general idea of the MS-AR is that the variations in inflation depend upon an unobserved regime variable, $S_t = \{1,2\}$, which represents the probability of being in a particular state with respect to the switching mechanism in various states.

The conditional probability density of the observed y_t is given by

$$P = \begin{pmatrix} P_{11} & P_{21} \\ P_{12} & P_{22} \end{pmatrix} = \begin{pmatrix} P_{11} & 1-P_{22} \\ 1-P_{11} & P_{22} \end{pmatrix}$$

with p_{ji} the probability of being in the state i knowing that we were in the state j for the preceding period.

$$Y_1 = \begin{cases} \varphi_{0.1} + \varphi_{1.1} Y_{t-1} + \quad + \varphi_{p_1,1} Y_{t-p_1} + \sigma_1 \varepsilon_t & \text{if} \quad S_t = 1 \\ \varphi_{0.2} + \varphi_{1.2} Y_{t-1} + \quad + \varphi_{p_2,2} Y_{t-p_2} + \sigma_2 \varepsilon_t & \text{if} \quad S_t = 2 \end{cases}$$

Results

Results from the TVP-VAR model (see graph 2) show that the parameters are variable through the time period and show the impulse response of core inflation to a shock to commodity prices. The core inflation response to commodity price shocks seems to be asym-

metric in Tunisia. On average, in the long run, a 1 per cent surge in oil price inflation leads to an increase in core inflation of 0.3 of a percentage point, whereas a decline in oil price inflation by the same amount results in a drop in core inflation of only 0.05 of a percentage points. In fact, the limited core inflation response to downward oil shocks is due to market rigidities preventing prices or wages adjusting and to the presence of a large proportion of administered prices. Tunisia's inflation is, then, partially driven by administrative decisions.

Results from the Markov switching process applied on the time-varying elasticity of core inflation to fluctuations in oil prices show that the first regime represents the recession state and the second regime is the growth state, since regime 1 variances of elasticity are smaller than those of regime 2. In fact, the Markov switching multi-fractal volatility (MSMV (1)) model is a mean-adjusted model after a switch in regime with variant mean and variance. Therefore, coefficients are positive in the first regime and second regime. Thus, this would imply that the average increase of quarterly inflation due to a shock to the oil price in regime 1 is 0.66 per cent, while the average increase in the second regime is about 0.33 per cent. This means that on average about two-thirds of the decline in index price growth during a commodity price downswing (low volatility) is cyclical ($p_{11} = 0.25$, that is, the state is not persistent) and one-third is structural ($p_{22} = 0.75$, that is, the state is persistent) (see graph 3).

Figure 2: Time-Varying Impulse Responses of Oil Prices on GDP Growth and Inflation

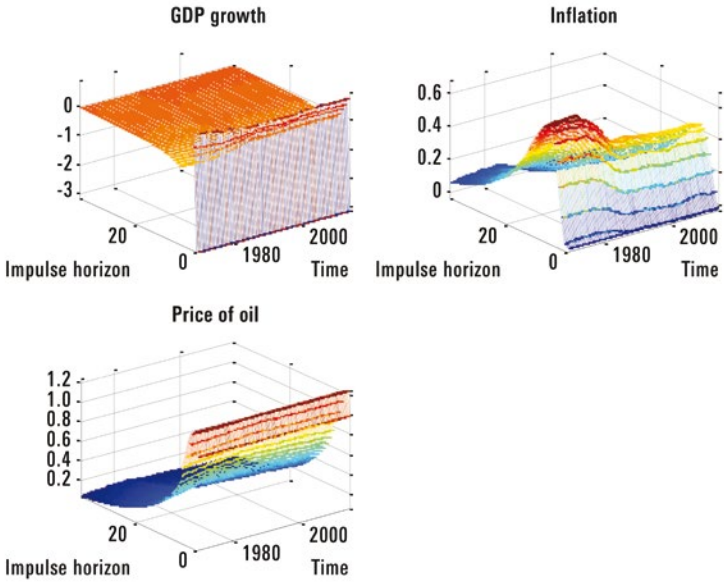
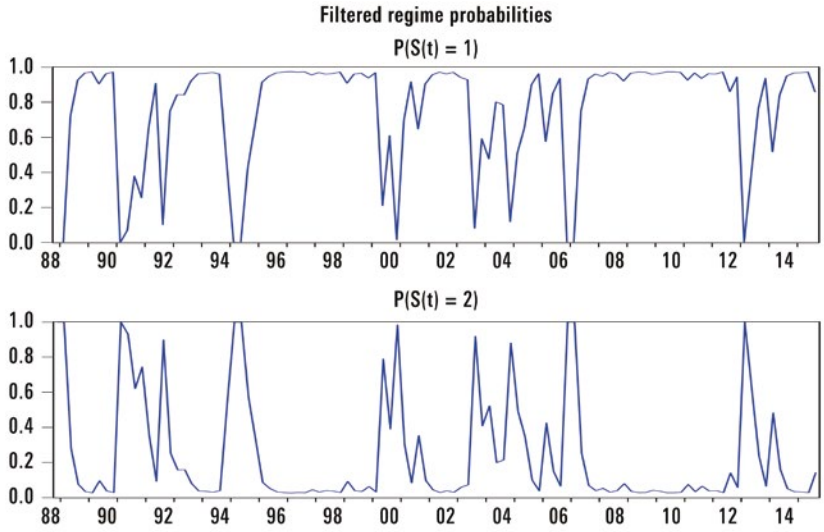


