Essays in Empirical Macroeconomics

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Declaration

This thesis is my own work.

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To Wendy, Wenjie, & Jiayi

Abstract

This thesis is a collection of five essays in empirical macroeconomics. The first paper evaluates the effectiveness of fiscal policy in different economic environments. The results show that, contrary to conventional wisdom, fiscal multipliers are not necessarily smaller in countries relatively open to trade and financial flows and operating under flexible exchange rates. The relationship between the size of fiscal multipliers and the three dimensions of openness—trade openness, capital mobility, and exchange rate flexibility—hinges on the response of the real exchange rate and the degree of monetary policy accommodation, which underscores the importance of fiscal and monetary policy interaction in understanding the fiscal transmission mechanism.

The second paper examines the effects of an adverse oil price shock in oil-exporting countries under alternative exchange rate and fiscal policy arrangements. The results show that output and government consumption fall, as expected, but the responses are smaller and smoother in countries with flexible exchange rates and oil funds. This highlights the shock-absorbing property of flexible exchange rates and the macroeconomic stabilization role of oil funds, making a case for oil exporters to adopt more flexible exchange rates and establish oil funds as fiscal buffers.

The third paper examines the roles of oil funds and institutional quality in reducing fiscal procyclicality and macroeconomic volatility in oil-exporting countries. The results show that oil funds are effective in reducing fiscal procyclicality in countries with high institutional quality. There is also a reduction in the procyclical bias in countries with low institutional quality but the evidence is less compelling. Nonetheless, oil funds are associated with reduced volatility of government consumption and the real exchange rate in countries with low institutional quality. These findings demonstrate the potency of oil funds in macroeconomic stabilization, but also reinforce the importance of good institutions.

The fourth paper examines the conduct of fiscal policy in Brunei, focusing on the cyclical patterns in government expenditure. In spite of relatively large fiscal buffers in Brunei's oil funds, the results provide evidence of procyclical fiscal policy, which exacerbates the business cycle. This behaviour is primarily driven by procyclical current expenditure while capital expenditure is largely acyclical. A key policy recommendation would be to adopt clear fiscal rules to integrate the oil funds into the country's macroeconomic policy framework to delink government spending from volatile oil revenue.

The fifth paper investigates the sources of macroeconomic fluctuations in Brunei. The results show that oil price shocks account for only a small proportion of output fluctuations while productivity shocks have the largest share. Real exchange rate movements are largely driven by demand shocks while monetary shocks explain most of the variability in prices. Economic policies should focus on productivity improvement and capital investment to increase output in the long run, and the conduct of fiscal policy should take into account the impact on real exchange rate volatility.

Contents

List of Tables

List of Figures

Chapter 1

Introduction

1.1 Global economic events in the 21st century

The revival and intensification of global integration towards an open international trading and financial system has been at the core of multilateral economic policies since the Second World War. Although globalization can contribute to economic growth and improvements in development outcomes, at least in theory, this interdependence in the global village also inherently poses serious threats. The Dot-com bubble burst was the first significant economic event in the new millennium, which prompted policy responses to avert a deep recession. The Federal Reserve in the United States (U.S.) subsequently eased monetary policy, perhaps for too long. The loose monetary policy stance is argued to have a hand in sparking the refinancing boom in the U.S. (see Taylor, 2007), which led to the subprime mortgage crisis, collapse of the financial sector, and a real economic meltdown. This turmoil culminated in the Great Recession, drawing many parallels to the Great Depression in the 1930s (Temin, 2010; Eichengreen, 2015). The ensuing banking and financial crises in Iceland and Ireland, the sovereign debt crises in Portugal, Ireland, Italy, Greece, and Spain (PIIGS), and the chaos of Brexit and the European Union are testaments to the interconnectedness of the world economy.

Commodity prices, particularly of energy and base metals, increased dramatically at the turn of the 21st century. The ascent was briefly interrupted by the global financial crisis (GFC), before continuing their upward trajectory until the middle of 2014. The subsequent plunge in commodity prices has mounted enormous pressures on the fiscal and external balances of commodity exporters. More so than other commodities, oil price movements and the responses of oil-exporting countries have increasingly grabbed international attention. The prevailing environment of low oil prices is supposed to be "good news for the global economy", proclaimed the International Monetary Fund (IMF) chief, Christine Lagarde, at The Wall Street Journal CEO Council annual meeting in December 2014. This sentiment is similarly echoed in policy circles (see e.g., Arezki

and Blanchard, 2014; Husain et al., 2015; Vrontisi et al., 2015). However, the widely anticipated benefits have yet to materialize as the transmission channels to the real economy have become more complicated (Obstfeld et al., 2016). Global economic growth prospects remain bleak—the IMF and the Organisation for Economic Co-operation and Development (OECD) have repeatedly revised forecasts downwards (see IMF, 2016a; OECD, 2016).

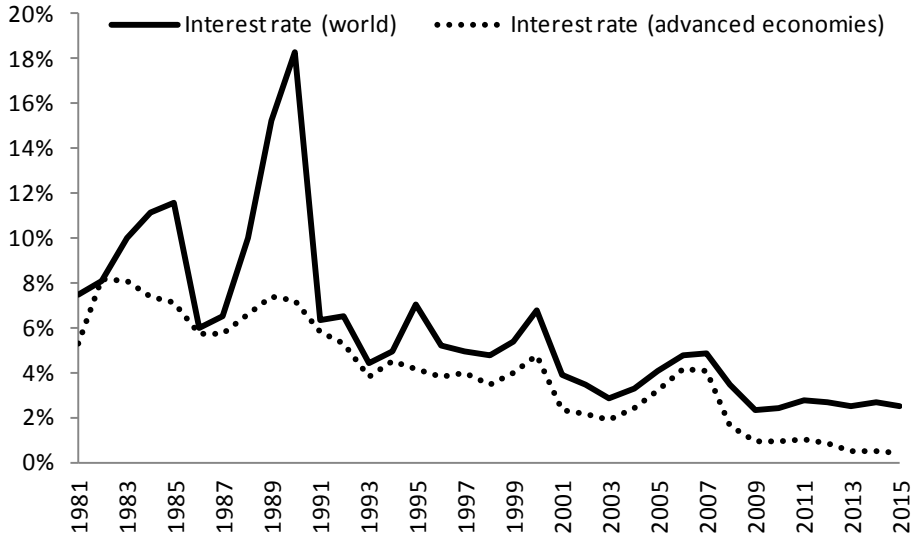
1.2 Global fiscal stimulus

Monetary policy acted as the first line of defence in response to the GFC, but the limits of conventional monetary policy became increasingly apparent as policy interest rates in advanced economies approached the nominal zero lower bound (see Fig. 1.1). Fiscal policy was thus essential to aid in economic recovery. Many countries embarked on an unprecedented level of fiscal expansion unseen since the Second World War (Mauro et al., 2015), in the form of stimulus packages. The size of the fiscal stimulus in the G-20 countries was estimated at US$2 trillion, about 1.4% of 2008 world GDP (IILS, 2011). Figure 1.2 shows the large output fall and the sharp increase in real government spending during the GFC, but the stimulus was unwound in the following years as substantial fiscal deficits emerged. Against the current backdrop of a lacklustre global economy, the IMF and OECD are again advocating a coordinated fiscal stimulus response by the G-20 countries (IMF, 2016b; OECD, 2016).[1]

The effectiveness of fiscal stimulus has been an intensely political subject over the past several years. There is also little consensus among economists, owing to contradictory theoretical predictions and mixed empirical evidence. Identifying exogenous fiscal spending shocks is an important element in measuring the size of fiscal multipliers. The standard approach of Blanchard and Perotti (2002), by assuming government spending does not respond to GDP in the same quarter, requires quarterly data for the identification scheme to be valid. Data availability is a major obstacle to obtain reliable estimates, especially in developing countries, which typically only have annual time series data that are sufficiently long.

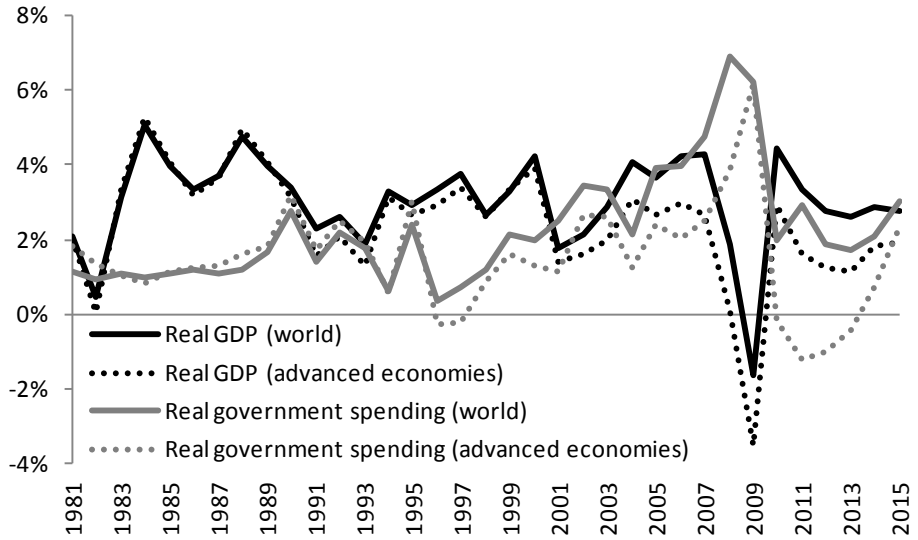
[1] McKibbin and Stoeckel (2012) examine the consequences of global fiscal adjustments and highlight the importance of a coordinated response to avoid worsening of global imbalances.

Fig. 1.1 Average policy interest rates



Notes: Data sourced from IMF International Financial Statistics. The averages are weighted by GDP in current U.S. dollars.

Fig. 1.2 Average growth rates of real GDP and real government expenditure



Notes: Data sourced from IMF World Economic Outlook, April 2016. The averages are weighted by GDP in current U.S. dollars.

An influential paper by Ilzetzki et al. (2013), based on a novel quarterly data set of 44 countries, finds that fiscal multipliers are smaller in developing countries, in countries relatively open to trade, under flexible exchange rate regimes, and when public debt is high. Interestingly, the estimated multipliers are negative in the long run. A sobering policy implication arising from the study is that fiscal stimulus could

become counterproductive due to increasing global integration and adoption of flexible exchange rate arrangements. However, Dellas et al. (2005) allude to the importance of fiscal and monetary policy interactions in determining the relationship between the size of fiscal multipliers and the degree of openness (trade openness, capital mobility, exchange rate flexibility). A corollary to this point is that there might, in fact, not be a systematic relationship.

1.3 The 'new normal' of low oil prices

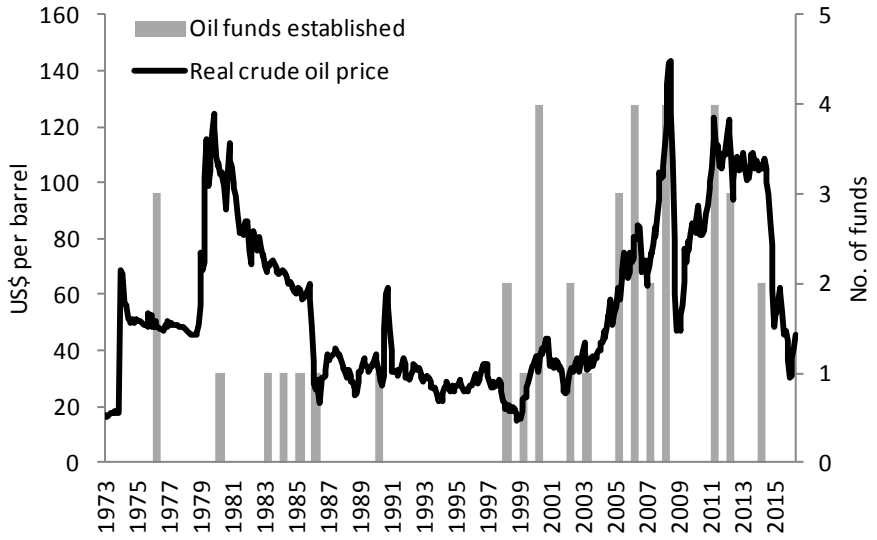
Apart from the oil price crashes of 1985–86 and 1990–91, during which the Organization of the Petroleum Exporting Countries (OPEC) abandoned price targets and the First Gulf War respectively, crude oil prices remained relatively stable, hovering around US$30 per barrel in real terms between the mid 1980s and the end of the 20th century (see Fig. 1.3). The new millennium ushered in an era of oil price booms, reaching an apex of over US$140 per barrel in mid 2008. Oil prices fell dramatically during the GFC, but rebounded to over US$100 per barrel relatively quickly. The budgets of many oil-exporting countries were, unfortunately, predicated on the optimistic assumption that oil prices will remain high. This can be observed from the fiscal break-even oil price for, say, the United Arab Emirates, which averaged US$33 per barrel over the period 2000–2012 but more than doubled to US$70 per barrel in 2012–15 (see IMF, 2016c). Oil prices began to steeply decline in June 2014, amid weak global demand and the supply glut following the boom in U.S. shale oil production, and was exacerbated by OPEC's decision to maintain production levels (Baffes et al., 2015).

With projected fiscal break-even prices in 2016 ranging from US$48 per barrel for Kuwait to a staggering US$364 per barrel for Yemen (IMF, 2016c), the growing fiscal deficits necessitate abrupt macroeconomic adjustments in the short term. The macroeconomic effects of the oil price decline will depend on monetary and fiscal arrangements (see Arezki and Blanchard, 2014). Economic theory dating back to Friedman (1953) and Poole (1970) suggests that countries with flexible exchange rate regimes can adjust through currency depreciations when faced with real shocks. Indeed, Russia, which had been operating on a managed float, transitioned to a free floating regime in November 2014. Kazakhstan and Azerbaijan also adopted a more flexible regime in August 2015 and January 2016 respectively. Nigeria is the latest to follow suit

in June 2016. There is ample empirical evidence documenting the merits of flexible exchange rates (e.g., Broda, 2004; Edwards and Levy Yeyati, 2005) although earlier studies find that the exchange rate regime does not seem to matter (e.g., Baxter and Stockman, 1989; Ghosh et al., 1997).

For those with rigid exchange rate regimes such as a hard peg, currency board arrangement, or dollarized currency, monetary policy is constrained and fiscal policy therefore bears the burden of macroeconomic stabilization. These countries require substantial fiscal spending cuts, especially if there are insufficient fiscal buffers such as oil funds. Interestingly, the oil price boom beginning in the late 1990s coincided with the proliferation of oil funds (see Fig. 1.3). Saving surplus revenues during good times is a prudent macroeconomic policy, and the oil funds can be run down to finance fiscal deficits during bad times. Frankel et al. (2013) find that a third of the developing world has 'graduated' from fiscal procyclicality over the past decade. About half of this cohort comprises of oil exporters, suggesting oil funds could have played an important role. However, there is mixed empirical evidence on the effectiveness of resource funds. Some studies do not find convincing evidence of resource funds reducing the procyclical bias (e.g., Davis et al., 2001; Ossowski et al., 2008) but there are others with favourable results (e.g., Coutinho et al., 2014; Asik, 2015).

Fig. 1.3 Real crude oil price and number of new oil funds established

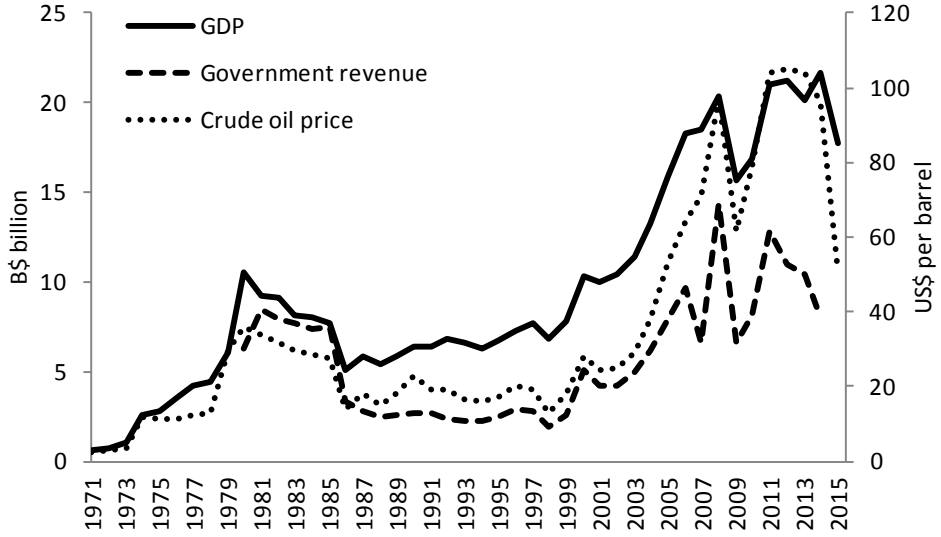


Notes: The real oil price is obtained by adjusting the nominal oil price by U.S. CPI; data sourced from IMF International Financial Statistics. Oil funds data sourced from the Sovereign Wealth Fund Institute.

1.4 Brunei's macroeconomic policy challenges

Brunei Darussalam, a small country on the northwest coast of Borneo Island in Southeast Asia, is ruled by a traditional monarch who has absolute executive and legislative powers. The official religion of the tiny sultanate is Islam, of which two-thirds of the population of 400,000 are Muslims. Brunei's economy is primarily driven by oil and gas, accounting for more than half of its GDP and over 90% of exports and government revenue. The high dependence on hydrocarbons is evident from Fig. 1.4, which shows the co-movements of Brunei's GDP and government revenue with the international crude oil price.

Fig. 1.4 Crude oil price and Brunei's GDP and government revenue



Notes: Oil price data sourced from IMF International Financial Statistics. GDP data sourced from World Bank World Development Indicators. Government revenue data obtained from the Brunei Department of Economic Planning and Development.

Brunei's implementation of the Shari'a law in 2014, much to the ire of international human rights groups, has catapulted the nation into the international spotlight and sparked a storm of controversy. However, a more pressing concern is the growing fiscal deficit amidst low oil prices. The government has announced a series of budgetary spending cuts and the fiscal deficit is projected to be an astounding 26% of GDP in 2016, the second largest globally after Libya (IMF, 2016a). The economy is also set to contract for the fourth consecutive year.

Brunei's natural resource rents are spent on building infrastructure, funding a large public sector, and maintaining universal subsidy programs such as free education and healthcare, low-cost public housing, old age pensions, as well as highly subsidized staple foods, public utilities, and petroleum products. Fiscal surpluses are accumulated in its oil fund, established in 1983 under the auspices of the Brunei Investment Agency (BIA). Before the GFC, BIA's assets were estimated at US$100 billion (Demange, 2009) but they have dwindled to US$40 billion in 2016 (SWFI, 2016). Nonetheless, this is still sufficient to finance fiscal deficits of the projected 2016 magnitude for about 20 years. However, there are no clear rules on how the fund is utilized in the conduct of fiscal policy. Brunei's oil fund has a Linaburg-Maduell transparency rating of 1, indicating that it is highly opaque and secretive.

Brunei has been operating on a currency board arrangement since 1967, in which the Brunei dollar is pegged at par to the Singapore dollar. Brunei, therefore, has no monetary policy autonomy and fiscal policy becomes an essential macroeconomic stabilization tool. Devising clear and transparent fiscal rules to better integrate the oil fund into the country's macroeconomic policy framework could help avoid unnecessary volatility in an environment that is already embroiled by uncertainty. The widely-touted successes of Norway and Chile in this regard are worthy of emulation.

Brunei's persistently low economic growth, with an average of 1.2% over the past three decades, is also alarming. This is a far cry from the nation's growth aspiration of 6% per annum. The perennial goal of economic diversification continues to elude Brunei, and its future prosperity is still very much subject to the vagaries of volatile oil prices. At the same time, oil production has fallen from a recent peak of 228 thousand barrels per day (tbpd) in 2006Q3 to 122 tbdp in 2015Q3 as oil wells are depleted. Oil prices are projected to remain low in the medium term (IMF, 2016a), and with proven oil reserves that can sustain current production for less than 25 years (BP, 2016), Brunei faces a dire economic future. There is an urgent need to develop a better understanding of the Brunei economy, which, unfortunately, has received scant attention in the economics literature.

1.5 Key research questions and findings

This thesis is a collection of five self-contained papers. The principal focus is on empirical macroeconomics; in essence, applying econometric techniques to analyse issues of contemporary economic policy interest. The research topics are motivated by the discussions in the subsections above. I examine: the effectiveness of fiscal stimulus in different economic environments (Chapter 2); how exchange rate and fiscal policy help oil-exporting countries adjust during bad times (Chapter 3); the roles of oil funds and institutional quality in macroeconomic stabilization (Chapter 4); the conduct of fiscal policy in Brunei (Chapter 5); and the sources of macroeconomic fluctuations in Brunei (Chapter 6).

In terms of the methodological approach, Chapters 2 to 4 feature panel data analyses using samples of as many countries as permitted by data availability. The estimation techniques used are panel vector autoregression (VAR) models, with different ways of identifying shocks. Chapters 5 and 6 focus on time series analysis for a single country using structural VAR models.