Figure 3: Estimated Transition Probabilities by Markov Switching



Conclusions

Large movements in oil prices have historically been followed by sharp fluctuations in activity and inflation in many countries. This basic observation has led to a strand of literature analysing the complex linkages between these movements. In this paper, we have focussed on how large the pass-through of changes in oil prices to inflation is and on whether commodity price related fluctuations in inflation, especially core inflation, are cyclical or structural. If declining oil prices ease structural inflation, central banks may respond with monetary loosening, which, in turn, can boost activity.

We have used two approaches for this purpose, a time-varying parameters VAR model and a Markov-switching mean and variance model. The output estimation for the TVP-VAR shows evidence of the variable and asymmetric effects on inflation due to a shock to oil prices. Such an asymmetric effect may result from costly factor reallocation, uncertainty or an asymmetric monetary policy response.

The estimation of the Markov-switching model confirms the existence of two regimes: the first is the recession period and the second is a growth state. While two-thirds of variation in core inflation is cyclical, one-third is structural.

Given these empirical results, administered prices should be reduced. In addition, the mechanism for adjusting administered prices introduces a fiscal bias into the control of inflation in the sense that the inflation target may lead to implicit accommodation of budgetary slippages. Thus, the subsidy reforms are required to improve the impact of interest rate on the impulse response mechanism.

6.10 COMMENTS BY RAHUL MUKHERJEE AND EMANUEL KOHLSCHEEN

RAHUL MUKHERJEE (LEFT) *The Graduate Institute, Geneva*
EMANUEL KOHLSCHEEN (RIGHT) *Bank for International Settlements*

— Mukherjee, R. and Kohlscheen, E., "Comments by Rahul Mukherjee and Emanuel Kohlscheen", Research Workshop, in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 145–152.

Permanent and Temporary Oil Price Shocks, Macroeconomic Policy and the Tradable Non-Oil Sector: The Cases of Azerbaijan, Kazakhstan and Russia

Ramiz Rahmanov

- *Comment by Rahul Mukherjee*

The main question addressed by this paper is: How do some key variables in the oil exporting countries of Azerbaijan, Kazakhstan and Russia respond to oil price shocks? The distinctive feature of the analysis is that oil price shocks are decomposed into permanent and temporary components to distinguish between long-term and short-term shocks (for example, the structural changes in the oil market in the last decade due to the emergence of fracking technologies in the US, as opposed to relatively short-lived low demand during the recent Great Recession). Obviously, it is of great general importance to policymakers in all oil exporting countries whether and for how long disturbances in world oil prices will last, because large proportions of government budgets may

be financed by oil revenue (for example, oil accounts for 60–90 per cent of the exports of the three countries in the analysis). The analysis in the paper is motivated by the permanent income hypothesis (PIH). Its basic premise therefore is that permanent price shocks lead to shifts in lifetime income while temporary changes do not, and thus that certain macroeconomic quantities should respond more to the former. This hypothesis is tested using quarterly data from 2003 to 2015, employing a VARX methodology. The two price shocks are treated as the exogenous variables, while the endogenous variables are the real short-term interest rate, the real effective exchange rate (RER), real budget expenditure, real imports and real tradable non-oil GDP. The main findings are that Azerbaijan and Kazakhstan conform more to the PIH, while Russia is found to respond more to temporary shocks. The effects of the shocks are found to be quite heterogeneous across the countries. The paper also finds that the RER appreciates, but there is no evidence of a decline in real tradable non-oil GDP (i.e. there were no symptoms of the Dutch Disease).

I found the paper interesting and well executed, but have a few comments. First, the Dutch Disease is also about the *relative* decline of the non-oil sector (relative to the other sectors), but the paper limits itself to testing for *absolute* decline. It could be that the real oil sector reacts positively and by more than the real non-oil sector so that productive resources are being diverted to the oil sector (which would be a symptom of the Dutch Disease), but both sectors expand (due to, perhaps, some improvement in total factor productivity in the overall economy that lets both sectors expand even with a constant amount of resources). I thought the findings, though they did not show a decline in the non-oil sectors, also did not rule out a relative decline in this sector. Hence I was not completely convinced by the lack of evidence in favour of the Dutch Disease in these economies. Another aspect that I found to be missing was any data or discussion on the real non-tradable non-oil (NT) sector, which is usually part of the Dutch Disease story: an increase in demand for NT goods through wealth effects could also contribute to RER appreciation and the further deindustrialisation of the tradable non-oil sector. Second, I would suggest that the PIH story be pushed a bit more using measurements of government or private savings, the current account or external wealth (in particular, reserves). The issue to be investigated here would be whether temporary windfalls are being saved by the government in some form, and if so, in what way? I would also like to see a robustness check with a government budget balance measurement rather than government expenditures, because it could be that tax rates are being reduced in response to temporary shocks, which would not show up in the analysis in any way. Here, it would be good to have an explicit model or at least a discussion, because depending on what variables are used, they will respond quite differently to permanent and transitory shocks. For example, consumption would react little to a transitory income shock, but savings would react little to a permanent income shock; so it would be good to have the hypotheses clearly set out at the start using a model, depending on whether the measure used is one of government expenditures or savings. Last but not least, it would also be good to have a measurement of overall economic activity and monetary policy stance in the VAR analysis.

- *Comment by Emanuel Kohlscheen*

The permanent income hypothesis is also the guiding principle of the contribution by Rahmanov (CB Republic of Azerbaijan). This paper analyses the responses of government consumption to exogenous oil price shocks in three economies were oil is the dominant export product as well as an important source of fiscal revenues (responsible for 59 per cent of total revenues in Azerbaijan, 22 per cent in Kazakhstan and 27 per cent in Russia). The paper also has a very interesting discussion of sovereign wealth funds. The author finds that oil price increases cause only one symptom of the Dutch Disease—which is that the exchange rate appreciates. Non-oil output however increases as well, instead of decreasing.

One question that emerges is what the precise mechanisms leading to the expansion of the non-oil sector are. In particular, it would be interesting to know whether non-oil products include commodities whose price is correlated with that of oil. Another possibility is that an oil boom leads to increased deposits in the banking sector, which then fund credit creation.

Another aspect to bear in mind is that the permanent income hypothesis is here being applied to government consumption, and not private sector consumption. The government however often faces constraints on the adjustment of consumption, which limits its capability to respond quickly to shocks. The dimension that can obviously be adjusted more quickly is how much exchange rate market pressure is absorbed by exchange rate variation. As this fraction varied considerably in the countries under study during the sample period of this study, the author may want to consider using an exchange market pressure index instead of the exchange rate as a robustness check in an eventual extension.

An additional variation could be to use the real exchange rate against the USD, instead of the real effective exchange rate. While this may appear to be only a small difference, the response to exchange rate shocks can often differ substantially depending on whether one uses the effective or the USD exchange rate. The reason for this is that the variation against the dollar, as the funding currency, tends to be much better for capturing the effects on credit.

Terms of Trade, the Real Exchange Rate and Non-Traditional Exports: Firm-Level Evidence from Peru

Renzo Castellares

- *Comment by Rahul Mukherjee*

This paper looks at the impact on Peruvian non-traditional exports (NTX), from 2007 to 2014, of Peru's own and its competitors' real exchange rate (RER and CRER, respectively). The paper uses detailed data from SUNAT at the firm, product, destination and time level, and follows the recent theory-motivated empirical literature (Berman et al. 2012) to investigate the heterogeneous pass-through of price shocks. The paper has a host

of interesting and intuitive results. The paper finds that the direct effects of the RER and CRER go in the directions predicted by theory; that larger firms have lower elasticity to RER movements (confirming the findings of the existing literature); that importing inputs from a country with whom the bilateral RER of Peru has depreciated lowers the effect of the depreciation on exports (perhaps because it is costlier to buy inputs); that larger firms are also less sensitive to the CRER; and that smaller firms are more likely to exit export markets in response to RER shocks.

My main comments about this paper have to do with the nature of the data and encouraging the authors to look at it in a bit more detail. The first comment is that it seemed from reading the paper that the data is available only for import and export values, not for volumes. This is why the paper deflates the value of exports, for example, by a sectoral price index. In effect, it is only possible to look at what happens to this measure of volume, not prices or markups at the firm level. It would be interesting to have this more detailed data at the firm level so that the paper can attempt to test both the hypotheses in Berman et al. (i.e. what happens to markups)? The data has some other drawbacks, the main one being that the measure of productivity or firm performance is imputed from exports itself (under the reasonable assumption that larger, more productive firms export more). This makes the results a bit harder to interpret, and of course brings in issues of endogeneity. Of course it would be much better if firm balance sheet data could be utilised to estimate TFP or labour productivity directly. My second set of comments concern an aspect of the paper that I found very interesting, and that could be explored more. This is the sectoral heterogeneity that is documented in the paper. Perhaps the authors can get at the channels through which the productivity of firms affects the various outcome variables using indices at the sector level such as for the external finance dependence of the sector, the tangibility of the sector's assets, or the complexity of its products? This would make the analysis much richer.

- *Comment by Emanuel Kohlscheen*

The paper by Castellares Anazco (BCRP) makes use of a very large data set to quantify the responses of non-commodity exports in Peru (which are 35 per cent of total exports according to their classification) to exchange rate variations. The author follows the approach of Berman et al. (2012). The study implicitly assumes that there is some form of increasing returns to scale, so that firm size—which here is captured by export values—can be used as a proxy for productivity. There is obviously the issue of endogeneity of export values, which is addressed in part by looking at past values. Unfortunately the author does not seem to have access to other alternative measurements from balance sheet data or productivity estimates.