In Chapter 2, I evaluate the effectiveness of fiscal stimulus in different economic environments using a large annual data set of 120 countries from 1960 to 2014. To credibly identify a shock to fiscal spending shock in annual data, I employ an alternative methodology based on sign restrictions. In concordance with the existing literature, I find that fiscal multipliers are larger in advanced economies, when public debt is low, at a high level of financial development, in a financial crisis, and during business cycle downturns. However, contrary to conventional wisdom, fiscal multipliers are not necessarily smaller in countries that are relatively open to trade and financial flows and operating under flexible exchange rate regimes. The relationship between the size of fiscal multipliers and the three dimensions of openness—trade openness, capital mobility, and exchange rate flexibility—hinges on the response of the real exchange rate and the degree of monetary policy accommodation. I also show that the results in Ilzetzki et al. (2013), who find smaller fiscal multipliers in open economies and flexible exchange rate regimes, are not sensitive to the choice of data frequency or the identification methodology but are driven by the country sample.

In Chapter 3, I examine the macroeconomic effects of an adverse oil price shock in oil-exporting countries under different exchange rate and fiscal policy arrangements. The results show that output and government consumption fall, as expected. However, the output decline is smaller and smoother under flexible exchange rate regimes due to a large and immediate real exchange rate depreciation. There is also less need for contractionary fiscal policy as the real depreciation plays a sufficient dampening role. In contrast, there is only a small and delayed real depreciation under fixed exchange rate regimes, leaving fiscal policy to bear the bulk of the macroeconomic adjustment costs. Nonetheless, the presence of oil funds is associated with smaller spending cuts and, hence, a reduced output fall. These findings highlight the shock-absorbing property of flexible exchange rates and the potential macroeconomic stabilization role of oil funds in insulating against adverse oil price movements, making a case for oil exporters to adopt more flexible exchange rate regimes and establish oil funds as fiscal buffers.

Oil-exporting countries face challenges in the conduct of fiscal policy due to volatile oil revenues, especially in countries with weak institutions. Many oil exporters have established oil funds to delink government expenditure from oil revenues; however, their effectiveness remains unresolved. In Chapter 4, I examine the roles of oil funds and institutional quality in reducing fiscal procyclicality and macroeconomic volatility in oil-exporting countries. The results show that oil funds are effective in reducing fiscal procyclicality in countries with high institutional quality. There is also a reduction in the procyclical bias in those with low institutional quality but the statistical evidence is weak. Nevertheless, oil funds are associated with reduced volatility of government consumption and the real exchange rate in countries with low institutional quality. These findings give credence to the macroeconomic stabilization role of oil funds but also reinforce the importance of good institutions.

In Chapter 5, I examine the conduct of fiscal policy in Brunei, focusing on the cyclical patterns in government expenditure. The results provide evidence that fiscal policy in Brunei is procyclical, which has an expansionary effect on output and thus exacerbates the business cycle. This behaviour is primarily driven by procyclical current expenditure while capital expenditure is largely acyclical. The government should exercise caution to avoid adding cyclical pressures to the economy already afflicted by volatile oil prices. A key policy recommendation would be to adopt clear fiscal rules to

better integrate Brunei's oil funds into the budgetary framework to delink government spending from volatile oil revenue.

In Chapter 6, I investigate the sources of macroeconomic fluctuations in Brunei. The results show that oil price shocks account for only a small proportion of output fluctuations while productivity shocks have the largest share. Real exchange rate movements are largely driven by demand shocks while monetary shocks explain most of the variability in prices. Economic policies should focus on productivity improvement and capital investment to increase output in the long run, and the conduct of fiscal policy should take into account the impact on real exchange rate volatility.

1.6 Organization

This thesis is organized as follows. Chapters 2 to 6 present the core research materials. Chapter 2 evaluates the effectiveness of fiscal policy in different economic environments. Chapter 3 examines the impact of an adverse oil price shock in oil-exporting countries under alternative exchange rate and fiscal policy arrangements. Chapter 4 examines the roles of oil funds and institutional quality in reducing fiscal procyclicality and macroeconomic volatility in oil-exporting countries. Chapter 5 examines the conduct of fiscal policy in Brunei, focusing on the cyclical patterns in government expenditure. Chapter 6 investigates the sources of macroeconomic fluctuations in Brunei. Chapter 7 concludes with a brief discussion of the policy implications of the empirical results and outlines possible avenues for future research.

Chapter 2

Fiscal multipliers: new evidence from a large panel of countries

ABSTRACT

This paper evaluates the effectiveness of fiscal policy by employing a structural panel vector autoregression model with a shock to fiscal spending identified via theoretical robust sign restrictions. Using an annual data set of 120 countries over the period 1960–2014, the results show that fiscal multipliers are larger in advanced economies, when public debt is low, at a high level of financial development, in a financial crisis, and during business cycle downturns. Contrary to conventional wisdom, fiscal multipliers are not necessarily smaller in countries that are relatively open to trade and capital flows and operating under flexible exchange rate regimes. The relationship between the size of fiscal multipliers and the three dimensions of openness—trade openness, capital mobility, and exchange rate flexibility—hinges on the response of the real exchange rate and the domestic monetary policy pursued.

2.1 Introduction

The effectiveness of fiscal policy has regained renewed attention in recent years as fiscal stimulus measures were implemented around the world to aid economic recovery from the global financial crisis; followed by fiscal consolidations and the ensuing austerity debate. However, there is still no consensus on the size of fiscal multipliers. Disagreements among economists not only emerge from theoretical predictions, but also from contradictory empirical evidence due to the use of different estimation methodologies and sample countries. Inaccurate estimation of fiscal multipliers can lead to significant growth forecast errors (Blanchard and Leigh, 2013), which have important consequences in the design of macroeconomic policies; for instance, in setting unrealistic fiscal targets on fiscal balance and public debt.

One of the central issues in estimating fiscal multipliers is the endogeneity problem between fiscal policy and output. The standard approach to identify exogenous fiscal shocks is to use the strategy of Blanchard and Perotti (2002) by assuming government expenditure does not respond to GDP in the same quarter. This restricts the country sample typically to advanced economies since quarterly data is required for the identification scheme to be valid. Ilzetzki et al. (2013), whose paper is among the most cited within this strand of the literature, construct a novel quarterly data set of 44 countries to examine the role of country characteristics. They find that long-run fiscal multipliers are smaller (in fact, the mean multipliers are negative) in developing countries, open economies, flexible exchange rate regimes, and periods of high public debt. These findings have important policy ramifications. With increasing global integration and countries moving towards exchange rate flexibility, fiscal stimulus could become counterproductive. If this view gains traction, it might potentially discourage policymakers in developing countries from pushing reforms to further open up their economies or transition towards flexible exchange rates, especially in countries where fiscal policy plays a prominent stabilization role.

While there is general consensus that fiscal multipliers tend to be smaller in developing and high-debt countries, the empirical evidence on the roles of openness and the exchange rate regime on the effectiveness of fiscal policy is mixed. There are studies that concur with the results in Ilzetzki et al. (2013); for example, Born et al.

(2013) find smaller multipliers in flexible exchange rate regimes, but there are also others with contradictory findings; for instance, Dellas et al. (2005) find that the size of fiscal multipliers does not vary systematically with the exchange rate regime.

The objective of this paper is to examine whether there are any empirical regularities on the size of fiscal multipliers; in particular to revisit the findings in Ilzetzki et al. (2013). The main motivation behind this research is partially attributed to Contreras and Battelle (2014) who question the robustness of the results in Ilzetzki et al. (2013). Using the same identification method with quarterly data, they could replicate the results based on the 44 countries in Ilzetzki et al. (2013) but some of the conclusions no longer hold when the country sample is extended to 55. This paper therefore naturally asks the following questions: (i) Are the results in Ilzetzki et al. (2013) still valid in a larger country sample, i.e., do they suffer from sample bias?; (ii) Are the results different with lower frequency data?; and (iii) How important is the identification method?

This paper further contributes to the debate on the effectiveness of fiscal policy by also assessing, in a coherent empirical framework, whether the size of fiscal multipliers depend on the degree of international capital mobility, level of financial development, occurrence of a financial crisis, and state of the business cycle, building on the work of Ilzetzki et al. (2013) who examine the relevance of economic development, trade openness, exchange rate flexibility, and public debt burden.

I construct a large annual data set comprising of 120 countries over the period 1960–2014. To credibly identify a fiscal spending shock using annual data, I employ an alternative methodology based on sign restrictions. A shock to government spending is identified by restricting the impact responses of output and fiscal deficit to increase with government expenditure, which Pappa (2009) shows to hold in both prototypical Real Business Cycle (RBC) and New Keynesian models. To the best of my knowledge, no other studies use sign restrictions to identify a shock to fiscal spending in determining the size of fiscal multipliers conditional on the economic environment across a large country sample. A summary of the results in this paper and related panel data studies is provided in Table 2.A1 in Appendix 2.A.

Briefly, the main findings are as follows: (i) In concordance with existing literature, fiscal multipliers are larger in advanced economies, when public debt is low, at a high level of financial development, in a financial crisis, and during business cycle downturns; (ii) However, contrary to conventional wisdom, fiscal multipliers in countries that are relatively open to trade are not smaller than their closed counterparts. Although there is demand leakage through imports in open economies, the increase in private consumption more than offsets the decline in net exports; (iii) Fiscal multipliers are also not smaller in countries with relatively high international capital mobility, contradicting the predictions of the traditional Mundell-Fleming model. This can be explained by the shaper depreciation of the real exchange rate and the relaxation in monetary policy; (iv) In addition, fiscal multipliers in flexible exchange rate regimes are not smaller than fixed regimes. There is no evidence of monetary policy accommodation under fixed exchange rate regimes, contrary to what the Mundell-Fleming model would suggest. Moreover, under flexible exchange rate regimes the real exchange rate does not appreciate in response to an increase in government spending; (v) The qualitative findings in Ilzetzki et al. (2013) can be obtained by using annual data for their country sample in both the standard structural vector autoregression (SVAR) and sign restriction identification schemes. This suggests that the results in Ilzetzki et al. (2013) are not sensitive to data frequency and the identification methodology, but are driven by the country sample; and (vi) The key to understanding the divergence of the results surrounding the three measures of openness—trade openness, capital mobility, and exchange rate flexibility—are the response of the real exchange rate and the degree of monetary policy accommodation. This underscores the importance of fiscal and monetary policy interactions in determining the size of fiscal multipliers.

The remainder of this paper is organized as follows. Section 2.2 reviews the theoretical predictions and empirical evidence on the effects of discretionary fiscal policy and how different economic characteristics affect the size of fiscal multipliers. Section 2.3 provides a brief overview of the issues in estimating fiscal multipliers. Section 2.4 describes the theoretical restrictions to identify a fiscal spending shock as well as the econometric framework. Section 2.5 presents the results on the effectiveness of fiscal stimulus, Section 2.6 discusses robustness checks, and Section 2.7 concludes.

2.2 Macroeconomic effects of fiscal policy: theory and empirics

It is instructive to briefly discuss what theory says about the expected consequences of a fiscal expansion. In the context of the closed economy textbook IS-LM model, an increase in government spending shifts the IS curve to the right. Labour demand increases, resulting in higher real wages and a higher level of output and consumption. Interest rates also rise, which can crowd out investment. The open economy counterpart to the IS-LM model is the Mundell-Fleming model. Under a flexible exchange rate regime, a fiscal expansion raises real interest rates and the nominal exchange rate appreciates. With nominal price sluggishness, the real exchange rate therefore appreciates and the trade balance deteriorates, thus limiting the expansionary effects of higher government spending. If there is perfect capital mobility, the resulting reduction in net exports completely offsets the fiscal expansion. In contrast, under a fixed exchange rate regime the monetary authority increases money supply to keep the exchange rate fixed, resulting in higher output while net exports remain unchanged.

These traditional models do not account for inter-temporal aspects of fiscal expansions. There are trade-offs between the short-run benefits and additional public debt accumulation that requires higher future tax increases or spending reductions. In neoclassical RBC models (e.g., Baxter and King, 1993) the discounted value of future tax rises generates a negative wealth effect that induces individuals to reduce private consumption and leisure. Labour supply increases, real wages fall and there is an increase in output. The increase in employment raises the marginal product of capital and attracts more private investment. Likewise, in a neoclassical open economy model setting (e.g., Baxter, 1995), the above dynamics are also at work. In addition, a fiscal expansion, which is typically more intensive in home-produced non-traded goods, leads to a real exchange rate appreciation (i.e., price of domestic goods increases relative to foreign goods) and a deterioration in the trade balance.

The two theoretical frameworks are seemingly at odds on the response of private consumption—Keynesian models predict an increase whereas neoclassical models predict the opposite. Nonetheless, both models agree that a fiscal expansion leads to a real exchange rate appreciation. However, empirical evidence does not usually conform fully to these theoretical predictions. In particular, an increase in government spending

is typically followed by an *increase* in private consumption (e.g., Fatás and Mihov, 2001; Blanchard and Perotti, 2002) and a real exchange rate *depreciation* (e.g., Kim and Roubini, 2008; Monacelli and Perotti, 2010; Ravn et al., 2012).

Several approaches have been proposed to account for these empirical 'puzzles'. Linnemann (2006) introduces non-separability of consumption and leisure in the household utility function. Due to consumption and leisure being substitutes, the reduction in leisure as a consequence of fiscal expansion increases the marginal utility of consumption. This positive effect on consumption could offset the negative wealth effect, and is more likely the higher the degree of substitutability between consumption and leisure and the lower the inter-temporal rate of substitution. Bouakez and Rebei (2007) introduce preferences which depend on private and public spending, along with habit formation. The complementarities between private and government consumption enable the model to generate a positive response of private consumption to a government spending shock. Galí et al. (2007) introduce non-Ricardian (rule-of-thumb) households that consume their current disposable income. If this group of consumers is sufficiently large, the positive effect on current consumption could offset the negative wealth effect of optimizing households.

On the real exchange rate depreciation puzzle, Kollmann (2010) emphasizes that the real exchange rate can depreciate if government spending shocks are persistent and international financial markets are incomplete. Corsetti et al. (2012a) show that if government spending contributes to debt stabilization, fiscal expansion today induces expectations of future spending cuts; long-run real interest rates therefore do not rise and the real exchange rate depreciates. Ravn et al. (2012) reconcile the puzzle by introducing deep-habit formation, in which an increase in domestic aggregate demand provides firms with incentives to lower markups. The decline in domestic markups relative to foreign markups leads to a real exchange rate depreciation.

The macroeconomic effects of a fiscal expansion also depend on key country characteristics. The following sub-sections discuss the theoretical predictions and empirical estimates in different economic environments.

2.2.1 Economic development

Studies on advanced economies typically produce fiscal multipliers between zero and one in the first year (see Batini et al., 2014). Kraay (2012), Estevão and Samaké (2013), and Ilzetzki et al. (2013) find that fiscal multipliers in advanced economies are larger than developing countries. Among the reasons put forth to explain why fiscal multipliers tend to be smaller in developing countries are implementation lags and weaker management in public spending and higher precautionary savings owing to instability and uncertainty.[2]

2.2.2 Trade openness

According to Keynesian models, government spending has maximum potency when the effects are contained in the domestic economy. Fiscal multipliers are therefore expected to be smaller in open economies, which have a higher propensity to import, as a fiscal expansion leads to demand leakage through imports instead of an increase in domestic production to satisfy the increase in aggregate demand. The findings of Ilzetzki et al. (2013) support this conventional view; fiscal multipliers are smaller in countries which are relatively open to trade. They find similar results even with alternative definitions of trade openness such as using tariff rates and economy size.

2.2.3 Capital mobility

Another important dimension of globalization is increasing financial integration and the reduction of barriers to international capital flows. However, the role of capital mobility has attracted considerably less attention as a determinant of the size of the fiscal multiplier. According to the traditional Mundell-Fleming model, the effectiveness of fiscal policy is an inverse function of the degree of international capital mobility. Capital mobility gives rise to an exchange-rate induced crowding-out effect, diminishing the efficacy of fiscal stimuli. This core result also holds in open economy general equilibrium models with micro foundations (e.g., Sutherland, 1996).

[2] Institutional factors could also be important in determining the effectiveness of fiscal policy. Developing countries tend to have lower institutional quality; to some extent, economic development captures the effect of institutions.

Contrary to conventional wisdom, Pierdzioch (2004) shows that a high degree of capital mobility can also increase the effectiveness of fiscal policy. He emphasizes the importance of taking into account the interaction between fiscal and monetary policy to understand the transmission of fiscal shocks. Adding a richer specification of the monetary policy rule into the model of Sutherland (1996), he finds that the output effect of a fiscal policy shock increases in the degree of capital mobility under nominal income targeting but the opposite is observed if the central bank keeps money supply constant.

In addition, according to the optimizing consumption-smoothing view, a high degree of capital mobility allows forward-looking agents to smooth consumption through the dynamics of the current account. From this inter-temporal standpoint, lower impediments to capital movements allow the current account to act as a buffer in the face of shocks; hence the negative wealth effect is smaller and fiscal multipliers could be larger.

2.2.4 Exchange rate regime

As discussed earlier, the Mundell-Fleming model predicts that a fiscal expansion is ineffective under flexible exchange rates as it leads to an exchange rate appreciation which crowds out net exports. In contrast, fiscal policy is effective under fixed exchange rates since monetary expansion keeps the exchange rate unchanged. Monetary policy accommodation therefore plays a crucial role. The findings in Corsetti et al. (2012b), Born et al. (2013), and Ilzetzki et al. (2013) provide support for this traditional view.

However, this conventional view does not go unchallenged. Dellas et al. (2005) show in an open economy New Keynesian model that fiscal multipliers can be larger under flexible exchange rates compared to a peg, depending on the domestic monetary policy pursued. This is primarily due to the depreciation of the real exchange rate in response to a fiscal expansion. Under a fixed exchange rate regime, the monetary authority must follow a contractionary monetary policy to keep the nominal exchange rate unchanged, which partially offsets the fiscal stimulus. With flexible exchange rates, the currency depreciation has a positive effect on net exports. Hence, it is possible for the output effect to be larger in flexible exchange regimes. However, the preceding

argument holds only when the monetary policy pursued is an exogenous money supply rule. If the monetary policy is based on inflation targeting instead, the picture is reversed. In this case, under a flexible exchange rate regime the monetary authority reacts to inflationary pressures of the fiscal expansion by raising interest rates. The resulting effect could be a smaller multiplier compared to a fixed regime. Based on these findings, Dellas et al. (2005) emphasize that one should not expect to see a systematic relationship between exchange rate flexibility and the size of fiscal multipliers in cross-country studies, unless one also conditions for the domestic monetary policy rule.

2.2.5 Debt burden

When public debt is high, forward-looking agents anticipate that they are more likely to pay higher taxes sooner and therefore increase their savings (Sutherland, 1997). The anticipation of such an adjustment could have a contractionary effect which could offset the expansionary impact of higher government spending today. In a model with heterogeneous households, Perotti (1999) shows that when the debt level is high, distortionary taxes amplify the negative wealth effects of unconstrained households which could outweigh the positive effects of a fiscal expansion on the income and consumption of credit-constrained households.

The few empirical studies thus far give credence to the notion that high debt is harmful. Kirchner et al. (2010) find evidence of higher debt-to-GDP ratios negatively affecting long-term fiscal multipliers in the Euro Area. Ilzetzki et al. (2013) estimate long-run fiscal multipliers of -3 in episodes of high government debt.

2.2.6 Financial development

The degree of financial development has an ambiguous effect on the size of fiscal multipliers, depending on how it affects liquidity constraints and how governments finance fiscal deficits (Spilimbergo et al., 2009). One view of a higher level of financial development is the availability of more savings possibilities for consumption smoothing. Economic agents therefore face lower credit and liquidity constraints, which implies smaller fiscal multipliers in more developed financial systems. However, one can also argue that there are more financing options for consumption and investment in

a more developed financial sector, hence, fiscal multipliers could be larger. The other aspect relates to the cost of government borrowing. In countries with limited access to financial markets, governments can only issue debt to finance deficits at high interest rates, which diminishes the effectiveness of fiscal policy. On the other hand, there is also the possibility that governments can issue debt to a captive domestic market in financially depressed countries, which increases the size of fiscal multipliers.

2.2.7 Financial crisis

In a financial crisis the proportion of credit-constrained agents typically increases, implying larger fiscal multipliers during such episodes. This can be seen in the New Keynesian model of Galí et al. (2007), whereby an increase in government spending increases the consumption demand of credit-constrained households, which reinforces the expansionary effects of fiscal policy. Using a panel of OECD countries, Corsetti et al. (2012b) find that fiscal multipliers are about two times larger during a financial crisis. However, Romer and Romer (2015) find that output declines are relatively moderate, depending on the severity and persistence of the distress.

In the case of interest rates reaching the zero lower bound, which is the prevailing economic environment in the aftermath of the global financial crisis, fiscal stimulus is then fully accommodated since the policy rate remains unchanged at zero. Fiscal multipliers can be unusually high, between two and four (see Eggertsson, 2010; Christiano et al., 2011; Woodford, 2011).