The prior that smaller/less-productive firms are the ones in which exports show larger sensitivity to prices is largely confirmed by the responses to both variation in the home exchange rate and variations in the exchange rates of competitors. The underlying idea is that the room for variations in the markup

is much smaller in small firms, so that these firms have to adjust prices by more, which makes quantities respond more strongly. The author shows that this is indeed the case in Peru. Also, as one would expect, quantitatively, the variation of the home exchange rate seems to matter more.

One aspect that the results show is that while price effects are found to matter a lot for Peruvian export volumes, the common free-trade area dummy is generally not found to be significant (except for textiles). This result would be interesting in itself. One wonders whether the FTA effect is already being captured in the fixed effects or whether this result would persist if these were dropped. This could be easily checked and would tell us whether tariffs for these products still have relevant economic effects.

Commodity Price Shocks & Current Account Dynamics in Mining & Non-mining Exporters

Fernando J. Pérez Forero and Sergio Serván

- *Comment by Rahul Mukherjee*

This paper explores the effect on the current account of commodity price shocks for a set of ten commodity exporters (Brazil, Chile, Colombia, Mexico, Peru, Canada, Australia, New Zealand, South Africa and Norway) for the years 1997–2015. The paper employs recently developed panel VAR techniques to answer its question, and also distinguishes between mining and non-mining countries. The theoretical motivation for the empirical exercise comes from the textbook small, open economy model of inter-temporal decision-making in which the current account of a country is the difference between domestic savings and investment rates. In keeping with this motivation, the paper selects a set of endogenous variables (year-to-year growth rates of GDP, the consumer price index, terms of trade, exchange rates, current account surplus as a percentage of GDP and the domestic interbank rate), as well as a group of variables that can be deemed to be plausibly exogenous to the developments in a small, open economy (annual growth rate of US GDP, the growth rate of an oil price index and a commodity price index, as well as the growth rate of some more disaggregated indices such as the prices of only metals, fuel and non-fuel commodity prices). The results of the paper correspond closely to the predictions of the basic small, open economy model that motivates it—namely, price booms (busts) are found to be associated with current account surpluses (deficits). The authors highlight some differences between fuel and metal price shocks, in particular that the current account reacts more robustly to metal price shocks. They also find that the response of the current account has been stronger in recent years (since 2002).

While the main findings of the paper about the current account are in line with theory, and are therefore uncontroversial and unsurprising, it could be improved along certain dimensions. First, the causes of the heterogeneity across countries and time, or across fuels and metals that is documented

by the authors could be explored in more detail. Second, I would have liked to see a bigger role played by financial variables, since the inter-temporal view of the current account places these measurements at centre stage. For example, some measurement of global liquidity surely plays a big role in driving current accounts, as can be seen from the recent work on the effect of unconventional monetary policy in the US on global capital flows. Third, I would have liked to see justification of the exogeneity assumption for all the commodity prices in question. Surely the ten countries (Brazil, Chile, Colombia, Mexico, Peru, Canada, Australia, New Zealand, South Africa and Norway) together or by themselves supply a large part of the market for certain commodities? Can commodity prices then be taken as exogenous? Fourth, a point to note is that the year-to-year growth rate of GDP is doing the heavy lifting for all the possible real factors that might affect a country's current account (in other words, cause a country to save or dis-save externally in the inter-temporal view of the world). For example, TFP growth or demographic factors might well be playing a role. If the authors believe that these factors are not important over the time horizon of the analysis, this should be explicitly discussed. Relatedly, the inter-temporal view places a lot of importance on future or expected variables; for example, lower expected growth in the future can cause countries to save externally. Is there a way to include such forward-looking measures in the analysis, perhaps using the techniques introduced into international macroeconomics by Gourinchas and Rey (2007) from the earlier, pioneering finance literature?

- *Comment by Emanuel Kohlscheen*

The paper by Forero and Serván (BCRP), estimates the effects of commodity prices on the current account for a panel of ten commodity exporters. The estimation is based on Canova and Cicarelli's (2009) Bayesian PVAR methodology, which allows for time-varying parameters and takes account of interdependencies across countries. The authors find that commodity price increases are associated with improvements in the current account, and that this effect has become stronger over time.

Most commodity exporting EMEs typically have relatively short continuous time-series and a panel approach in principle is a nice way around the limitations that small sample sizes impose on econometricians. And the authors chose a nice methodology. Having said that, the responses that they get appear too similar between countries. Variations in impulse responses from country to country appear to be marginal.

While one would need to have the responses of exchange rates and output to commodity prices to make a more complete evaluation, the response to the recent drop in commodity prices suggests that countries can react very differently to the same shock. Following the 2014 fall in commodity prices, for instance, Norway's current account surplus indeed fell in a very significant way (from almost 12 per cent of GDP to 7 per cent). On the other hand, the current account in some emerging markets improved substantially following the same shock. It would be interesting to learn more about which factors condition responses.