2.2.8 State of the business cycle

During the expansionary phase of the business cycle, fiscal stimulus is less effective since at full employment, an increase in public demand crowds out private demand, thus leaving output unchanged. In the contractionary phase, credit-constrained agents cannot borrow to smooth consumption and fiscal stimulus therefore has more traction on output. While there is mounting evidence that the effectiveness of fiscal stimulus depend on the state of the business cycle, the issue is still evolving. Studies on advanced economies find that fiscal multipliers are larger during recessions than in expansions (e.g., Auerbach and Gorodnichenko, 2012; Owyang et al., 2013; Riera-Crichton, 2015), but Ramey and Zubairy (2014) report the absence of any state dependence.

2.3 Estimating fiscal multipliers

Empirically, estimating fiscal multipliers faces some challenges. Fiscal multipliers measure the change in output in response to an exogenous change in fiscal policy. Identifying exogenous shocks is difficult due to reverse causality—government spending affects GDP, but GDP also affects government spending. There are generally two approaches to identify fiscal spending shocks in the literature.[3] The first is based on the 'natural experiment' or narrative approach in identifying exogenous variation by using military spending (e.g., Ramey and Shapiro, 1998; Edelberg et al., 1999; Burnside et al., 2004; Barro and Redlick, 2011). The main idea behind this approach is that military spending is determined by wars and can therefore be treated as exogenous. However, this argument is invalidated in many developing countries since wars could be due to prevailing economic conditions, thus making military spending endogenous to the economy. Another criticism points to the possibility of other fiscal shocks occurring around the same time, which raises doubts on the identification of military build-ups.

The second is based on the SVAR approach to model dynamic relationships of endogenous variables (e.g., Fatás and Mihov, 2001; Blanchard and Perotti, 2002; Perotti, 2005). Blanchard and Perotti (2002) identify fiscal spending shocks by assuming that government expenditure does not respond to GDP in the same quarter; hence, exogenous fiscal policy can be isolated by using quarterly data and ordering government expenditure before GDP. Another empirical challenge is the lack of high-frequency and long time series data, especially for developing countries. Many studies rely on the Blanchard and Perotti (2002) identification method which necessitates the use of quarterly data if the fiscal shocks are to be considered credible.

Nevertheless, there are studies that apply the SVAR approach to lower frequency data. For instance, Beetsma et al. (2008) justify that the use of annual data provides several advantages. First, the identified fiscal shocks using annual data may correspond more closely to actual shocks since government expenditure decisions typically follow an annual cycle. Second, the role of anticipation effects is less relevant as a given shock is less likely to be anticipated one year beforehand. Anticipation effects are usually

[3] Only empirical estimation approaches are discussed here. Batini et al. (2014) provides a summary on the pros and cons of empirical and model-based DSGE approaches.

present in VAR models estimated with quarterly data (Ramey, 2011). Third, seasonality effects are less important in annual data.

Recent methodological advances utilize sign restrictions to identify fiscal shocks (e.g., Canova and Pappa, 2007; Mountford and Uhlig, 2009; Dungey and Fry, 2009; Pappa, 2009).[4] As Pappa (2009) notes, the sign restriction approach offers a few advantages over the conventional SVAR approach: it is theory-based, applicable to data with any frequency, and largely solves the problem of endogeneity and predictability of fiscal variables.

2.4 Data and methodology

2.4.1 Identifying a shock to fiscal spending

Existing studies typically require quarterly data to identify a fiscal spending shock, which narrows the scope of analysis to advanced economies. Although Ilzetzki et al. (2013) use a larger quarterly data set, their sample is confined mainly to advanced and larger developing (emerging) economies. To examine the robustness of the empirical findings in Ilzetzki et al. (2013) for a larger country sample, especially including developing countries, an alternative approach to credibly identify a shock to fiscal spending is required since only annual data is available. The sign restriction methodology comes in handy in this context.

I adopt the theoretical restrictions in Pappa (2009) to identify a shock to fiscal spending. Pappa (2009) shows that in both prototypical flexible price RBC and sticky price New Keynesian models, a fiscal spending shock increases output and the deficit on impact. These responses are robust for a wide range of parameterizations. Furthermore, other shocks cannot produce the same responses on impact. In particular, technology, labour supply, and monetary shocks decrease the fiscal deficit at least on impact. A shock to fiscal spending is therefore identified by employing the sign restrictions in Table 2.1.

[4] The sign restriction methodology is originally developed by Faust (1998), Canova and De Nicolò (2002), and Uhlig (2005) applied to monetary policy analysis.

Table 2.1 Sign restrictions to identify a shock to fiscal spending

	Government consumption	GDP	Fiscal balance	Real exchange rate
Fiscal spending shock	> 0	> 0	< 0	

Notes: Sign restrictions hold only on impact.

It is important to note that the fiscal policy analysed here is a deficit-spending scenario. Tax cuts can also increase output and the deficit. However, a deficit-financed tax cut fiscal policy does not usually lead to an increase in government expenditure. One way to ensure the identified shock is not polluted by tax cuts is to add another restriction that requires tax revenues to be zero or positive. Including this additional sign restriction does not change any of the results in the paper but requires estimating a larger VAR.[5]

A related issue in identifying a single shock is the 'multiple shocks problem' as highlighted in Fry and Pagan (2011), i.e., the set of responses could have been generated by more than one potential shock and there is insufficient information to discriminate among the shocks. A possible solution is to reject all the draws for which the unidentified shocks deliver impulse responses that are consistent with the signs of the identified shock. However, potentially some useful information is lost when such draws are discarded. An alternative solution, which is used in this paper, is to apply magnitude restrictions to disentangle the shocks. For instance, if two shocks have the same set of impulse responses, the shock in which the response of government consumption is larger is considered as a fiscal spending shock. This is similar to the approach taken in Peersman (2005) and Dungey and Fry (2009).

2.4.2 The sign restriction approach

A structural panel VAR model of m variables can be represented as:

[5] Government revenue is used as a proxy for tax revenue since long time series data on tax revenue is not available for many countries. Adding government revenue in the VAR decreases the sample size by about 25%.

$$B_0 Y_{i,t} = \sum_{k=1}^{K} B_k Y_{i,t-k} + \varepsilon_{i,t}\,, \quad t = 1, \ldots, T \tag{2.1}$$

where $Y_{i,t}$ is a vector of the m endogenous variables for country i in year t, K is the lag length, B_0 is the contemporaneous coefficient vector of $Y_{i,t}$, B_k is a m x m matrix of coefficient parameters, and $\varepsilon_{i,t}$ denotes the 'fundamental' or structural macroeconomic shocks.

The reduced form representation of (2.1) is given by:

$$Y_{i,t} = \sum_{k=1}^{K} A_k Y_{i,t-k} + e_{i,t}\,, \quad t = 1, \ldots, T \tag{2.2}$$

where $A_k = B_o^{-1} B_k$, and $e_t = B_o^{-1} \varepsilon_{i,t}$ are the reduced-form residuals with m x m variance-covariance matrix $E\left(e_{i,t} e_{i,t}'\right) = \Sigma$.

Given a set of sign restrictions imposed on the impulse responses, the sign restriction method searches over the space of possible impulse vectors to find those satisfying the criteria. To construct structural impulse response functions, an estimate of the matrix $\hat{B}_o^{-1}$ in $e_t = \hat{B}_o^{-1} \varepsilon_t$ is required. Let $\Sigma = P \Lambda P'$ and $B = P \Lambda^{0.5}$ such that B satisfies $BB' = \Sigma$. Then $\hat{B}_o^{-1} = BD$ also satisfies $\hat{B}_o^{-1}\left(\hat{B}_o^{-1}\right)' = \Sigma$ for any orthogonal matrix D. The sign restrictions procedure used in this paper is based on the Householder transformation (see Rubio-Ramírez et al., 2010) and involves the following steps:

(i) Draw an independent standard normal m x m matrix X and derive the QR decomposition of X such that $X = QR$ and $QQ' = I_m$;

(ii) Let $D = Q'$. Compute the impulse responses using the orthogonalization $\hat{B}_o^{-1} = BD$ and keep the structural models that satisfy the sign restrictions;

(iii) Repeat the first two steps until the number of admissible structural models reaches the desired number;

(iv) Sort the structural models and select the one whose impulse responses are closest to the median values (median target method; see Fry and Pagan, 2011).[6]

[6] Since each structural model represents a different relationship between variables in the VAR, there exists a 'multiple models problem' as discussed in Fry and Pagan (2011). Presenting the median as a summary of the central tendency of impulse response across models appears to be a popular choice.

The impulse responses closest to the 16 and 84 percentiles are obtained in a similar fashion.

2.4.3 Data, variables, and definitions

The panel VAR model in eq. (2.2) consists of four variables ($m = 4$)—real government consumption, real GDP, ratio of fiscal balance to GDP, and the real exchange rate—and is estimated with fixed effects. The matrix A_k is homogeneous across countries and time, but the fixed effects capture the country-specific time-invariant factors which allow for individual heterogeneity. Annual data from 1960 to 2014 is used, but data availability varies by country. Only countries with at least 10 observations are included, which yields a data set of 120 countries. The list of countries is provided in Table 2.A2 in Appendix 2.A. The results remain qualitatively unaltered if only countries with at least 20 observations are selected (data set reduced to 82 countries); see Section 2.6 and Appendix 2.F. In view of the annual data frequency, one lag is used ($K = 1$) but results are robust with two lags.[7] The variables are entered as first log differences except for the fiscal balance-to-GDP ratio. Table 2.2 shows that the variables are stationary based on the Im-Pesaran-Shin (IPS) panel unit root test, which allows for unbalanced panels (see Im et al., 2003).

Table 2.2 Im-Pesaran-Shin (IPS) panel unit root test

Variable	No time trend		With time trend	
	Z-t-tilde bar statistic	p-value	Z-t-tilde bar statistic	p-value
Δg	-23.83	0.00	-25.75	0.00
Δy	-20.98	0.00	-22.96	0.00
f	-10.98	0.00	-14.50	0.00
Δq	-25.40	0.00	-26.01	0.00

However, the conventional approach of inferring an impulse response function from pointwise medians of the posterior distribution of admissible responses does not have a structural interpretation. Instead, the admissible structural model closest to the median is selected.

[7] Ilzetzki et al. (2013) show that their results are robust for 1 to 8 lags in their quarterly data set, which is equivalent to 1 to 2 lags in the annual data set here. Using a more formal statistical criterion suggests 1 and 2 lags based on BIC and AIC respectively.

Notes: g is log of real government consumption, y is log of real GDP, f is the fiscal balance-to-GDP ratio, q is log of the real effective exchange rate, and Δ is the first difference operator. The null and alternative hypothesis tests of the IPS panel unit root test are H_o: all panels contain unit roots vs. H_a: some panels are stationary.

In the panel data estimations, the sample is divided into groups mainly following the classifications in Ilzetzki et al. (2013). Using the World Bank's income classification in 2000, 'advanced economies' are high-income countries with a GNI per capita of $9,266 or more; all other countries are classified as 'developing countries'. On the degree of trade openness, countries with an average trade-to-GDP ratio less than 60% are categorized as 'low trade openness', and all others as 'high trade openness'. The degree of international capital mobility is based on the Chinn-Ito index, which is a de jure measure of capital account openness (see Chinn and Ito, 2006). Countries with an index score higher than the global median is classified as 'high capital mobility', and 'low capital mobility' otherwise. Episodes of 'fixed' and 'flexible' regimes are obtained from the de facto exchange rate regime classifications in Ilzetzki et al. (2010).[8] Episodes of government debt-to-GDP ratio higher than 60% are considered 'high debt', and all others 'low debt', using data from the IMF's Historical Public Debt Database (see Abbas et al. 2010). Domestic credit to the private sector as a share of GDP is used as an indicator of financial development. Episodes with ratios higher than 50% are classified as 'high credit', and 'low credit' otherwise. Financial crisis episodes are obtained from Reinhart (2010).[9] The deviation of GDP from the Hodrick-Prescott trend is used as a naive measure of the business cycle. Output deviations higher and lower than the trend are defined as 'expansionary' and 'recessionary' phases respectively. Table 2.A3 in Appendix 2.A provides further details on the variables and data sources.

[8] Fixed regimes include no separate legal tender, hard pegs, crawling pegs, and crawling bands narrower than or equal to ±2%. Eurozone countries therefore have fixed exchange rates. Flexible regimes include bands wider than the 2% threshold, managed floats, and free floats. Freely falling currencies and those with dual markets in which parallel market data is missing are excluded.

[9] Romer and Romer (2015) classify financial distress on a finer scale instead of a binary variable. However, in the context of this paper, using a 0–1 classification is more appropriate because of the sample splitting approach. Moreover, it is unclear how to aggregate the fine classifications in Romer and Romer (2015). Their data set also includes 24 OECD countries only.

A few definitions are in order. The impact fiscal multiplier is defined as the ratio of the change in output (y) to the change in government consumption (g) at the impact impulse horizon. Since the variables are in first log differences, approximating growth rates, the ratio of the impulse responses can be interpreted as elasticities. The fiscal multiplier is then obtained by dividing the elasticity by the average ratio of government consumption to GDP in the sample:

$$Impact\ fiscal\ multiplier = \frac{\Delta y_0}{\Delta g_0} \Big/ \left(\overline{g/y}\right)$$

At longer horizons, the cumulative fiscal multiplier in year T is defined as:

$$Cumulative\ fiscal\ multiplier\ (T) = \frac{\sum_{t=0}^{T}(1+i)^{-t}\Delta y_t}{\sum_{t=0}^{T}(1+i)^{-t}\Delta g_t} \Big/ \left(\overline{g/y}\right)$$

where i is the median interest rate in the sample. Of particular interest is the long-run fiscal multiplier, where the full effects of a fiscal expansion are realized, defined as the cumulative multiplier when $T \to \infty$.

2.5 Empirical results

To examine the size of fiscal multipliers conditional on economic characteristics, the country sample is divided into groups. A drawback of this approach is that it allows only one dimension to be isolated at a time, which complicates the identification of distinct effects. Notwithstanding this limitation, the segregation of the country sample into meaningful sub-groups provides insights into how the fiscal transmission mechanism depends on the economic environment. Adopting a common estimation framework also allows progress to be made in finding empirical regularities that may verify or cast doubt on the results in the existing literature.

2.5.1 Panel data estimation based on 44 countries

The first empirical exercise is to run the panel data estimation using the 44 countries in Ilzetzki et al. (2013), but with the use of sign restrictions to identify a shock to fiscal spending in the annual data set. The question of interest is whether the findings in

Ilzetzki et al. (2013) still hold with an alternative identification method and lower frequency data.

The cumulative fiscal multipliers are displayed in Figs 2.1 to 2.4. The solid line represents the median impulse response obtained from the set of admissible models from 1,000 draws from the posterior distribution which satisfy the imposed sign restrictions in Table 2.1. The dotted lines are the 16 and 84 percentile impulse responses. As the figures show, the qualitative results in Ilzetzki et al. (2013) can be reproduced even with the use of annual data and identifying a fiscal spending shock using sign restrictions—long-run fiscal multipliers are larger in advanced economies, countries with low trade openness, fixed exchange rate regimes, and a low debt environment.[10] The plots of the empirical distributions of the long-run cumulative multipliers are shown in Appendix 2.B, along with the corresponding non-parametric Kolmogorov-Smirnov equality-of-distributions tests. The tests indicate that the results are statistically significant. In addition, Ilzetzki et al.'s (2013) results can also be obtained when the Blanchard and Perotti (2002) identification strategy is used; see Section 2.6 and Appendix 2.G. This illustrates their conclusions are not very sensitive to the choice of data frequency and the identification method.

2.5.2 Panel data estimation based on 120 countries

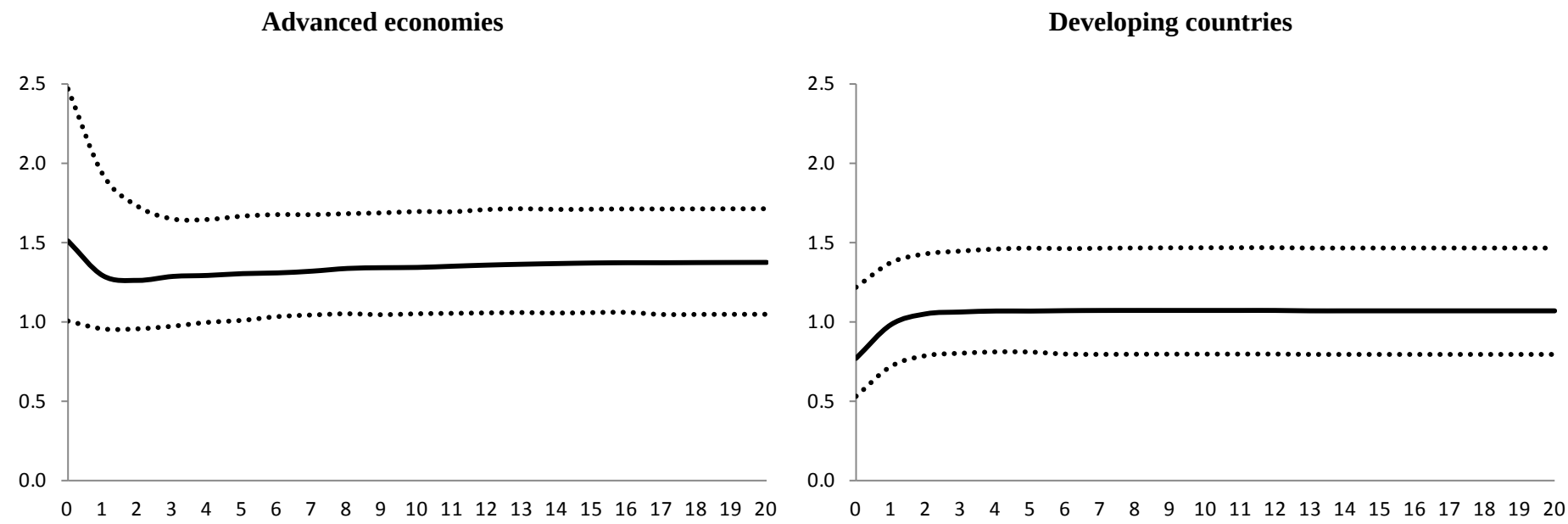
Next, the panel VAR is estimated using the large data set of 120 countries. The findings under different economic characteristics are discussed in turn. Emphasis is also placed on assessing the robustness of Ilzetzki et al.'s (2013) results, i.e., whether their results suffer from sample bias. The plots of the empirical distributions of the long-run fiscal multipliers and their associated statistical tests are in Appendix 2.C.

2.5.2.1 Economic development

Cumulative fiscal multipliers in advanced economies and developing countries are shown in Fig. 2.5. The median impact multipliers are 0.97 and 0.63 for advanced and developing countries respectively. These are typical values reported for first-year multipliers. The multipliers increase to 1.28 and 0.78 in the long run, providing support

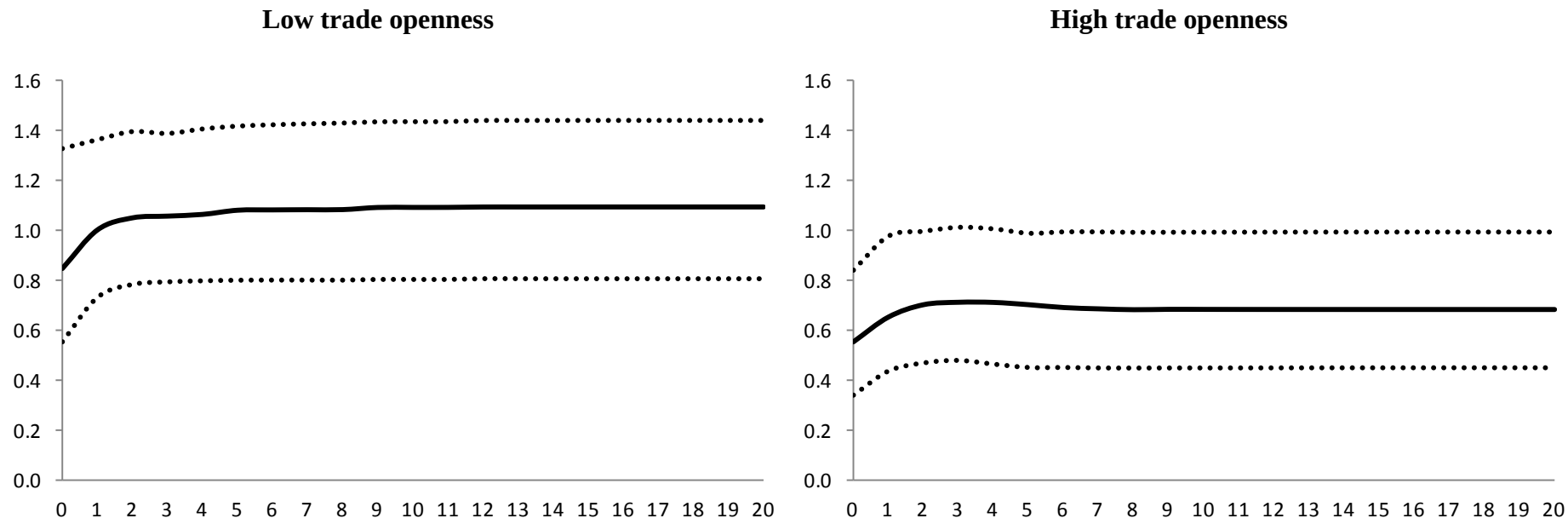
[10] However, the quantitative estimates are clearly different. In particular, negative long-run fiscal multipliers are not observed.

Fig.2. 1 Cumulative fiscal multipliers in advanced and developing countries (Ilzetzki et al.'s (2013) country sample)



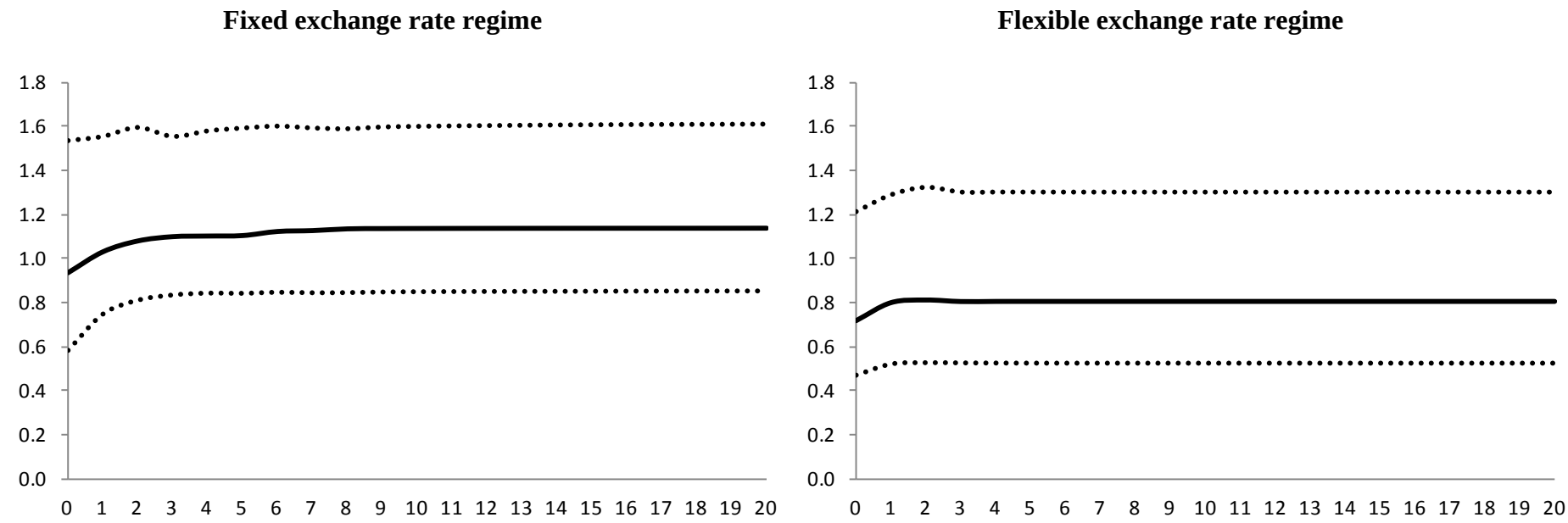
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Definition is based on the World Bank's income classification in 2000. Advanced economies are high-income countries with GNI per capita of $9,266 or more, all others are categorized as developing countries. GNI per capita data available from 1960–2014, obtained from World Development Indicators. Number of observations: Advanced – 635, Developing – 703.

Fig. 2.2 Cumulative fiscal multipliers in countries with low and high trade openness (Ilzetzki et al.'s (2013) country sample)



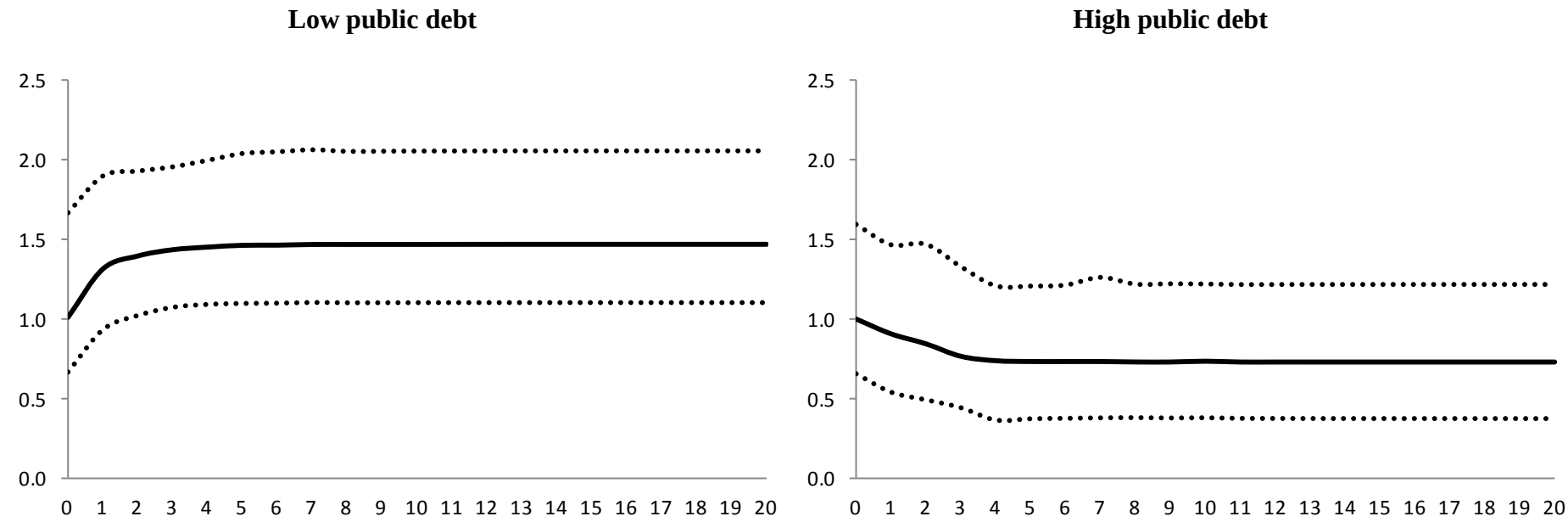
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Countries with an average trade-to-GDP ratio less than 60% are classified as low trade openness, and high trade openness otherwise. Trade-to-GDP data available from 1960–2014, obtained from World Development Indicators. Number of observations: Low trade openness – 715, High trade openness – 623.

Fig. 2.3 Cumulative fiscal multipliers in episodes of de facto fixed and flexible exchange rate regimes (Ilzetzki et al.'s (2013) country sample)



Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Episodes coded from 1–8 are classified as fixed regime, and 9–13 as flexible regime. De facto exchange rate regime classification is based on the fine classification in Ilzetzki et al. (2010) with data available from 1960–2010. Number of observations: Fixed regime – 736, Flexible regime – 385.

Fig. 2.4 Cumulative fiscal multipliers in episodes of low and high public debt (Ilzetzki et al.'s (2013) country sample)



Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Episodes with debt-to-GDP ratio exceeding 60% are classified as high debt, and low debt otherwise. Debt-to-GDP data available from 1960–2012, obtained from IMF Historical Public Debt Database. Number of observations: Low debt – 933, High debt – 324.

that fiscal multipliers are larger in advanced economies.

It is worth highlighting that the sharp results in Ilzetzki et al. (2013) are not observed with the large data set. The long-run multipliers in their study are 0.66 and -0.63 for advanced and developing countries respectively, suggesting fiscal expansion is futile in developing countries. However, the results here show otherwise; although the fiscal multipliers in developing countries are smaller, there is still some expansionary effect.[11]

2.5.2.2 Trade openness

Figure 2.6 displays the results in countries with low and high trade openness. A striking observation is that fiscal multipliers in economies which are relatively open to trade are not smaller than their closed counterparts. This is in contrast to the findings in Ilzetzki et al. (2013), whereby they obtain long-run multipliers of 1.1 and -0.46 in countries with low and high trade openness respectively. When the data set is extended from 44 countries in Ilzetzki et al.'s (2013) sample to 120 countries, the commonly accepted view that fiscal multipliers are smaller in countries relatively open to trade is no longer true.

To understand why the results are not as expected a priori, the model is re-estimated by replacing GDP with private consumption, investment, and net exports. Figure 2.7 plots the impulse responses of private consumption, investment, net exports, and the real exchange rate to a government consumption shock normalized to 1%. In countries relatively open to trade, net exports fall as expected due to a higher propensity of demand leakage through imports. However, there is an increase in private consumption, which more than compensates the decline in net exports. This helps to explain why fiscal multipliers in countries with high trade openness are not necessarily smaller. Interestingly, the empirical puzzles discussed in Section 2.2—increase in private

[11] Ilzetzki et al. (2013) also examine the multiplier on government investment using a subset of their country sample and find no significant difference between advanced and developing countries. The impact of a government investment shock is not explored in the paper since data on government investment is not available for most countries.

consumption and a depreciation of the real exchange rate—are only observed in open economies.[12]

2.5.2.3 Capital mobility

The cumulative fiscal multipliers in countries with low and high international capital mobility are shown in Fig. 2.8. They are evidently not smaller when capital movements are less restricted, contradicting the predictions of the Mundell-Fleming model. The impulse responses in financially open economies are similar to those of high trade openness, i.e., sharper increase in private consumption and depreciation of the real exchange rate. This is not surprising since about three-quarters of the countries in the data set which are relatively open to trade also have high international capital mobility.

The standard theory of inter-temporal consumption smoothing suggests that higher international capital flows would reduce the sensitivity of consumption to transitory changes in income, i.e., the negative wealth effect induced by a fiscal expansion would be smaller. This could explain why private consumption is higher in countries with high capital mobility.

Pierdzioch (2004) offers an alternative view by focusing on the endogenous response of the monetary authority. In this vein, Fig. 2.9 plots the impulse responses of private consumption, the short-term interest rate, and the real exchange rate to a 1% government consumption shock. In countries with high capital mobility, monetary policy appears to be more accommodative to the fiscal expansion; interest rates fall by 10 basis points on impact compared to 5 basis points in countries with more capital restrictions. The depreciation of the real exchange rate is also larger when capital is more mobile. These responses could well be a reflection of the underlying domestic monetary policy pursued, so perhaps one should not expect empirical results to conform to theoretical predictions of models which do not incorporate fiscal and monetary policy interactions.

[12] There is some empirical support for the ambiguity of the response of the real exchange rate at the individual country level. da Silva et al. (2015) find that the effects are not uniform even in countries that are relatively homogeneous—an increase in government spending leads to a real exchange rate depreciation in Brazil and Chile, but an appreciation in Mexico.

2.5.2.4 Exchange rate regime

Figure 2.10 shows the fiscal multipliers in episodes of fixed and flexible exchange rate regimes. The multipliers in flexible regimes are not smaller than those in fixed regimes, again contradicting the predictions of the Mundell-Fleming model and the findings of Ilzetzki et al. (2013). They estimate long-run multipliers of 1.4 for fixed regimes and -0.69 for flexible regimes.

The sources of divergence from Ilzetzki et al.'s (2013) results centre on the responses of monetary policy and the real exchange rate. According to the Mundell-Fleming model, fiscal expansion is more effective under fixed exchange rate regimes as the monetary authority increases money supply to prevent the domestic currency from appreciating, i.e., monetary policy accommodates the rise in output. On the other hand, the real exchange rate is allowed to appreciate under flexible regimes which results in a reduction in net exports and thus offsets the increase in government spending; output therefore remains unchanged.

To examine these theoretical predictions of the traditional Keynesian model, Fig. 2.11 displays the impulse responses of private consumption, the short-term interest rate, and the real exchange rate to a 1% government consumption shock. There is no evidence of monetary policy accommodation in fixed exchange rate regimes. Instead, the median impulse response shows that the monetary authority increases the interest rate instead and the real exchange rate appreciates. Given the large data set which includes many developing countries, a currency peg might not be perfectly credible in these countries. It is conceivable that a fiscal expansion triggers uncertainty in the domestic currency and the monetary authority therefore increases the interest rate to defend the currency.

There is also no evidence of a real exchange rate appreciation in flexible exchange rate regimes. The median impulse response instead indicates a depreciation of the real exchange rate and a loosening of monetary policy, which helps to explain why fiscal multipliers can be larger in flexible regimes. In fact, this non-uniformity in the response of the real exchange rate across exchange rate regimes is not without precedent. Bénétrix and Lane (2013) find that a fiscal shock appreciates the real exchange rate in European Monetary Union (EMU) countries, but a depreciation is observed in a sample

of floating-currency economies (Australia, Canada, the United Kingdom, and the United States).

An important conclusion from the analysis here is that the size of fiscal multipliers hinges on the degree of monetary accommodation and the response of the real exchange rate. This is the central tenet of the model in Dellas et al. (2005) as discussed in Section 2.2.

2.5.2.5 Debt burden

Fiscal multipliers in episodes of high and low public debt are displayed in Fig. 2.12. They are significantly smaller when the debt burden is high. This echoes the results of Ilzetzki et al. (2013). However, their long-run estimates are -0.36 and -3 for low and high debt episodes respectively, suggesting that fiscal stimulus is counter-productive even at low debt levels, which is rather puzzling. Although the long-run fiscal multiplier in episodes of debt-to-GDP ratio exceeding 60% in this paper is low at 0.40, there is still some output gain from fiscal expansions. I also experiment with the debt-to-GDP ratio and find that fiscal multipliers are close to zero when the debt burden is larger than 100%, which is the definition used in Perotti (1999).

2.5.2.6 Financial development

Figure 2.13 shows the fiscal multipliers in low and high levels of financial development. Fiscal stimulus is about twice as effective in more developed financial systems. Going back to the discussion in Section 2.2.6, this suggests that governments are able to finance deficits at relatively low interest rates with better access to borrowing. Also, a more developed financial sector provides ample financing options for consumption and investment. It also implies that a high credit-to-GDP ratio is not a good indicator of savings opportunities. If so, one would expect smaller fiscal multipliers in episodes of high credit-to-GDP ratio due to lower liquidity constraints to smooth consumption.

2.5.2.7 Financial crisis

Episodes of financial crisis are a better reflection of liquidity and credit constraints. As Fig. 2.14 shows, fiscal multipliers are three times larger during a financial crisis since agents typically have lower access to credit to smooth consumption. This finding lends

support to the use of fiscal stimuli as a stabilization tool in alleviating the impact of a financial crisis.

2.5.2.8 State of the business cycle

Figure 2.15 shows the fiscal multipliers across business cycle phases. They are significantly larger during contractions compared to expansions. While existing studies which find that fiscal stimulus is more effective in recessions typically focus on advanced economies, the findings here provide evidence that the conclusion remains robust in a large panel of countries. It is worthwhile to note that recessions could emerge due to financial crises, but the results in Section 2.5.2.7 above shows that fiscal multipliers are larger during financial distress compared to a general definition of cycle downturns.

2.6 Robustness checks

I conduct two important robustness checks on the results. First, I use the conventional identification approach following Blanchard and Perotti (2002). Admittedly, the use of annual data renders the identification of a fiscal spending shock less credible, as the approach relies on the crucial assumption that policymakers take more than a quarter to learn about a GDP shock, and hence ordering government expenditure before GDP in a quarterly VAR model captures the exogenous part of discretionary fiscal spending. Nonetheless, as a robustness exercise, it is useful to check whether the findings in Section 2.5 hold. Such a strategy using annual data is also used in Beetsma et al. (2008), who find that results based on annual data are relatively robust.

As before, the reduced-form panel VAR specification in eq. (2.2) is estimated with fixed effects and one lag; results are unaltered with two lags. In the panel VAR model, government consumption is ordered first, followed by GDP, fiscal balance, and the real exchange rate. The cumulative fiscal multipliers, derived from impulse responses of GDP to a government consumption shock, are displayed in Appendix 2.D. The estimated multipliers are generally smaller than those obtained via sign restrictions in Section 2.5.2, but the conclusions are equally valid: no observable output contractions from fiscal expansions; larger fiscal multipliers in advanced economies, when public debt is low, in developed financial systems, in a financial crisis, and during cycle

downturns; and contrary to Ilzetzki et al.'s (2013) study, fiscal stimulus in open economies and flexible exchange rates are not necessarily less effective.

Second, I amend the sample selection criteria to include only countries with at least 20 observations, which results in a data set of 82 countries. This is to ascertain whether sample bias is still present in Ilzetzki et al.'s (2013) study by extending their sample only from 44 to 82 countries. The estimated multipliers are shown in Appendix 2.E. The results are in total agreement with the findings for the data set of 120 countries. These conclusions are also obtained when sign restrictions are used; see Appendix 2.F.

I then turn to the estimation for Ilzetzki et al.'s (2013) country sample. The cumulative fiscal multipliers are displayed in Appendix 2.G. The qualitative conclusions of Ilzetzki et al. (2013) can be obtained even with the use of the Blanchard and Perotti (2002) approach on annual data. The divergence of the findings still centres on openness and exchange rate regimes.

To summarize, the qualitative findings in Ilzetzki et al. (2013) can be reproduced with the use of either the sign restriction or Blanchard and Perotti (2002) approach on annual data. However, when a larger annual data set of either 82 or 120 countries is used with a shock to fiscal spending identified using either the sign restriction or conventional SVAR approach, the findings on openness and exchange rate flexibility are no longer valid. This illustrates that data frequency and the identification method are not as sensitive as the country sample composition.

2.7 Conclusion

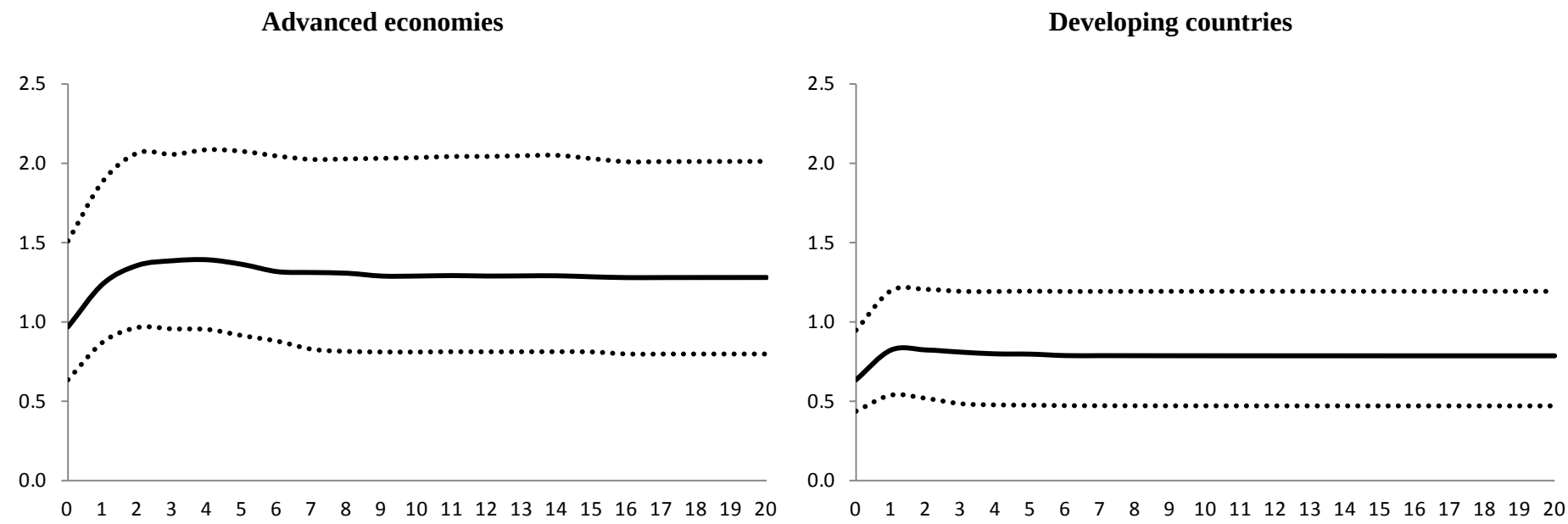
The proliferation of fiscal stimulus packages implemented in recent years and the subsequent fiscal consolidations have revived the debate on the size of fiscal multipliers. The crucial element required to properly assess the effectiveness of fiscal stimuli is to credibly identify fiscal spending shocks, which is often plagued with problems.

This paper adopts the sign restriction methodology to identify a fiscal spending shock in a large annual panel data set of 120 countries from 1960 to 2014. The results show that fiscal stimulus has an expansionary effect on output, with multipliers in the

range of 0.4–1.8. Fiscal multipliers are larger in a financial crisis and also during business cycle downturns more generally, supporting the widespread use of fiscal stimulus packages to aid in economic recovery. Fiscal multipliers are also considerably lower in developing countries and under high debt burden, pointing to the importance of better public expenditure management, which is usually lacking in developing countries, and a need to establish sustainable fiscal debt frameworks.