Figure 1

	Current account / GDP (in %)			
	2013	2014	2015	2016
Australia	-3.4	-3.0	-4.7	-3.5
Norway	10.2	11.9	9.0	7.0
Brazil	-3.0	-4.3	-3.3	-0.8
Indonesia	-3.2	-3.1	-2.1	-2.3
Peru	-4.2	-4.0	-4.4	-3.8
Russia	1.5	2.8	5.2	3.0
South Africa	-5.9	-5.3	-4.3	-3.3

Source: IMF WEO

One aspect that may also matter is the exchange rate regime or the extent of the intervention that goes on. One could explore how sensitive results are to exclusions of periods when the exchange rate regime was different, as the regime may have been important for how shocks were transmitted in the economy. Another question is whether commodity prices are really exogenous to some of these countries. This could be an issue for countries that are producers of a substantial share of specific metals or agricultural products.

In general, the theoretical framework that most economists use to think about such issues is the permanent income rationale. It says that following temporary price increases the optimal response would indeed be to save the windfalls, meaning that current account surpluses should increase. In contrast, when price increases are permanent, the optimal response would be to adjust consumption immediately to the new levels. Of course, one of the problems is that we never know if shocks are temporary or permanent in real time, when decisions have to be made. The prudent response to such uncertainty is to always err on the side of caution.

A much more fundamental problem, however, is that the permanent income rationale may miss important dimensions particularly in the context of emerging markets (or when there are credit constraints). Large changes in commodity prices typically mean significant variations in the wealth that is under the ground. These changes to the value of explicit or implicit collateral can have first-order implications for credit flows. The current account response can then be very different from what is predicted by the PI hypothesis, also because the exchange rate and output are affected.

Time-Varying Impulse Responses to an Oil Price Shock to Core Inflation: Structural and Cyclical Effects

Hajer Ben Romdhane

- *Comment by Rahul Mukherjee*

The question addressed by this paper is whether and to what extent domestic inflation is affected by external commodity price shocks. The techniques used by the paper are the time varying parameters and Markov switching models. These are used to explore the pass-through of oil prices into inflation in Tunisia. The variables used are oil price inflation (which is treated as an external shock), the quarterly growth rate

of Tunisian real GDP and quarterly CPI core inflation in Tunisia. The paper finds that oil prices have a significant and asymmetric effect on both the CPI and real economic activity. In addition, on average, about two-thirds of the decline in the growth of index prices during a commodity price downswing is cyclical, while the rest is structural. However, cyclical fluctuations explain a relatively small share of inflation variability in the case of Tunisia.

This paper is work in progress and therefore its expositional aspects can be improved substantially. This will make it much easier to read and the policy messages clearer and more communicable. A related comment is that the motivation for the small set of variables could be made more explicit: Given that the basic model underlying the exercise seems to be a Phillips curve model for a small, open economy, it was not completely clear to me why there is no variable included to account for endogenous monetary policy responses. An expanded set of variables that also takes into account the fiscal burden necessary when oil prices fluctuate might be more appropriate.

- *Comment by Emanuel Kohlscheen*

The informative paper of Romdhane (Central Bank of Tunisia) employs different methodologies to investigate the effects of oil prices on core inflation and on output in Tunisia. Importantly, one learns that Tunisia has two important characteristics that are not atypical in EMEs. One is that one-third of the products in the CPI basket have administered prices. The other is that prices at the pump are adjusted by an asymmetric formula, which is to be replaced by a symmetric one. Administered prices of course tend to limit the reach of monetary policy. On the other hand, under administered prices the government has one additional tool with which to control inflation; but repressed prices tend to introduce substantial distortions and/or have undesirable quasi-fiscal effects.

The author tackles the question on the macroeconomic effects of oil prices by means of a very parsimonious TVP-VAR model. The main advantage of this methodology is that it does not require the response to shocks to be constant over time, which is quite convenient for the application to Tunisia. One possible extension would be to see whether the result that inflation increases when oil prices rise would still hold if the exchange rate is included in the model.

In the second part, the author relies on a Markov switching model to conclude that oil price increases lead to stronger effects on inflation during a low growth regime. One conjecture would be that during oil busts there is less fiscal space to manage fuel prices.

7. Concluding Remarks

POLICY RESPONSES TO COMMODITY PRICE FLUCTUATIONS: A REVIEW AND INTERPRETATION

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— Aizenman, J., "Concluding Remarks — Policy Responses to Commodity Price Fluctuations: A Review and Interpretation", in *Policy Responses to Commodity Price Fluctuations, Proceedings of the Fourth Annual Conference of the Bilateral Assistance and Capacity Building for Central Banks (BCC) programme*, Bern: Swiss State Secretariat for Economic Affairs; Geneva: The Graduate Institute, 2016, p. 153–158.