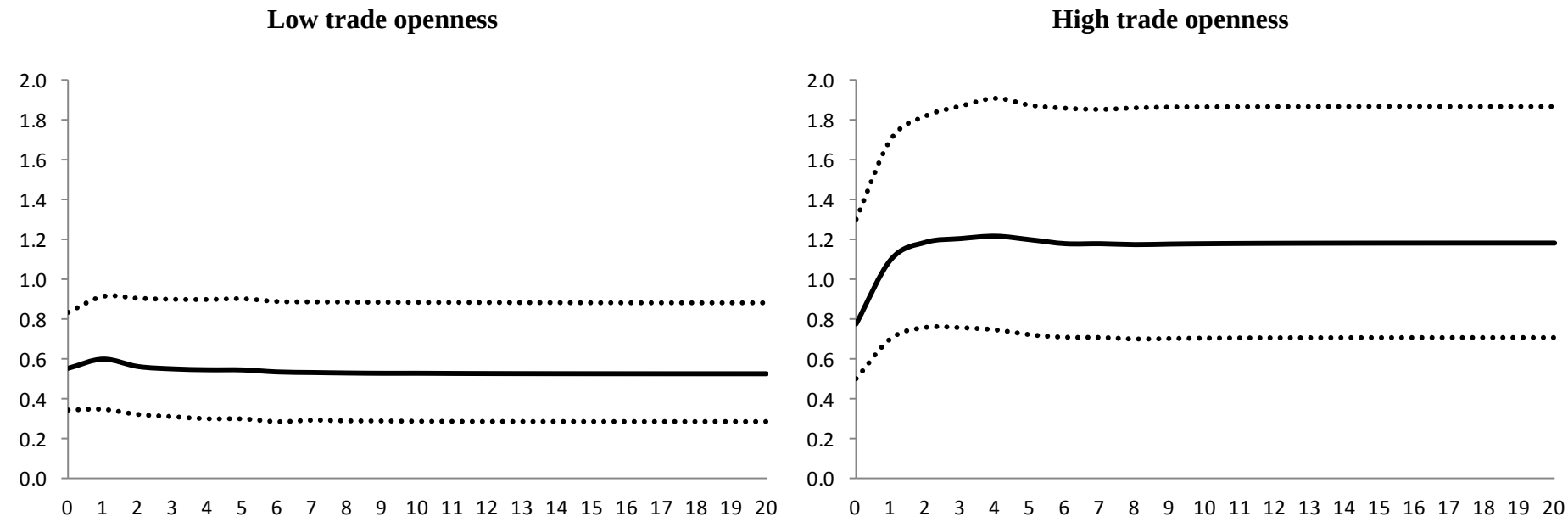
Contrary to what many economists believe, fiscal multipliers are not necessarily smaller in countries that are relatively open to trade and financial flows and operating under flexible exchange rate regimes. The size of fiscal multipliers also depends on the response of the real exchange rate and the domestic monetary policy pursued. It should therefore not be taken for granted that the effectiveness of fiscal policy fits nicely in the paradigm of conventional macro modelling frameworks. With increasing global integration and adoption of inflation targeting regimes, there is a need for further research to understand fiscal and monetary policy interactions; in particular, on how the fiscal transmission mechanism depends on the three dimensions of openness—trade openness, capital mobility, and exchange rate flexibility.

Fig. 2.5 Cumulative fiscal multipliers in advanced and developing countries (120 country sample)



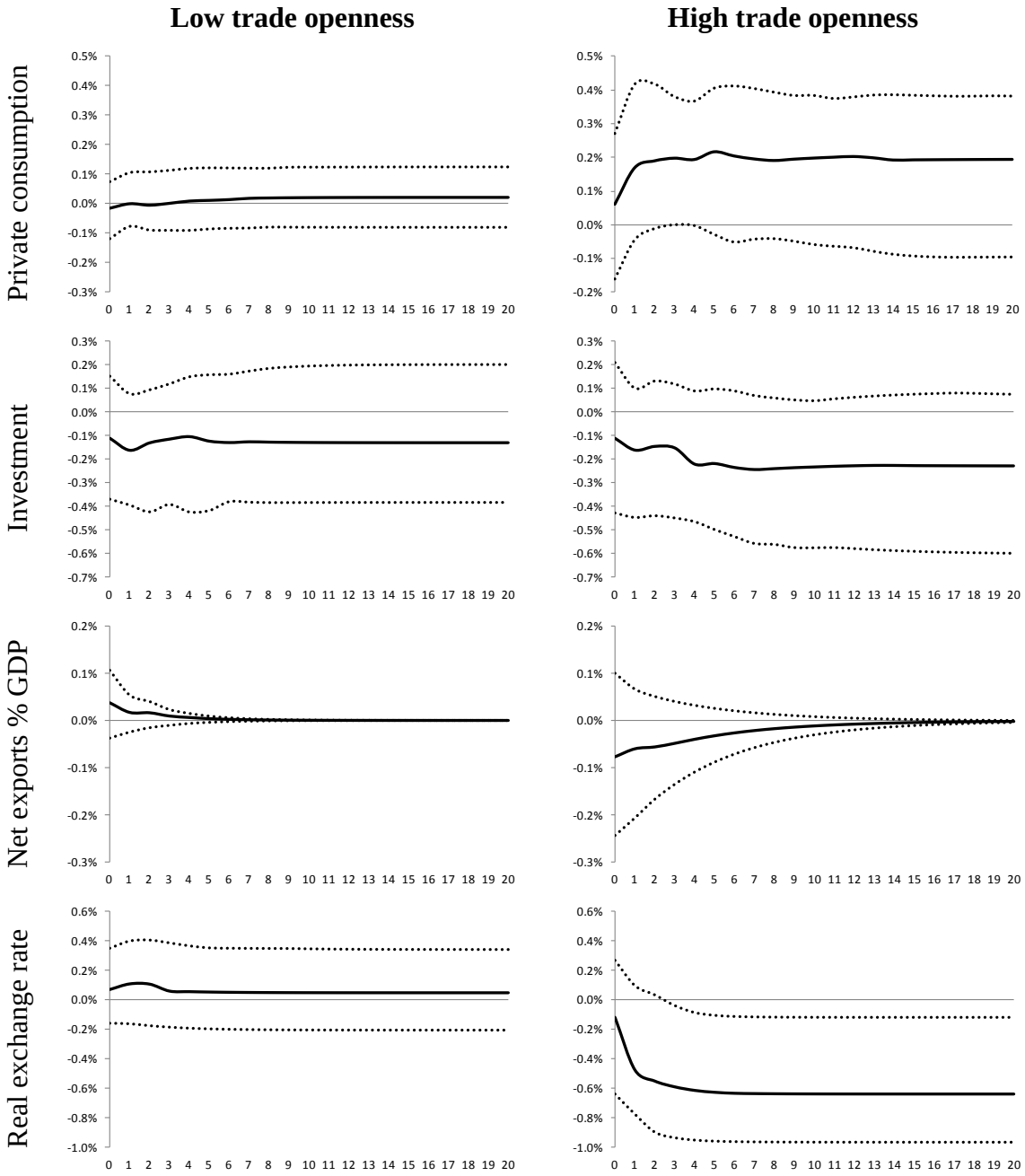
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Definition is based on the World Bank's income classification in 2000. Advanced economies are high-income countries with GNI per capita of $9,266 or more, all others are categorized as developing countries. GNI per capita data available from 1960–2014, obtained from World Development Indicators. Number of observations: Advanced – 986, Developing – 2249.

Fig. 2.6 Cumulative fiscal multipliers in countries with low and high trade openness (120 country sample)



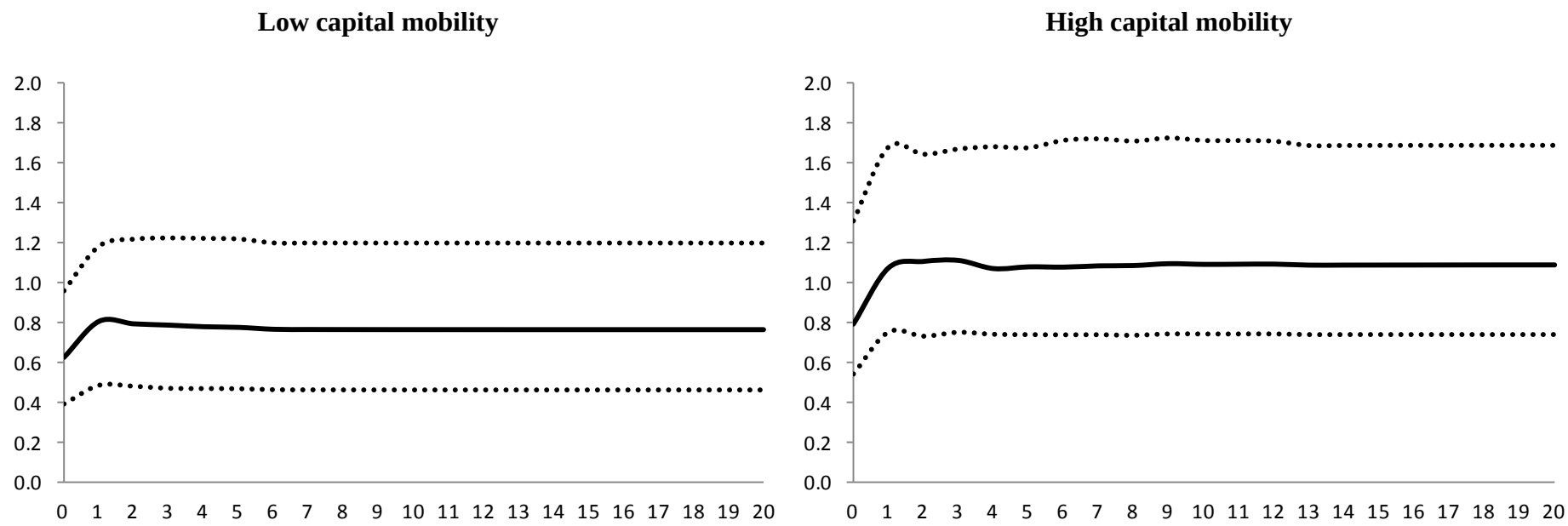
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Countries with an average trade-to-GDP ratio less than 60% are classified as low trade openness, and high trade openness otherwise. Trade-to-GDP data available from 1960–2014, obtained from World Development Indicators. Number of observations: Low trade openness – 1405, High trade openness – 1830.

Fig. 2.7 Impulse responses to a 1% government consumption shock in countries with low and high trade openness (120 country sample)



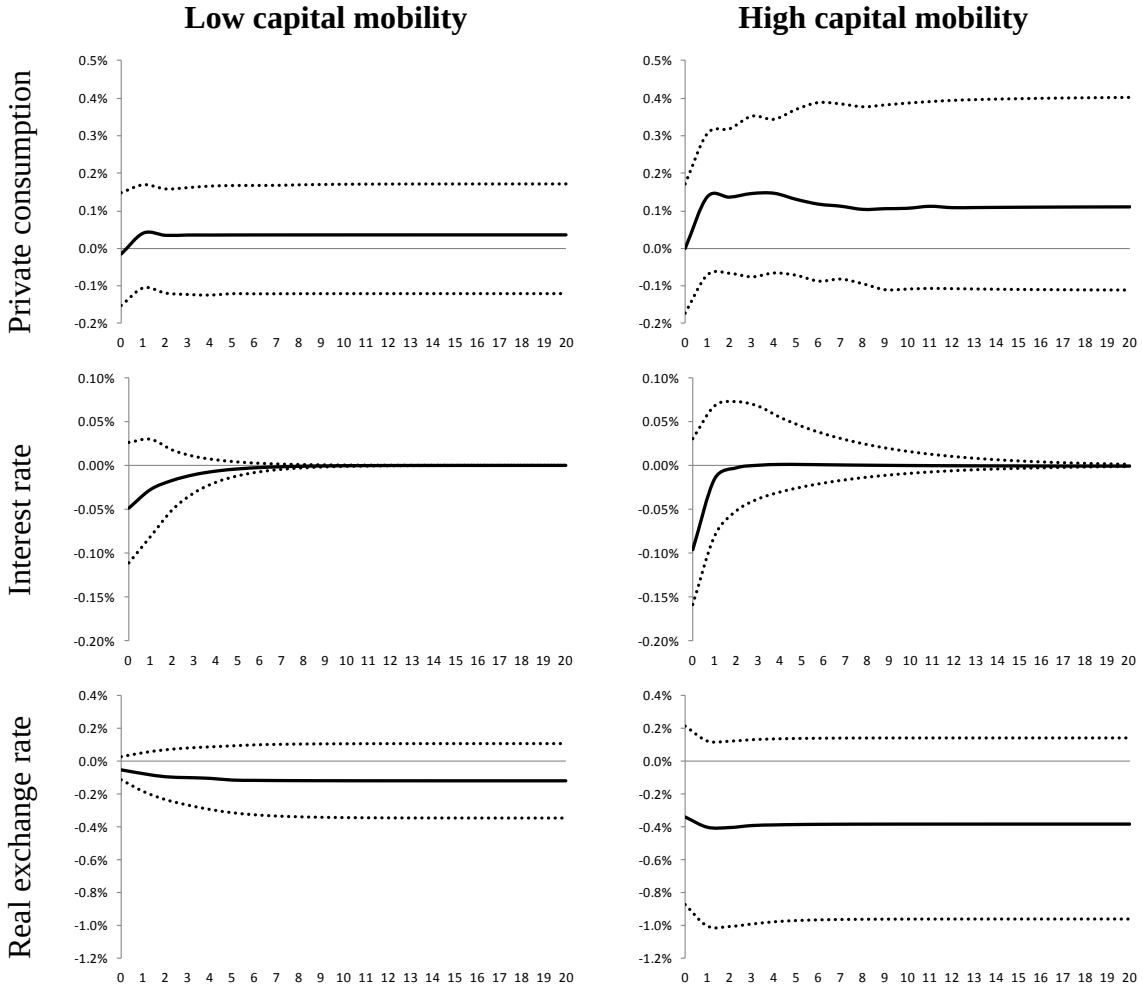
Notes: Impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median impulse response and the dotted lines are the 16 and 84 percentile values. Countries with an average trade-to-GDP ratio less than 60% are classified as low trade openness, and high trade openness otherwise.

Fig. 2.8 Cumulative fiscal multipliers in countries with low and high international capital mobility (120 country sample)



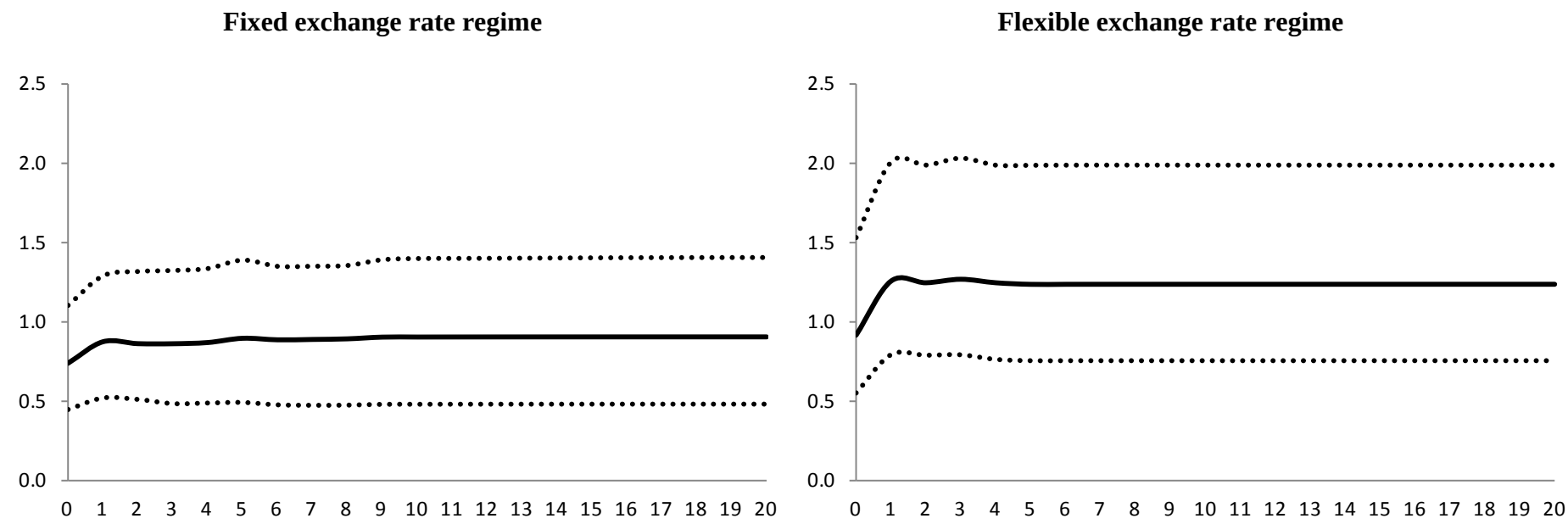
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Countries with an average Chinn-Ito capital account openness index (Chinn and Ito, 2006) lower than the global median are classified as low capital mobility, and high capital mobility otherwise. The Chinn-Ito index data is available from 1970–2014. Number of observations: Low capital mobility – 1161, High capital mobility – 2031.

Fig. 2.9 Impulse responses to a 1% government consumption shock in countries with low and high international capital mobility (120 country sample)



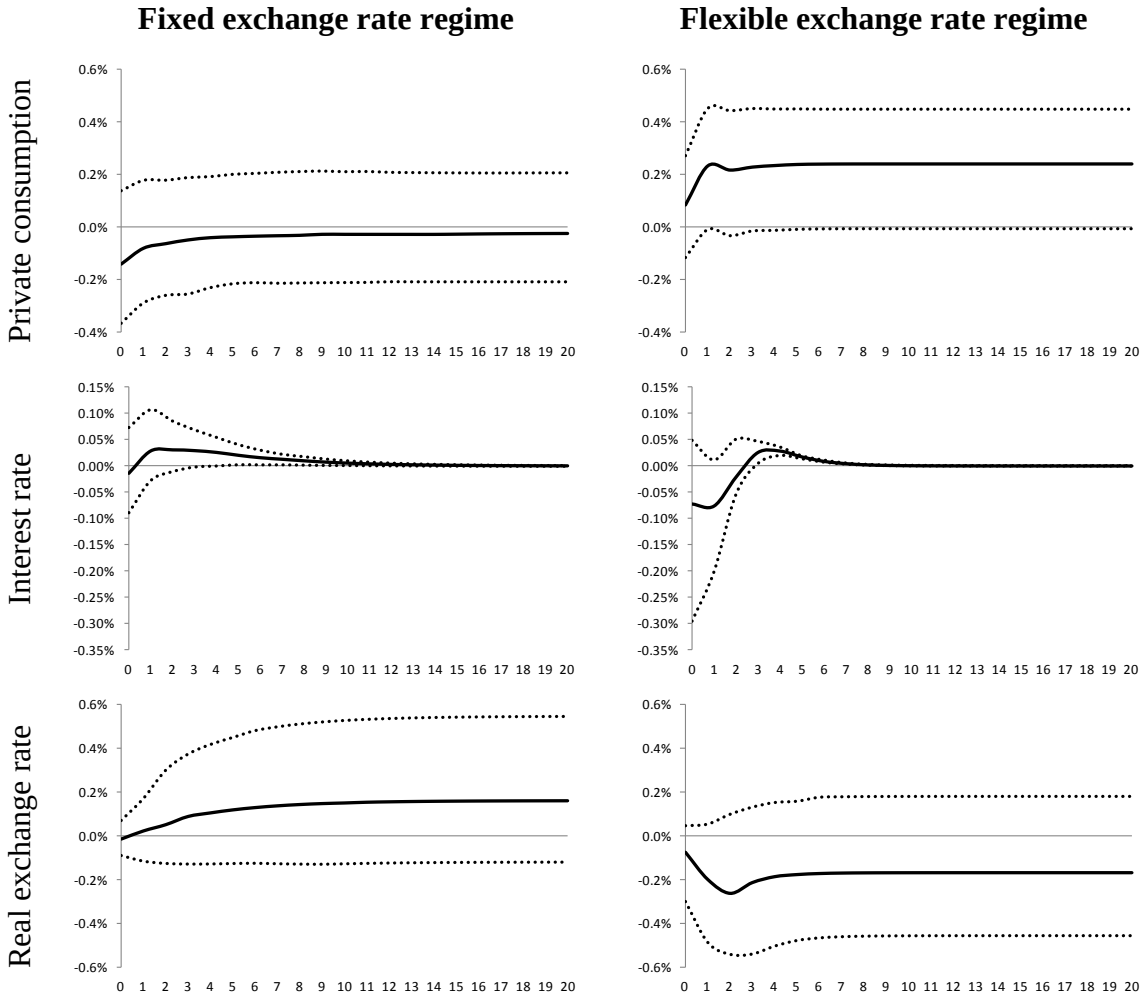
Notes: Impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median impulse response and the dotted lines are the 16 and 84 percentile values. Countries with an average Chinn-Ito capital account openness index (Chinn and Ito, 2006) lower than the global median are classified as low capital mobility, and high capital mobility otherwise.