Background

Commodities is practically the most cyclical sector, impacted by a host of macroeconomic factors, such as global supply and demand shocks, real interest rate shocks, political and geo-economic instability, risk tolerance, funding shocks, and the like. Commodity prices doubled in the three years prior to the Global Financial Crisis (GFC), dropped to their 2005 level by 2009, doubled again by 2011, and dropped back by 2015 to their 2005 level (see Kinda et al., 2012). It is certain that commodities will continue to be characterised by their high price volatility.

The export and fiscal revenue of commodity-exporting countries is heavily dependent on commodity prices. These countries are also exposed to high terms-of-trade volatility (IMF (2014)). Past studies have found that higher real exchange rate volatility is associated with lower average GDP growth rate (Aghion et al., 2009 and the references therein). Thus, the challenge facing emerging markets is to design policies that will mitigate the impact of exogenous terms-of-trade shocks on the real exchange rate and other macro variables. We will review examples of these polices for commodity-exporting countries.

Monetary Policy and Exchange Rate Adjustments

Developing and emerging markets exhibited a clear preference for fixed exchange rate regimes during the Bretton Woods system. However, the collapse of this system suggests that fixing the currency to a global currency thereby implies floating against all of the other flexible global currencies. This observation may explain the growing share of emerging market economies (EMEs) and developing countries that have converged to regimes of managed exchange rate flexibility, sometimes in the context of a formal inflation-targeting regime. While 'fear of float' as characterised by Calvo and Reinhart (2000) remains relevant in normal times, a growing share of countries are willing to depreciate their currencies following a commodity terms-of-trade deterioration shock (i.e. following a drop in the prices of their exportable commodities relative to their importable commodities).[1] In such circumstances, drops in export revenue are mitigated by selling some of the countries' international reserves in tandem with controlled exchange rate depreciation. The reverse adjustment is applied following a commodity price hike. The management of exchange rate pressure is guided by the wish to maintain, over time, a prudent buffer of international reserves, using it to mitigate the adverse macro implications of plummeting prices of the countries' commodities. A good illustration of this mechanism is Russia during the first decade of the twenty-first century. In the top panel of figure 1, the red solid curve depicts Russian international reserves, in billions of US dollars (left scale, monthly data); the blue broken curve plots the log of the RUB/USD exchange rate (right scale, monthly data) from 2000 to 2014. The line in the bottom panel depicts the Russian terms-of-trade index (normalised to 100 in 2000), where higher index indicates terms-of-trade improvement.

The terms-of-trade of Russia closely followed the price of oil; that is, they increased sharply during 2003–08, collapsed during the Global Financial Crisis (GFC), then recovered by 2011–12, only to plummet again during 2012–14. Russia was slow to spend the growing trade surpluses of the pre-GFC years, when the rising price of oil sharply increased oil revenues.[2] The huge price rise in 2004–08 led to large reserve hoarding in Russia, reaching about USD 600 billion in August 2008. During the collapse of oil prices, the Central Bank of Russia was willing to buffer the adjustment by hoarding international reserves.[3] Large initial reserve outlays, about USD 200 billion between 8-2008 and 8-2009, were needed to cover the Russian corporate sector's exposure to hard currency debt. This occurred in tandem

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1 Commodity terms-of-trade is defined by the ratio of commodity export prices to commodity import prices, with each price weighted by the share of the relevant commodity in the country's GDP or total trade. With the proper normalisation, the rate of change in the commodity terms-of-trade is an approximation to the country's income effect relative to the GDP associated with changes in the real individual commodity prices (see Spatafora and Tytell, 2009).

2 This probably reflected uncertainty regarding the permanence of the price rise, implying that Russians' demand for foreign products did not rise fast enough to catch the windfall gains of strong terms-of-trade in the boom years.

3 This 'leaning against the wind' intervention mitigated the rouble's appreciation prior to the global financial crisis, and is reflected in the tight negative correlation between the rouble/dollar rate and international reserves prior to, during and after the 2008 crisis. See Aizenman and Riera-Crichton (2008; 2nd ed. 2014), confirming that active international reserve management reduces the effects of transitory commodity terms-of-trade shocks on the real exchange rate and real GDP.

with a rouble depreciation of about 25 per cent against the US dollar. Similar patterns had been observed in Korea and several other countries during the 2008–09 crisis, reflecting the use of reserves to meet the balance sheet exposure of systemic or politically powerful agents in the first phase of the crisis. The resultant reduced balance sheet exposure of key players and declining stock of reserves led to a sharp reduction in reserve depletion over time, shifting the adjustment from reserves depletion in the first phase of the crisis to exchange rate deprecation in the second phase (see Aizenman and Sun, 2012).

Russian corporations had rapidly expanded their foreign debt during the boom, taking advantage of strong terms-of-trade. During the crisis however, part of the depleted international reserves were used to cover their position, thereby preventing the rouble's depreciation from spiralling into a banking crisis. In a similar vein, countries with large short-term foreign debt, or a banking system that had dollar liabilities funding dollar assets offshore, opted to follow a similar adjustment. In these circumstances, central banks tended to hoard reserves in boom years. The central banks then used these reserves to mitigate exchange rate depreciations in the first phase of the crisis, and provided hard currency to its corporate sector and banks so that they could pay off their foreign creditors. This policy might have been also supplemented by prudential regulations aimed at reducing external hard-currency borrowing in good times to reduce the central banks' need to bail out domestic borrowers in bad times (see Bruno and Shin, 2013).