Fig. 2.10 Cumulative fiscal multipliers in episodes of de facto fixed and flexible exchange rate regimes (120 country sample)



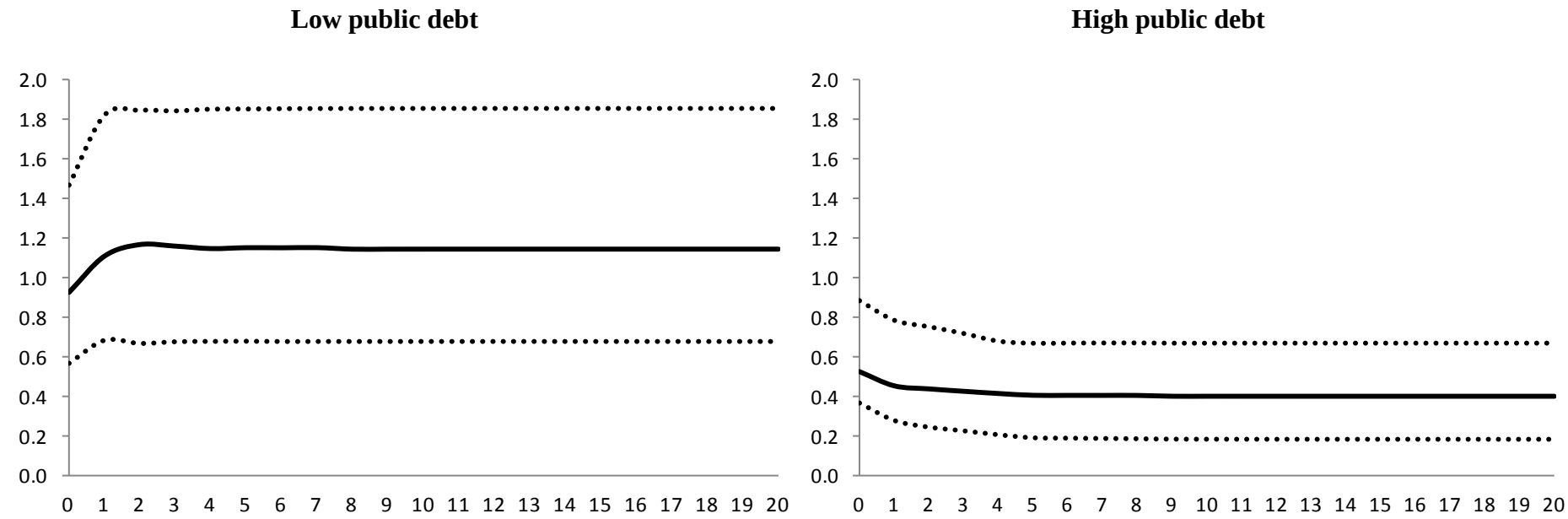
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Episodes coded from 1–8 are classified as fixed regime, and 9–13 as flexible regime. De facto exchange rate regime classification is based on the fine classification in Ilzetzki et al. (2010) with data available from 1960–2010. Number of observations: Fixed regime – 1977, Flexible regime – 711.

Fig. 2.11 Impulse responses to a 1% government consumption shock in episodes of de facto fixed and flexible exchange rate regimes (120 country sample)



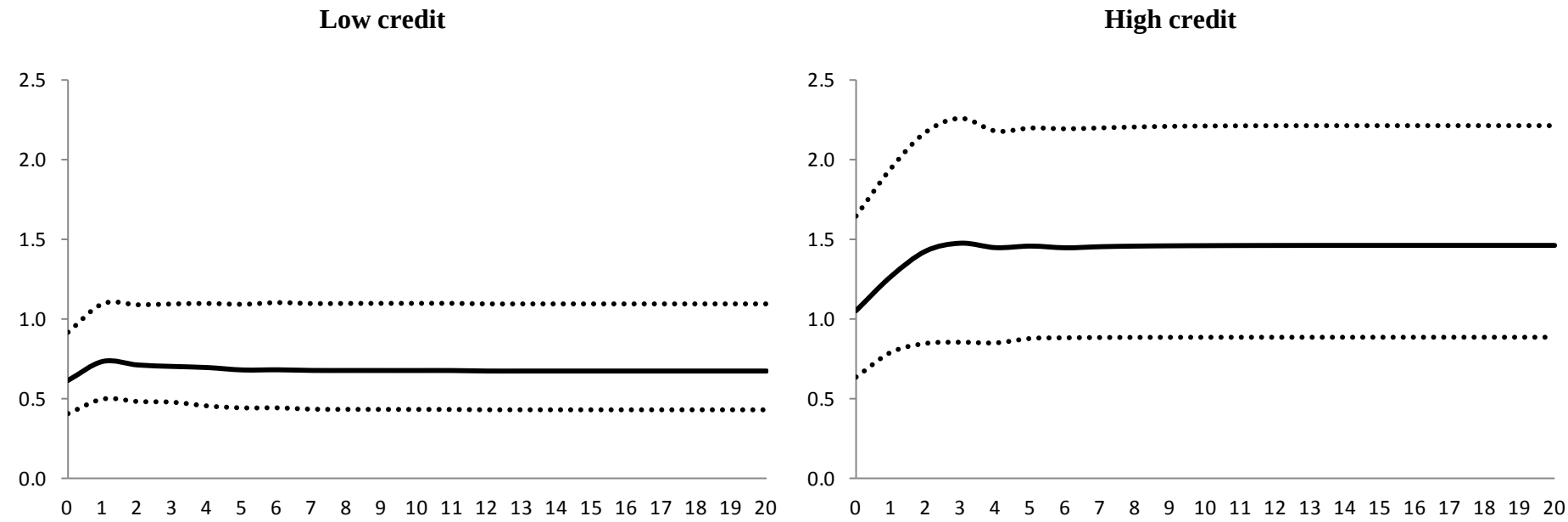
Notes: Impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median impulse response and the dotted lines are the 16 and 84 percentile values. Episodes coded from 1–8 are classified as fixed regime, and 9–13 as flexible regime. De facto exchange rate regime classification is based on the fine classification in Ilzetzki et al. (2010).

Fig. 2.12 Cumulative fiscal multipliers in episodes of low and high public debt (120 country sample)



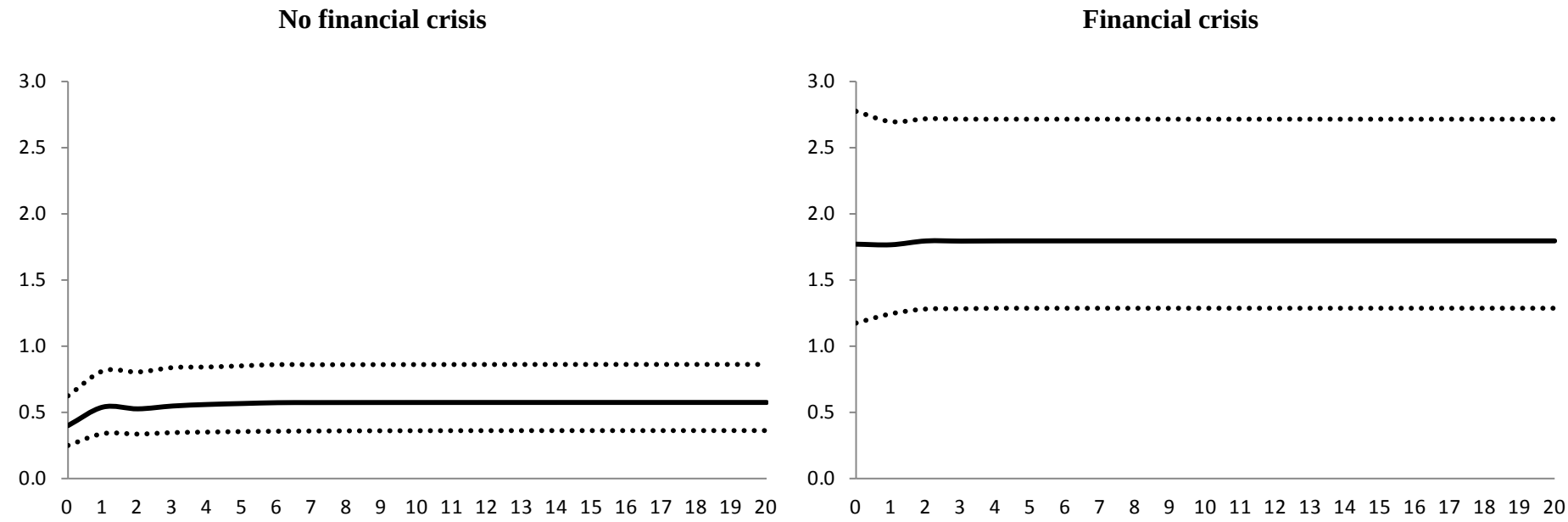
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Episodes with debt-to-GDP ratio exceeding 60% are classified as high debt, and low debt otherwise. Debt-to-GDP data available from 1960–2012, obtained from IMF Historical Public Debt Database. Number of observations: Low debt – 2081, High debt – 890.

Fig. 2.13 Cumulative fiscal multipliers in episodes of low and high credit (120 country sample)



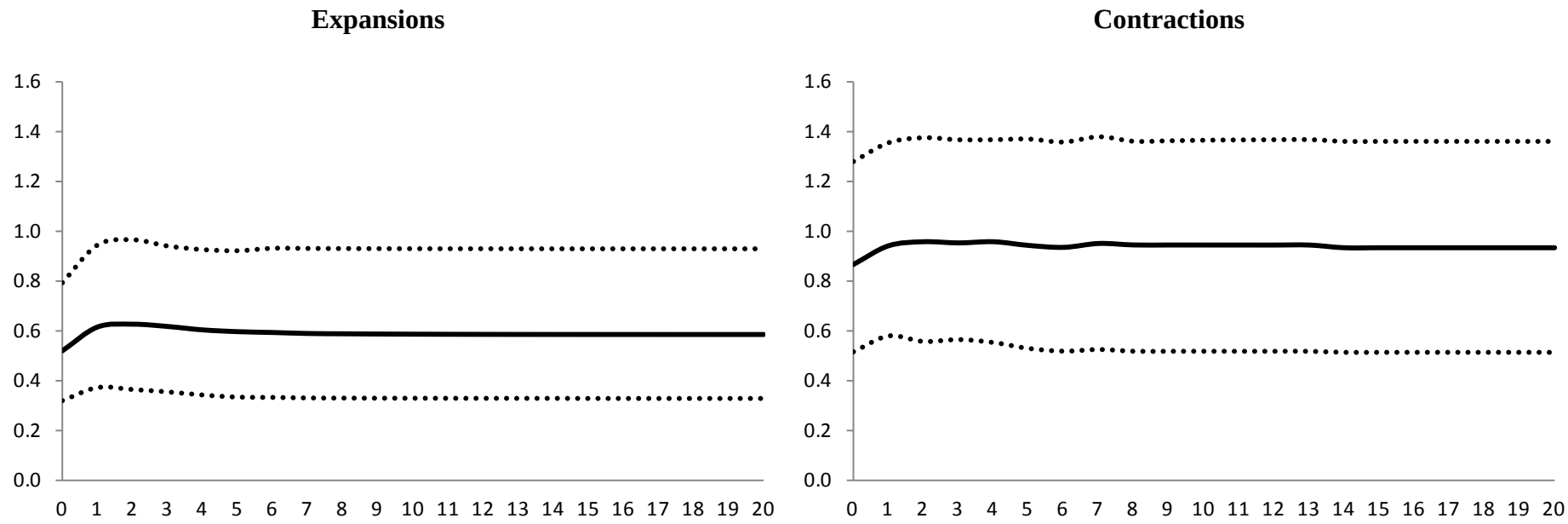
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Episodes with credit-to-GDP ratio exceeding 50% are classified as high credit, and low credit otherwise. Credit-to-GDP data available from 1960–2014, obtained from World Development Indicators. Number of observations: Low credit – 1946, High credit – 1187.

Fig. 2.14 Cumulative fiscal multipliers in episodes without and with financial crisis (120 country sample)



Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Episodes with financial crisis are obtained from Reinhart (2010), defined as type I and II banking crisis. Data available from 1960–2010 for a smaller subset of countries. Number of observations: No financial crisis – 1493, Financial crisis – 270.

Fig. 2.15 Cumulative fiscal multipliers in expansionary and recessionary phases of the business cycle (120 country sample)



Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Phases of expansions and contractions obtained from deviation of output from the Hodrick-Prescott trend as a measure of the business cycle. Data available from 1960–2014. Number of observations: Expansions – 1577, Recessions – 1658.

Appendix 2.A

Table 2.A1 Summary of selected panel data studies on the size of fiscal multipliers

Authors	No. of countries	Data frequency	Methodology	Country characteristics	Impact fiscal multiplier	Long-run fiscal multiplier
This paper	120	Annual	SVAR with sign restrictions	Advanced economies	0.97	1.28
				Developing countries	0.63	0.78
				Low trade openness	0.55	0.53
				High trade openness	0.78	1.18
				Low capital mobility	0.63	0.77
				High capital mobility	0.80	1.09
				Fixed exchange rate regime	0.74	0.91
				Flexible exchange rate regime	0.91	1.23
				Low debt	0.92	1.14
				High debt	0.53	0.40
				Low credit	0.62	0.68
				High credit	1.05	1.46
				No financial crisis	0.40	0.58
				Financial crisis	1.77	1.80
				Expansions	0.51	0.58
				Contractions	0.86	0.93
Beetsma et al. (2008)	14 (EU)	Annual	SVAR	Advanced economies	1.2	
				Open economies	0.83	

				Closed economies	1.43	
Auerbach and Gorodnichenko (2012)	24 (OECD)	Semi-annual	Smooth transition VAR	Expansions	-0.20	
				Contractions	0.46	
Kraay (2012)	29	Annual	Natural experiment	Developing countries	0.48	
Ravn et al. (2012)	4	Quarterly	SVAR	Advanced economies	0.52	
Born et al. (2013)	24 (OECD)	Semi-annual	SVAR	Fixed exchange rate regime	1.5	
				Flexible exchange rate regime	0.5	
Estevão and Samaké (2013)		Annual	SVECM	Advanced economies	0.43	0.78
				Emerging market economies	0.34	1.04
				Low income countries	0.17	-0.33
				Oil producing countries	0.31	0.44
Ilzetzki et al. (2013)	44	Quarterly	SVAR	Advanced economies	0.39	0.66
				Developing countries	-0.03	-0.63
				Open economies	-0.08	-0.46
				Closed economies	0.61	1.1
				Fixed exchange rate regime	0.15	1.4
				Flexible exchange rate regime	0.14	-0.69
				Low debt	-0.04	-0.36
				High debt	-0.03	-3
Contreras and Battelle (2014)	55	Quarterly	SVAR	Advanced economies	0.36	0.38
				Developing countries	0.39	0.88
				Open economies	0.27	0.23

	Closed economies	0.62	1.76
	Fixed exchange rate regime	0.41	1.06
	Flexible exchange rate regime	0.29	0.54
	Low debt	0.44	1.49
	High debt	0.37	0.39

Table 2.A2 List of countries and structural characteristics

Country	Years included	Income classification	Trade % GDP	Chinn-Ito index	Exchange rate regime	Debt % GDP	Credit % GDP	% years in financial crisis	% years in recessionary phase
Algeria	1997–2013	DEV	64.0	0.16	7.9	38.6	11.2	0.00	0.53
Argentina	1994–2014	DEV	29.5	0.42	5.1	65.0	15.9	0.29	0.38
Armenia	2003–2012	DEV	67.6	1.00	9.0	27.2	19.4	N/A	0.70
Australia	1970–2013	ADV	34.7	0.69	10.7	21.9	65.6	0.10	0.39
Austria	1976–2014	ADV	78.2	0.87	3.4	56.0	85.1	0.09	0.54
Azerbaijan	1993–2012	DEV	88.3	0.22	4.0	15.6	9.3	N/A	0.50
Bahamas, The	1990–2014	ADV	96.4	0.06	2.0	30.2	64.3	N/A	0.52
Bahrain	1990–2011	DEV	147.0	0.97	2.0	22.8	47.6	N/A	0.50
Bangladesh	2001–2011	DEV	36.0	0.16	5.5	46.0	31.9	N/A	0.64
Barbados	1974–2006	DEV	103.6	0.19	2.0	46.3	43.8	N/A	0.58
Belarus	1992–2012	DEV	130.2	0.11	5.1	19.7	18.3	N/A	0.57
Belgium	1971–2013	ADV	122.0	0.82	3.1	95.4	44.9	0.08	0.51
Belize	1990–2012	DEV	114.8	0.21	2.0	70.3	47.4	N/A	0.52
Benin	2001–2012	DEV	46.4	0.16	2.0	39.3	18.2	N/A	0.50
Bhutan	1990–2009	DEV	84.8	0.16	2.0	57.0	12.9	N/A	0.65
Bolivia	1990–2013	DEV	59.6	0.63	6.1	63.9	45.4	0.24	0.46
Botswana	1976–2014	DEV	102.9	0.55	6.9	19.7	16.6	N/A	0.56
Brazil	1975–2008	DEV	19.9	0.12	10.2	58.4	50.9	0.18	0.53

Brunei Darussalam	1990–2013	ADV	106.5	N/A	8.0	1.4	43.1	N/A	0.58
Bulgaria	1988–2014	DEV	99.6	0.43	2.0	74.2	47.0	N/A	0.56
Burkina Faso	1973–2005	DEV	36.1	0.15	2.1	35.9	12.5	N/A	0.45
Burundi	1971–2012	DEV	34.0	0.13	6.7	70.4	11.5	N/A	0.57
Cambodia	2002–2012	DEV	126.7	0.62	7.0	33.3	18.6	N/A	0.55
Canada	1971–2013	ADV	58.8	1.00	8.5	71.4	93.9	0.08	0.42
Chile	1990–2014	DEV	63.9	0.51	9.9	23.7	74.6	0.00	0.52
China	1979–2013	DEV	35.9	0.11	8.0	12.6	94.4	0.25	0.54
Colombia	1961–2011	DEV	31.2	0.13	9.7	25.2	29.3	0.16	0.53
Congo, Dem. Rep.	1994–2010	DEV	52.7	0.18	13.0	173.6	2.0	N/A	0.47
Costa Rica	1970–2006	DEV	75.8	0.37	6.5	51.6	22.0	0.11	0.51
Croatia	1996–2013	DEV	79.2	0.59	8.0	40.8	50.7	N/A	0.61
Cyprus	1976–2003	ADV	115.5	0.20	6.3	37.1	105.9	N/A	0.57
Czech Republic	1995–2014	DEV	113.3	0.79	8.0	26.5	44.9	N/A	0.50
Denmark	1995–2014	ADV	87.4	1.00	4.8	47.5	134.6	0.19	0.50
Dominican Republic	1961–2000	DEV	57.4	0.08	9.4	34.1	21.9	0.03	0.48
Ecuador	1961–2007	DEV	38.8	0.47	5.2	46.3	16.1	0.13	0.45
Egypt, Arab Rep.	2002–2012	DEV	54.5	0.90	6.7	85.1	43.7	0.00	0.55
El Salvador	1969–2013	DEV	61.3	0.45	6.0	42.5	33.4	0.02	0.49

Estonia	1995–2012	DEV	129.2	0.93	2.0	5.9	55.6	N/A	0.67
Ethiopia	1990–2011	DEV	34.0	0.15	7.0	88.3	17.1	N/A	0.45
Fiji	1970–1997	DEV	102.1	0.29	N/A	26.7	25.5	N/A	0.43
Finland	1975–2014	ADV	63.5	0.86	5.2	32.0	66.6	0.11	0.40
France	1971–2014	ADV	46.3	0.70	4.4	45.0	84.9	0.13	0.48
Georgia	1998–2014	DEV	81.0	0.71	8.6	40.7	21.5	N/A	0.53
Germany	1971–2014	ADV	53.1	1.00	9.1	48.4	86.0	0.15	0.43
Greece	1995–2012	ADV	50.4	0.85	1.8	112.3	65.7	0.25	0.56
Guatemala	1961–2014	DEV	45.6	0.66	4.7	23.9	18.1	0.06	0.61
Honduras	1965–2006	DEV	79.5	0.48	5.3	52.9	30.2	0.07	0.60
Hong Kong SAR, China	1981–2014	ADV	300.9	1.00	2.6	31.0	159.5	N/A	0.38
Hungary	1995–2013	DEV	132.4	0.77	8.9	67.1	40.8	0.25	0.63
Iceland	1998–2013	ADV	82.0	0.50	10.0	55.4	151.7	0.31	0.63
India	1990–2013	DEV	33.0	0.16	6.7	72.5	34.0	0.29	0.54
Indonesia	2000–2014	DEV	55.8	0.62	11.1	47.5	27.5	0.27	0.60
Iran, Islamic Rep.	1970–2007	DEV	42.5	0.22	9.2	26.8	25.9	N/A	0.55
Ireland	1971–2002	ADV	113.6	0.55	5.4	63.7	47.3	0.00	0.47
Israel	1996–2013	ADV	70.7	0.79	7.6	85.8	80.7	N/A	0.33
Italy	1971–2011	ADV	43.0	0.61	6.1	89.5	62.4	0.18	0.49
Japan	1994–2013	ADV	24.9	0.98	13.0	161.7	193.9	0.47	0.60
Jordan	1977–2014	DEV	122.1	0.61	4.3	94.4	65.5	N/A	0.53

Kazakhstan	1998–2013	DEV	85.6	0.16	7.1	13.8	31.2	N/A	0.56
Kenya	1970–2012	DEV	58.4	0.36	6.3	43.7	27.0	0.22	0.53
Korea, Rep.	1970–2014	DEV	65.9	0.35	7.9	18.6	70.3	0.29	0.42
Kuwait	1993–2013	ADV	91.7	0.77	5.2	38.9	55.6	N/A	0.52
Kyrgyz Republic	1993–2014	DEV	105.0	0.57	7.5	70.2	9.7	N/A	0.68
Latvia	1996–2014	DEV	97.5	0.97	9.2	18.8	49.1	N/A	0.74
Lebanon	1995–2014	DEV	84.8	0.75	2.0	143.8	79.3	N/A	0.50
Lesotho	1987–2007	DEV	166.5	0.20	2.0	82.4	16.0	N/A	0.48
Lithuania	1999–2014	DEV	132.9	0.91	4.7	24.9	47.9	N/A	0.75
Luxembourg	1995–2013	ADV	285.1	N/A	1.8	9.7	84.9	N/A	0.53
Madagascar	2000–2011	DEV	69.2	0.39	12.0	65.2	10.0	N/A	0.50
Malaysia	1970–2013	DEV	144.5	0.63	6.2	53.1	87.8	0.24	0.43
Mali	1976–2002	DEV	52.7	0.35	2.0	90.2	16.6	N/A	0.59
Mauritius	1990–2009	DEV	123.8	0.70	8.3	49.5	57.8	0.00	0.50
Mexico	1980–2012	DEV	43.5	0.54	9.7	46.9	18.8	0.29	0.45
Moldova	1995–2012	DEV	128.1	0.17	7.1	62.3	22.5	N/A	0.44
Morocco	2002–2012	DEV	74.0	0.16	5.3	57.6	56.7	N/A	0.45
Namibia	1990–2011	DEV	96.2	0.13	2.0	21.4	41.4	N/A	0.50
Nepal	1976–2013	DEV	41.4	0.17	5.9	45.3	23.4	N/A	0.63
Netherlands	1971–2011	ADV	109.9	0.81	4.1	58.1	86.2	0.08	0.59
New Zealand	1986–2013	ADV	57.8	0.99	12.0	42.5	97.4	0.16	0.61
Nicaragua	1995–2012	DEV	71.6	0.93	5.0	154.7	22.5	0.31	0.50

Nigeria	2003–2012	DEV	57.0	0.30	7.6	24.8	19.0	0.00	0.50
Norway	1995–2014	ADV	70.3	0.97	12.0	41.6	69.4	0.00	0.45
Oman	2001–2012	DEV	89.9	0.96	2.0	10.7	37.9	N/A	0.58
Pakistan	1990–2013	DEV	34.2	0.16	7.3	66.4	23.7	N/A	0.33
Panama	1988–2005	DEV	159.0	1.00	1.0	72.5	75.4	0.11	0.44
Papua New Guinea	1975–2004	DEV	99.3	0.28	7.0	46.5	18.8	N/A	0.53
Paraguay	1977–2012	DEV	99.5	0.41	9.1	29.1	21.8	0.18	0.47
Peru	1971–2013	DEV	34.2	0.57	8.1	37.8	19.4	0.23	0.49
Philippines	1985–2014	DEV	77.4	0.36	8.2	57.3	30.4	0.31	0.60
Poland	1995–2013	DEV	69.1	0.36	11.4	45.8	33.3	0.06	0.37
Portugal	1995–2014	ADV	66.7	0.99	1.8	67.4	123.5	0.19	0.40
Qatar	1981–2013	ADV	90.0	1.00	2.0	36.8	36.4	N/A	0.45
Romania	1995–2014	DEV	73.2	0.63	11.8	22.8	25.3	0.31	0.65
Russian Federation	1999–2013	DEV	56.3	0.41	8.2	26.8	32.0	0.17	0.73
Rwanda	1968–2008	DEV	31.9	0.18	7.3	44.5	6.7	N/A	0.44
Saudi Arabia	1969–2014	DEV	78.0	0.89	2.0	55.7	20.4	N/A	0.54
Seychelles	1993–2003	DEV	110.3	0.69	7.0	119.9	20.5	N/A	0.45
Sierra Leone	1999–2012	DEV	48.4	0.07	9.7	115.4	4.3	N/A	0.57
Singapore	1976–2014	ADV	354.2	0.94	11.0	83.2	89.3	0.06	0.51
Slovak Republic	1995–2014	DEV	141.1	0.45	7.3	32.4	43.3	N/A	0.50

Slovenia	1995–2014	ADV	116.4	0.67	6.0	28.7	52.8	N/A	0.65
South Africa	1961–2014	DEV	52.6	0.16	9.5	38.3	95.5	0.06	0.41
Spain	1971–2007	ADV	40.9	0.61	5.3	37.8	83.5	0.24	0.41
Sri Lanka	1990–2011	DEV	72.9	0.47	6.6	91.0	25.5	0.19	0.50
Sudan	1994–2014	DEV	30.2	0.22	7.0	136.6	7.2	N/A	0.52
Swaziland	1981–2012	DEV	152.6	0.28	2.7	22.2	18.8	N/A	0.53
Sweden	1995–2014	ADV	81.5	0.99	11.4	57.3	102.3	0.00	0.60
Switzerland	1980–2007	ADV	87.2	0.43	9.3	49.7	139.8	0.00	0.61
Syrian Arab Republic	1990–2007	DEV	68.4	0.00	10.0	135.3	10.3	N/A	0.44
Tanzania	1991–2012	DEV	47.2	0.17	8.7	72.1	8.7	N/A	0.50
Thailand	1966–2003	DEV	65.1	0.41	4.5	28.7	67.4	0.37	0.58
Tunisia	1990–2005	DEV	86.4	0.23	8.0	58.5	61.3	0.31	0.50
Turkey	2005–2014	DEV	52.7	0.36	11.5	42.9	45.5	0.00	0.20
Uganda	1999–2012	DEV	42.8	0.99	8.3	53.1	10.1	N/A	0.57
Ukraine	1999–2013	DEV	104.3	0.11	4.5	31.9	47.1	N/A	0.67
United Arab Emirates	2002–2014	ADV	141.5	1.00	2.0	11.6	57.4	N/A	0.46
United Kingdom	1990–2014	ADV	54.1	1.00	10.8	53.3	137.9	0.24	0.60
United States	1961–2009	ADV	17.9	1.00	10.0	52.5	119.4	0.22	0.47
Uruguay	1990–2012	DEV	46.4	0.89	8.9	56.3	31.3	0.05	0.43
Venezuela	1961–2009	DEV	47.5	0.51	4.2	25.3	29.3	0.22	0.45

Notes: Advanced economies (ADV) are based on the World Bank's classification of high income countries in 2000; all other countries are classified as developing (DEV). Chinn-Ito normalized index is a de jure measure of capital account openness (see Chinn and Ito, 2006). Exchange rate regimes are based on the de facto fine classifications in Ilzetzki et al. (2010). Data on debt is obtained from the IMF Historical Public Debt Database. Financial crisis episodes are taken from Reinhart (2010), defined as type I and II banking crisis. Recessionary phases are the output deviations lower than trend from a Hodrick-Prescott filter. Trade and credit data are obtained from World Development Indicators. The values of the country characteristics are the averages of the included years. N/A denotes data not available.

Table 2.A3 Variables and data sources

Variables	Definition	Source
Real government consumption	General government final consumption expenditure (constant LCU)	WDI, IFS
Real GDP	GDP (constant LCU)	WDI, IFS
Fiscal balance % GDP	Cash surplus/deficit (% of GDP)	WDI, IFS
	General government deficit (% of GDP)	OECD
	General government balance (% of GDP)	Eurostat
	Fiscal balance (% of GDP)	CEIC Data
Real exchange rate	Real effective exchange rate (2007=100)	Darvas (2012)
Economic development	GNI per capita, Atlas method (current US$) Advanced: GNI per capita ≥ $9,266 Developing: GNI per capita < $9,266	WDI
Trade openness	Trade (% of GDP) Low trade openness: Trade % GDP ≤ 60% High trade openness: Trade % GDP > 60%	WDI
International capital mobility	Chinn-Ito normalized index Low mobility: Index ≤ global median High mobility: Index > global median	Chinn and Ito (2006)
Exchange rate regime	Fixed: fine classification 1–8 Flexible: fine classification 9–13	Ilzetzki et al. (2010)
Debt burden	Gross general government debt (% of GDP) Low debt: Debt % GDP ≤ 60% High debt: Debt % GDP > 60%	HPDD
Financial development	Domestic credit to private sector (% of GDP) Low credit: Credit % GDP ≤ 50% High credit: Credit % GDP > 50%	WDI
Financial crisis	Banking crisis types I and II	Reinhart (2010)
State of the business cycle	Deviation of output from Hodrick-Prescott trend Expansions: deviation higher than trend Contractions: deviation lower than trend	Author's calculations

Notes: WDI – World Bank World Development Indicators, IFS – IMF International Financial Statistics, HPDD – IMF Historical Public Debt Database. The primary data source is WDI, supplemented by alternative sources. The data source with the longer time series is used.

Real effective exchange rate data is obtained from http://bruegel.org/publications/datasets/real-effective-exchange-rates-for-178-countries-a-new-database/.

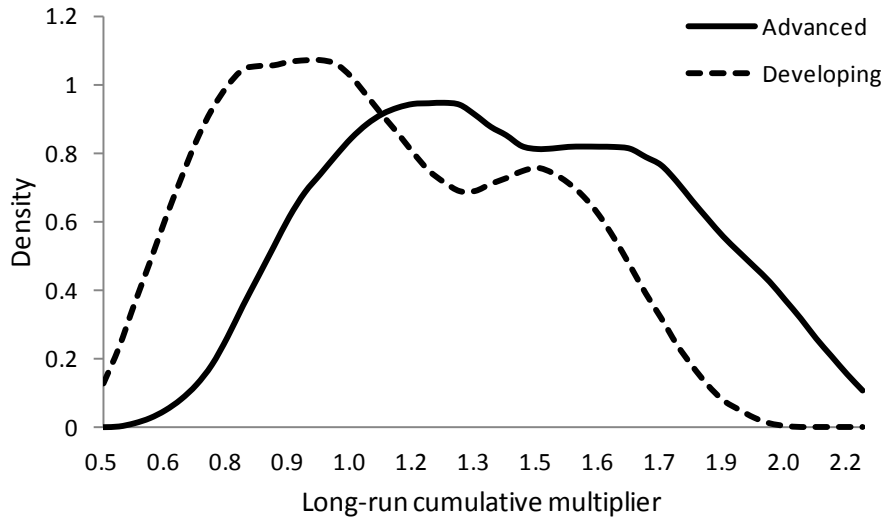
Chinn-Ito capital account openness index is obtained from http://web.pdx.edu/~ito/Chinn-Ito_website.htm.

Exchange rate regime data is obtained from http://personal.lse.ac.uk/ilzetzki/IRRBack.htm.

Financial crisis data is obtained from http://www.carmenreinhart.com/data/browse-by-topic/topics/7/.

Appendix 2.B – Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers for 44 countries

Fig. 2.B1 Empirical distributions of long-run cumulative fiscal multipliers in advanced and developing countries (Ilzetzki et al.'s (2013) country sample)



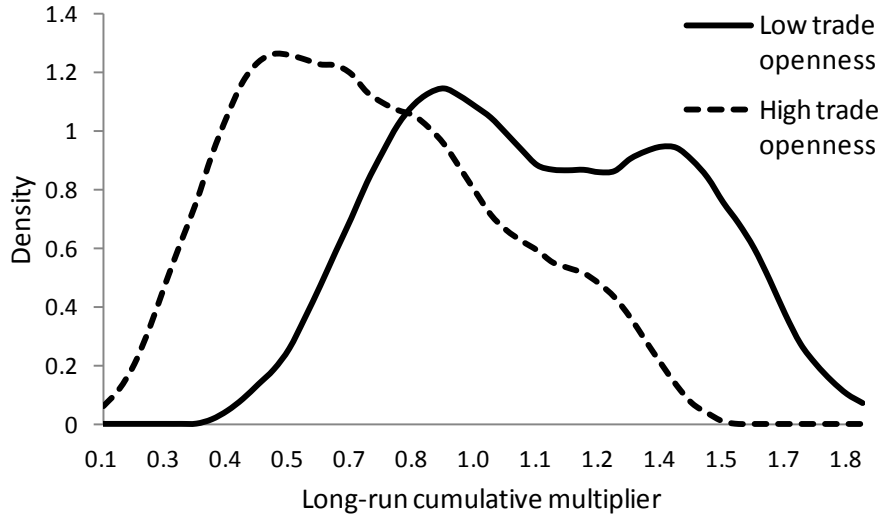
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The empirical distributions plotted above are the cumulative multipliers at the 20th year horizon for all accepted draws.

Table 2.B1 Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers in advanced and developing countries (Ilzetzki et al.'s (2013) country sample)

Smaller group	D	P-value	Corrected
Advanced	0.000	1.000	
Developing	-0.319	0.000	
Combined	0.319	0.000	0.000

Notes: The first line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is smaller in advanced economies. The p-value of 1 indicates that the null hypothesis cannot be rejected. The second line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is larger in advanced economies. This hypothesis is confirmed with a p-value of 0. The third line shows that the two-tailed test rejects the equality of the two distributions.

Fig. 2.B2 Empirical distributions of long-run cumulative fiscal multipliers in countries with low and high trade openness (Ilzetzki et al.'s (2013) country sample)



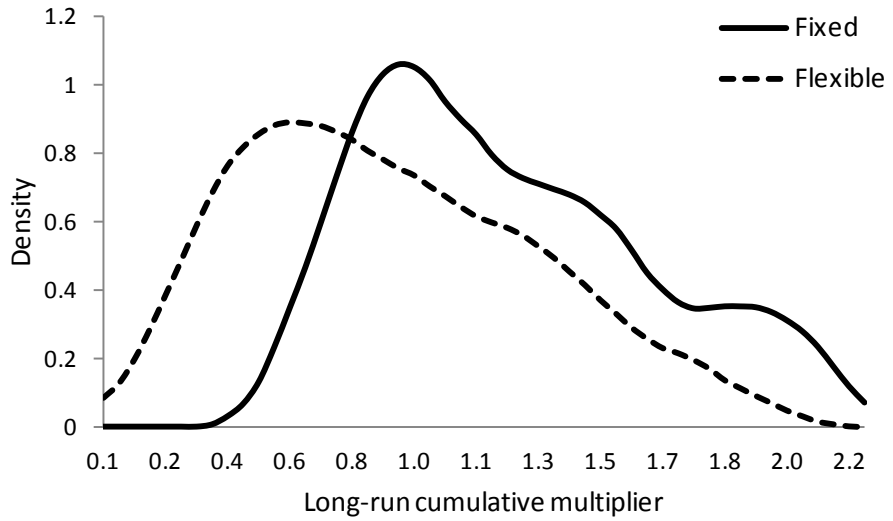
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The empirical distributions plotted above are the cumulative multipliers at the 20th year horizon for all accepted draws.

Table 2.B2 Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers in countries with low and high trade openness (Ilzetzki et al.'s (2013) country sample)

Smaller group	D	P-value	Corrected
Low trade openness	0.000	1.000	
High trade openness	-0.452	0.000	
Combined	0.452	0.000	0.000

Notes: The first line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is smaller in countries with low trade openness. The p-value of 1 indicates that the null hypothesis cannot be rejected. The second line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is larger in countries with low trade openness. This hypothesis is confirmed with a p-value of 0. The third line shows that the two-tailed test rejects the equality of the two distributions.

Fig. 2.B3 Empirical distributions of long-run cumulative fiscal multipliers in episodes of de facto fixed and flexible exchange rate regimes (Ilzetzki et al.'s (2013) country sample)



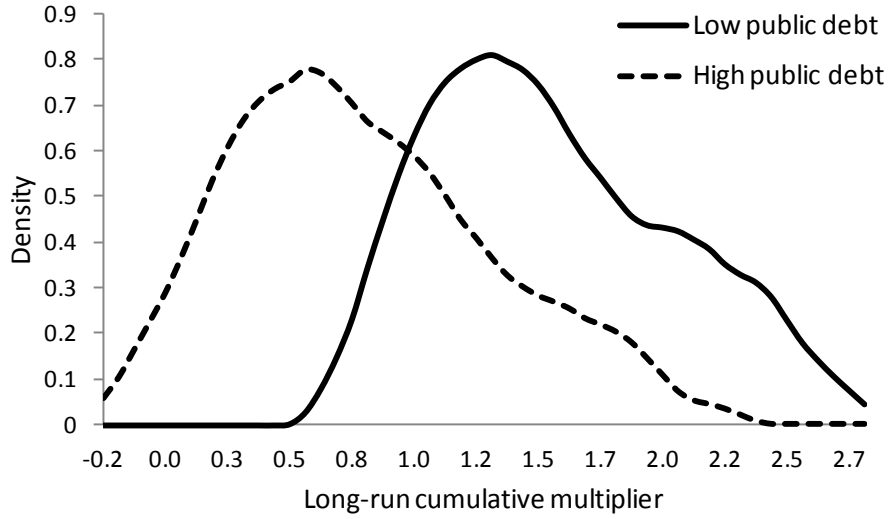
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The empirical distributions plotted above are the cumulative multipliers at the 20th year horizon for all accepted draws.

Table 2.B3 Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers in episodes of de facto fixed and flexible exchange rate regimes (Ilzetzki et al.'s (2013) country sample)

Smaller group	D	P-value	Corrected
Fixed	0.000	1.000	
Flexible	-0.359	0.000	
Combined	0.359	0.000	0.000

Notes: The first line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is smaller under fixed exchange rate regimes. The p-value of 1 indicates that the null hypothesis cannot be rejected. The second line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is larger under fixed exchange rate regimes. This hypothesis is confirmed with a p-value of 0. The third line shows that the two-tailed test rejects the equality of the two distributions.

Fig. 2.B4 Empirical distributions of long-run cumulative fiscal multipliers in episodes of low and high public debt (Ilzetzki et al.'s (2013) country sample)



Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The empirical distributions plotted above are the cumulative multipliers at the 20th year horizon for all accepted draws.

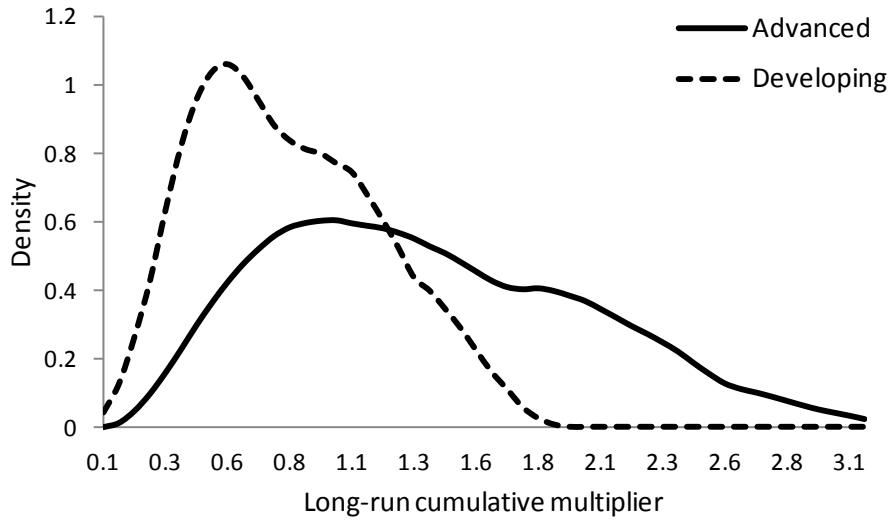
Table 2.B4 Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers in episodes of low and high public debt (Ilzetzki et al.'s (2013) country sample)

Smaller group	D	P-value	Corrected
Low public debt	0.000	1.000	
High public debt	0.581	0.000	
Combined	0.581	0.000	0.000

Notes: The first line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is smaller when public debt is low. The p-value of 1 indicates that the null hypothesis cannot be rejected. The second line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is larger when public debt is low. This hypothesis is confirmed with a p-value of 0. The third line shows that the two-tailed test rejects the equality of the two distributions.