The viability of the fixed exchange rate for commodity countries was tested during the recent commodity bust and boom, and the results were discouraging. A fixed exchange rate regime, while anchoring domestic inflation to the inflation of the base country, is not well suited to dealing with the challenges imposed by large commodity boom–bust swings. The was vividly illustrated by the experience of Kazakhstan, summarised by Epstein and Portillo (2014):

> "In early 2009, as a result of the sharp drop in global oil prices during the second half of 2008 (and following significant depreciation in the Russian Ruble and in currencies of other resource-exporting economies), the NBK devalued the tenge by 20 per cent against the USD to a level of 150 tenge/USD. (…) In September 2013, the NBK switched to the use of a multi-currency basket (with weights of 70, 20, and 10 per cent for the USD, euro, and ruble, respectively) in smoothing "excessive" exchange rate fluctuations. However, in February 2014, the NBK unexpectedly devalued the tenge (by 18 per cent), to a level of 185, and reestablished a tight new corridor of +/- 3 tenge (roughly 1.5 per cent) around the new devalued rate."

The new 'tight corridor' regime collapsed in August 2015, and morphed into float, more than halving the value of the tenge to the dollar by January 21, 2016 (390 tenge/dollar).

A similar experience occurred in Azerbaijan over the past two years, following the collapse of an enduring fixed exchange rate to the US dollar. The benefit of anchoring a commodity country's inflation by pegging it to a global currency comes with the cost of an inability to accommodate real shocks by depreciation. The longer the peg, the greater the economic and political costs of devaluation or depreciation in the aftermath of a major drop in commodity

prices. This reflects a tendency to ignore hedging the exchange rate risk, presuming either that the peg is credible or the expectation of a bailout from the central bank. Managed float avoids this cost. Alternatively, pegging to a basket composed of currencies (say the US dollar and the euro) *and* to the main exported commodity (say, oil for Kazakhstan) would increase exchange rate flexibility. Such a generalised basket peg would provide a transparent and more credible anchor, allowing the currency to automatically weaken versus the dollar when the dollar price of oil drops. Alternatively, the commodity-exporting country may target the producer price index (PPI) instead of the consumer price index (CPI). When the price of the commodity drops, the PPI declines more than the CPI. Thus, targeting the PPI induces a more expansionary policy in bad times than targeting the CPI (see Frankel, 2010).

Fiscal Rules Buffered by Management of SWFs

Countries with fiscal space and sizable buffers composed of an SWF and international reserves (IR) may benefit from a countercyclical fiscal policy in tandem with the monetary and exchange rate policies outlined in section 1. A looser fiscal policy in bad times (i.e. low commodity prices) may complement the looser monetary policy. The opposite adjustment may take place in good times, thereby increasing the counter-cyclicality of stabilisation policies.

The needed fiscal space may be provided by following transparent rules, like the ones used by Norway in recent years. The fund's functioning is guided by the following heuristic rule:

- **i.** Build a buffer in good times—save more when revenue is above the average. This average itself is based on past experience.
- **ii.** Spend a fraction of the buffer each year, according to a transparent fiscal rule—for example, 4 per cent.
- **iii.** Countercyclical fiscal adjustments—in booms, reduce the fiscal allocation from the buffer to below 4 per cent (say to (4 – y) per cent). In busts, increase the fiscal allocation from the buffer to above 4 per cent (say to (4 + y) per cent).

Ideally, the fiscal rule should be integrated with the monetary policy. The value of a fund's average spending (4 per cent in the abovementioned example) should be linked to the expected return of the fund; and the countercyclical adjustment, y, should be linked to the amplitude of the boom or bust.[4]

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4 The Management of the Norwegian Government Pension Fund (2015) states on page 17: 'the state's net cash flow from petroleum activities is transferred to the Fund in full. An amount is withdrawn from the Fund annually pursuant to a resolution passed by the Storting to cover the non-oil budget deficit. This approach makes petroleum revenue spending in the fiscal budget a visible part of an integrated budget process. As long as the state does not accumulate debt by borrowing to fund expenditure, the GPFG's capital will reflect true financial saving on the part of the state. The fiscal policy guideline is aimed at phasing petroleum revenues gradually into the Norwegian economy, more or less in line with developments in the expected real rate of return on the GPFG, which is estimated at four percent.'

The efficacy of the abovementioned fiscal rule critically hinges on realistic forecasts of the fund's future return, and of the future prices of the exportable commodities. Frankel (2013) identifies a structural optimistic bias of forecasts, which frequently induced a short-term spending bias and hindered a bulging-up of the buffering fund, thus reducing the long-run stabilisation capacity of the fund. Chile offers an important case study in ways to overcome these biases by novel structural budget institutions, guiding Chile's copper stabilisation fund by the following rules:

First rule: Governments must set a budget target. Deficits are allowed only to the extent that

(1) Output falls short of trends, in a recession, or
(2) The price of copper is below its trend.

Second rule: Trends are projected by two panels of independent experts who are outside the political process and thereby less susceptible to short-term 'optimistic biases'. The structural budget surplus must be 0 when output and copper prices are equal to their long-run trend values. Thus, in a boom the government can only spend increased revenues that are deemed permanent; any temporary copper bonanzas must be saved.

The outcome of adopting these rules in recent decades has been remarkable: by 2007, Chile had become a net creditor. By 2010, Chile's sovereign rating had climbed to A+, and the country was able to respond effectively to the 2008–09 recession.

Hedge Commodity Exposure—Options and Output Diversification

The compelling logic for applying financial derivatives to hedge commodity prices is outlined by Borensztein et al. (2013). Mexico provides a clear case study of the potential gains associated with this strategy (see Ordonez et al., 2016). Mexican public revenues are reliant on oil-related revenues, in which about one-third of the total fiscal revenue during the last decade came from oil revenues. Mexico has implemented policies to smooth the impact of oil price uncertainty by establishing a sovereign fund and using financial derivatives to cover the risk of plummeting oil prices. Mexico does this by purchasing put options, which cover its annual exposure to adverse revenue effects associated with collapsing oil prices. The put options give Mexico the right to sell oil at a pre-set price (the strike price) for a fee (the premium); thus, the options insure the country against risk of oil prices collapsing below the strike price. The outcome has been remarkable: Mexico received USD 5 billion from its hedges for 2009. The resultant income hedged and the SWF income implied a loss of oil revenues of only 0.7 per cent of the revenue loss that the government would have incurred otherwise. Similarly, Mexico gained USD 6.5 billion from its hedges for 2015 (Bloomberg, 2016).

A long-run real hedging strategy entails diversification into non-commodity sectors and increasing the tax base beyond commodities. This may require a significant gestation period, as production diversification entails investing in the needed human and physical capital

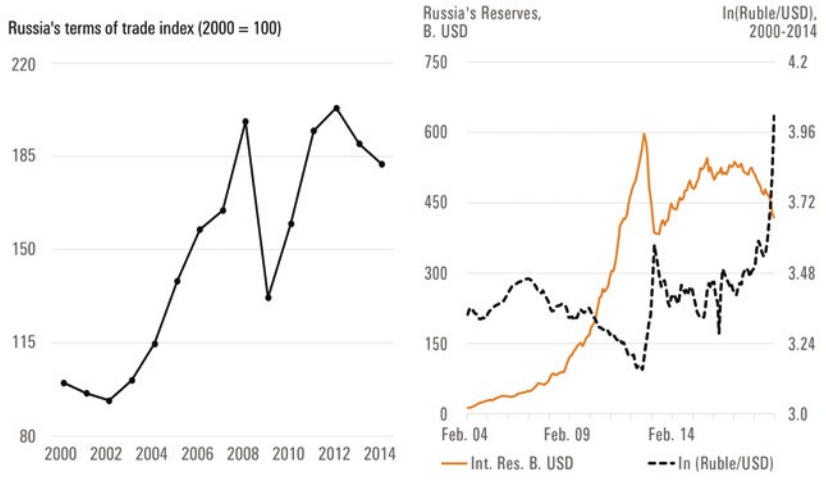
that, over time, will diminish reliance on commodity exports and improve tax collection capacities. A prime example of the feasibility of this strategy is Mexico.

Oil and gas extraction represented only about 5.3 per cent of its gross domestic product in 2015, about half of the level when the North American Free Trade Agreement took effect two decades ago, and a contribution that is easily trumped by manufacturing and service industries such as tourism. Furthermore, tax reforms and industrialisation helped reduce the fiscal dependence on oil revenues. While oil sales traditionally funded more than one-third of the government's spending, that contribution dropped to less than 20 per cent last year. This is the outcome of a sweeping tax increase—Mexico raised the maximum income tax rate to 35 per cent, increased the sales tax in states along the US border and applied an 8 per cent levy to junk food, among other measures. 'While oil production is falling, gains in auto production and consumer spending are helping give Mexico the fastest growth among major economies in Latin America and an expansion that's quicker than several large oil producers' Bloomberg (2016).

Concluding Remarks

While the policies overviewed in this note are not a panacea, growing evidence suggests that effective application of these strategies mitigates the transmission of commodity volatility to the volatility of the GDP and the real exchange rate. Such strategies also reduce both the odds that plummeting commodity prices could induce a deep recession, thereby reducing a country's exposure to sudden stops that could lead to sovereign debt and banking crises.

Figure 1: Russia's Terms of Trade, International Reserves and Rouble/USD Rate, 2000–14



Left panel: Russia's terms-of-trade index (higher index indicates TOT improvement).
Right panel: International reserves (left scale); ln (rouble/USD) (right scale); 2000–14.
Data sources: rouble/USD, monthly data—FRED. International reserves, monthly data—Bank of Russia. Terms-of-trade—World Bank.

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