Appendix 2.C – Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers for 120 countries

Fig. 2.C1 Empirical distributions of long-run cumulative fiscal multipliers in advanced and developing countries (120 country sample)



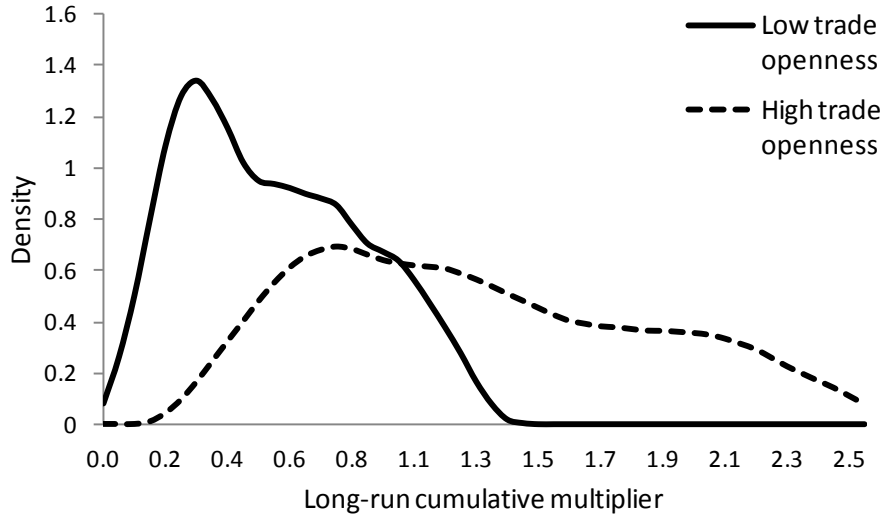
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The empirical distributions plotted above are the cumulative multipliers at the 20th year horizon for all accepted draws.

Table 2.C1 Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers in advanced and developing countries (120 country sample)

Smaller group	D	P-value	Corrected
Advanced	0.000	1.000	
Developing	-0.411	0.000	
Combined	0.411	0.000	0.000

Notes: The first line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is smaller in advanced economies. The p-value of 1 indicates that the null hypothesis cannot be rejected. The second line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is larger in advanced economies. This hypothesis is confirmed with a p-value of 0. The third line shows that the two-tailed test rejects the equality of the two distributions.

Fig. 2.C2 Empirical distributions of long-run cumulative fiscal multipliers in countries with low and high trade openness (120 country sample)



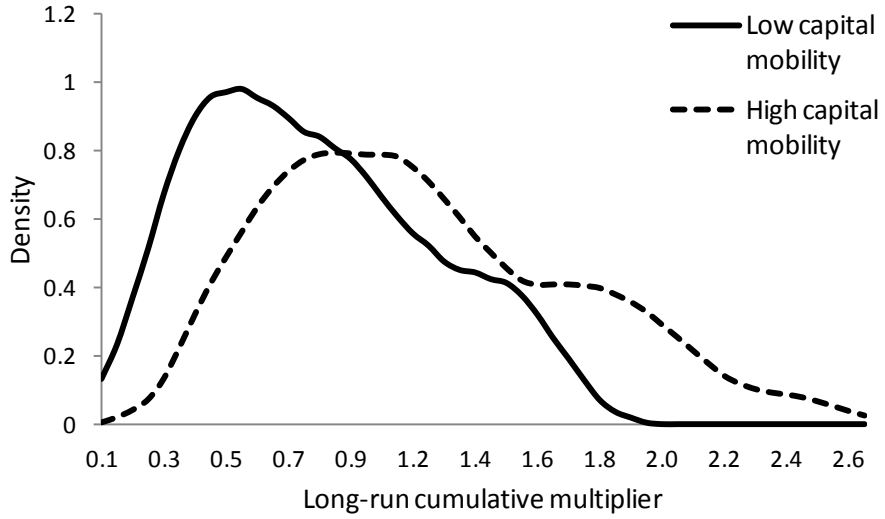
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The empirical distributions plotted above are the cumulative multipliers at the 20th year horizon for all accepted draws.

Table 2.C2 Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers in countries with low and high trade openness (120 country sample)

Smaller group	D	P-value	Corrected
Low trade openness	0.512	0.000	
High trade openness	0.000	1.000	
Combined	0.512	0.000	0.000

Notes: The first line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is smaller in countries with low trade openness. This hypothesis is confirmed with a p-value of 0. The second line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is larger in countries with low trade openness. The p-value of 1 indicates that the null hypothesis cannot be rejected. The third line shows that the two-tailed test rejects the equality of the two distributions.

Fig. 2.C3 Empirical distributions of long-run cumulative fiscal multipliers in countries with low and high international capital mobility (120 country sample)



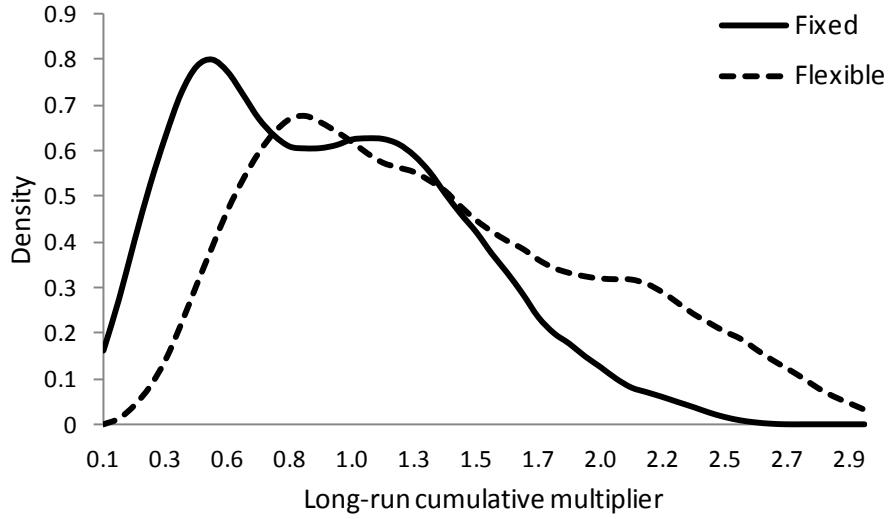
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The empirical distributions plotted above are the cumulative multipliers at the 20th year horizon for all accepted draws.

Table 2.C3 Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers in countries with low and high international capital mobility (120 country sample)

Smaller group	D	P-value	Corrected
Low capital mobility	0.307	0.000	
High capital mobility	0.000	1.000	
Combined	0.307	0.000	0.000

Notes: The first line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is smaller in countries with low capital mobility. This hypothesis is confirmed with a p-value of 0. The second line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is larger in countries with low capital mobility. The p-value of 1 indicates that the null hypothesis cannot be rejected. The third line shows that the two-tailed test rejects the equality of the two distributions.

Fig. 2.C4 Empirical distributions of long-run cumulative fiscal multipliers in episodes of de facto fixed and flexible exchange rate regimes (120 country sample)



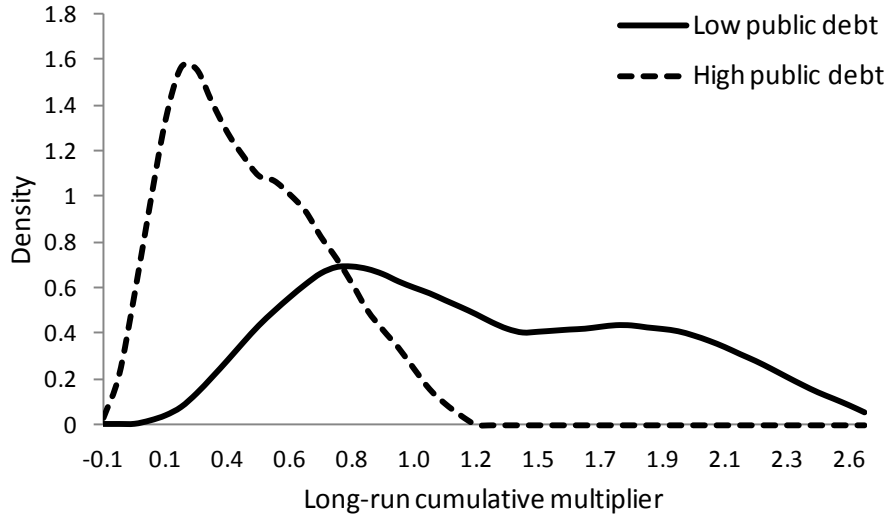
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The empirical distributions plotted above are the cumulative multipliers at the 20th year horizon for all accepted draws.

Table 2.C4 Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers in episodes of de facto fixed and flexible exchange rate regimes (120 country sample)

Smaller group	D	P-value	Corrected
Fixed	0.274	0.000	
Flexible	0.000	1.000	
Combined	0.274	0.000	0.000

Notes: The first line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is smaller under fixed exchange rate regimes. This hypothesis is confirmed with a p-value of 0. The second line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is larger under fixed exchange rate regimes. The p-value of 1 indicates that the null hypothesis cannot be rejected. The third line shows that the two-tailed test rejects the equality of the two distributions.

Fig. 2.C5 Empirical distributions of long-run cumulative fiscal multipliers in episodes of low and high public debt (120 country sample)



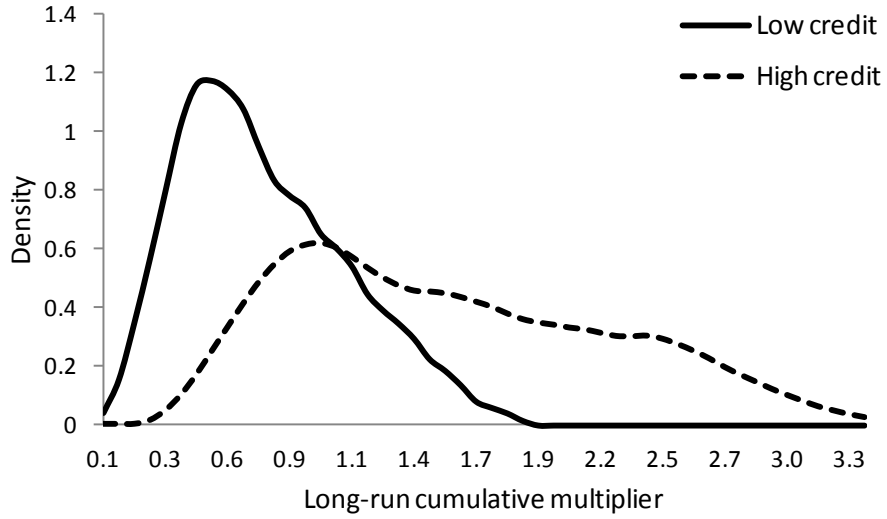
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The empirical distributions plotted above are the cumulative multipliers at the 20th year horizon for all accepted draws.

Table 2.C5 Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers in episodes of low and high public debt (120 country sample)

Smaller group	D	P-value	Corrected
Low public debt	0.000	1.000	
High public debt	0.633	0.000	
Combined	0.633	0.000	0.000

Notes: The first line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is smaller when public debt is low. The p-value of 1 indicates that the null hypothesis cannot be rejected. The second line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is larger when public debt is low. This hypothesis is confirmed with a p-value of 0. The third line shows that the two-tailed test rejects the equality of the two distributions.

Fig. 2.C6 Empirical distributions of long-run cumulative fiscal multipliers in episodes of low and high credit (120 country sample)



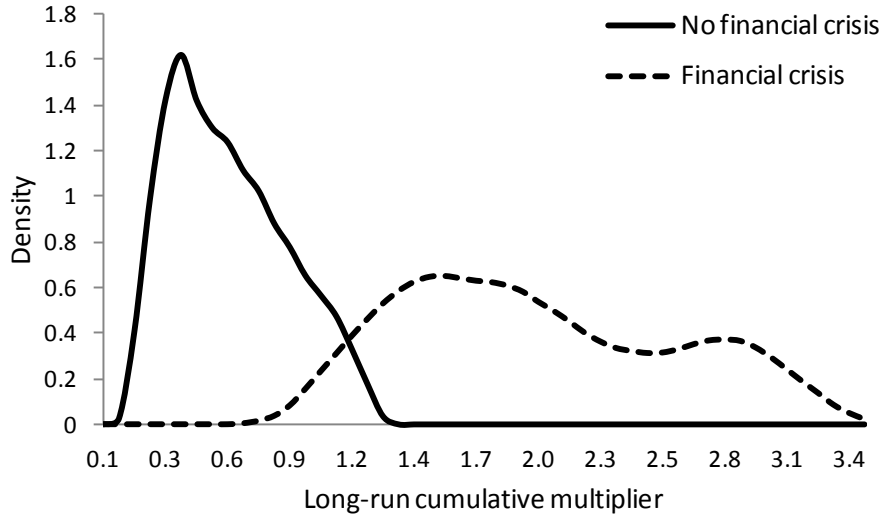
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The empirical distributions plotted above are the cumulative multipliers at the 20th year horizon for all accepted draws.

Table 2.C6 Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers in episodes of low and high credit (120 country sample)

Smaller group	D	P-value	Corrected
Low credit	-0.500	0.000	
High credit	0.000	1.000	
Combined	0.500	0.000	0.000

Notes: The first line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is smaller when access to credit is low. This hypothesis is confirmed with a p-value of 0. The second line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is larger when access to credit is low. The p-value of 1 indicates that the null hypothesis cannot be rejected. The third line shows that the two-tailed test rejects the equality of the two distributions.

Fig. 2.C7 Empirical distributions of long-run cumulative fiscal multipliers in episodes without and with financial crisis (120 country sample)



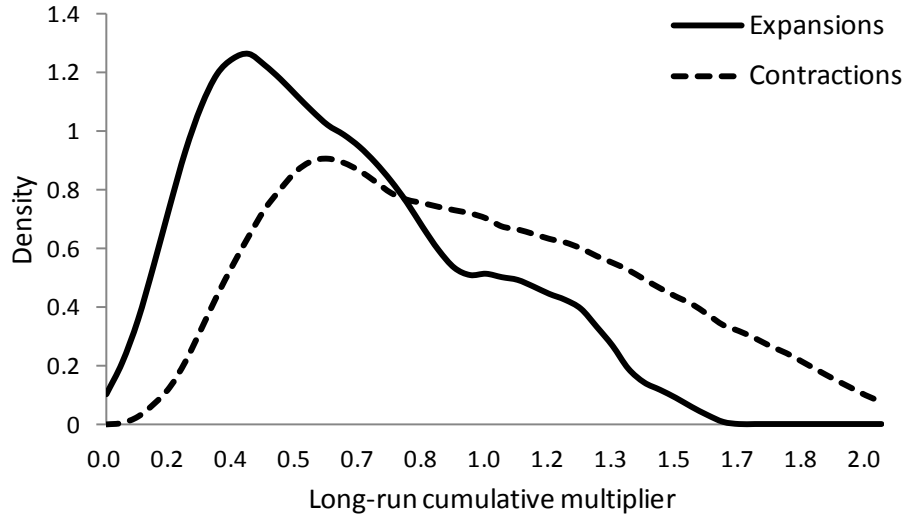
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The empirical distributions plotted above are the cumulative multipliers at the 20th year horizon for all accepted draws.

Table 2.C7 Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers in episodes without and with financial crisis (120 country sample)

Smaller group	D	P-value	Corrected
No financial crisis	-0.960	0.000	
Financial crisis	0.000	1.000	
Combined	0.960	0.000	0.000

Notes: The first line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is smaller when there is no financial crisis. This hypothesis is confirmed with a p-value of 0. The second line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is larger when there is no financial crisis. The p-value of 1 indicates that the null hypothesis cannot be rejected. The third line shows that the two-tailed test rejects the equality of the two distributions.

Fig. 2.C8 Empirical distributions of long-run cumulative fiscal multipliers in expansionary and recessionary phases of the business cycle (120 country sample)



Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The empirical distributions plotted above are the cumulative multipliers at the 20th year horizon for all accepted draws.

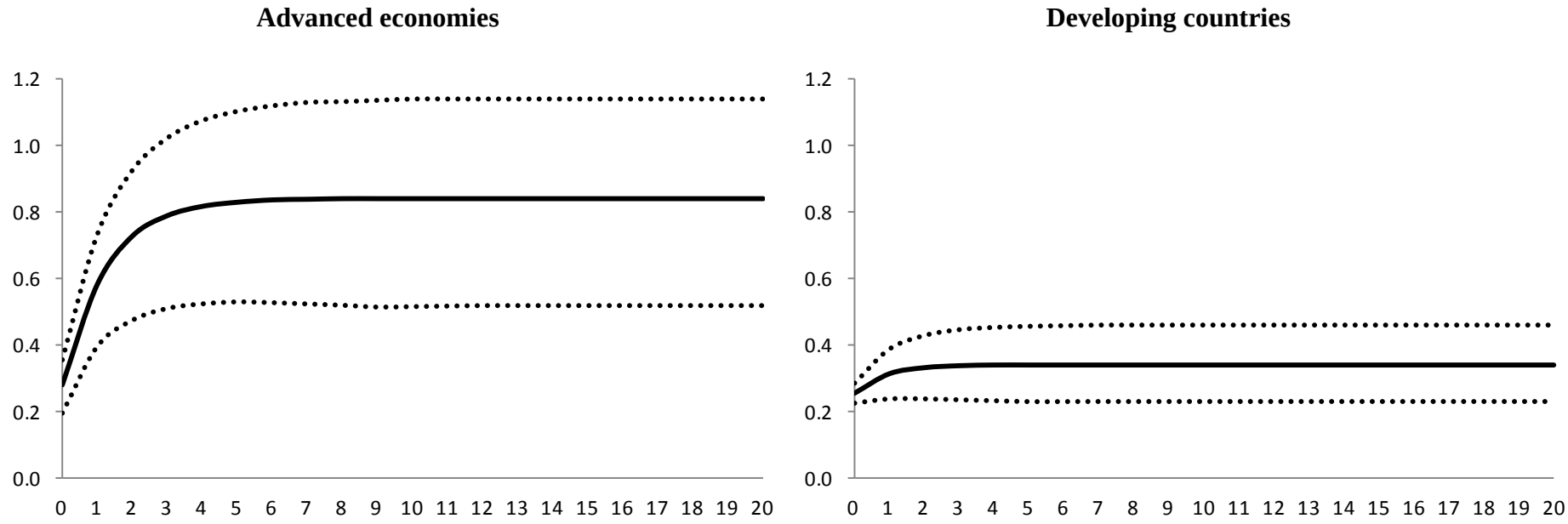
Table 2.C8 Kolmogorov-Smirnov equality-of-distributions tests of long-run cumulative fiscal multipliers in expansionary and recessionary phases of the business cycle (120 country sample)

Smaller group	D	P-value	Corrected
Expansions	0.315	0.000	
Contractions	0.000	1.000	
Combined	0.315	0.000	0.000

Notes: The first line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is smaller during expansions. This hypothesis is confirmed with a p-value of 0. The second line tests the alternative hypothesis that the long-run cumulative fiscal multiplier is larger during expansions. The p-value of 1 indicates that the null hypothesis cannot be rejected. The third line shows that the two-tailed test rejects the equality of the two distributions.

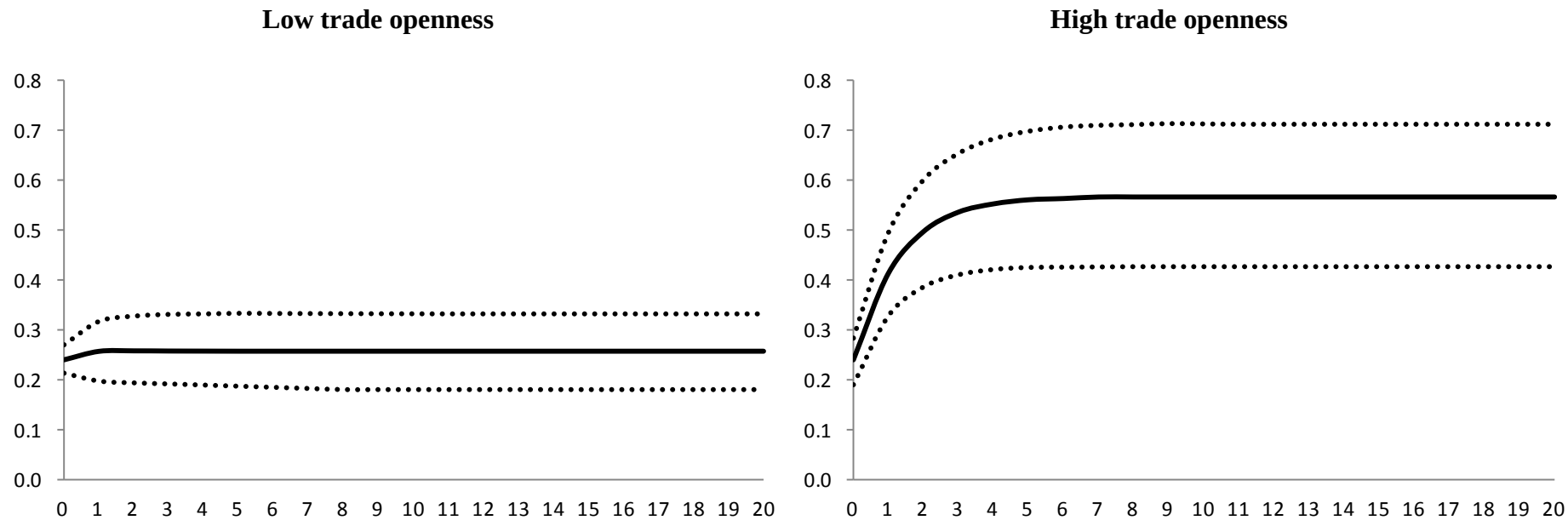
Appendix 2.D – estimated cumulative fiscal multipliers using standard SVAR for 120 countries

Fig. 2.D1 Cumulative fiscal multipliers in advanced and developing countries (120 country sample); standard SVAR



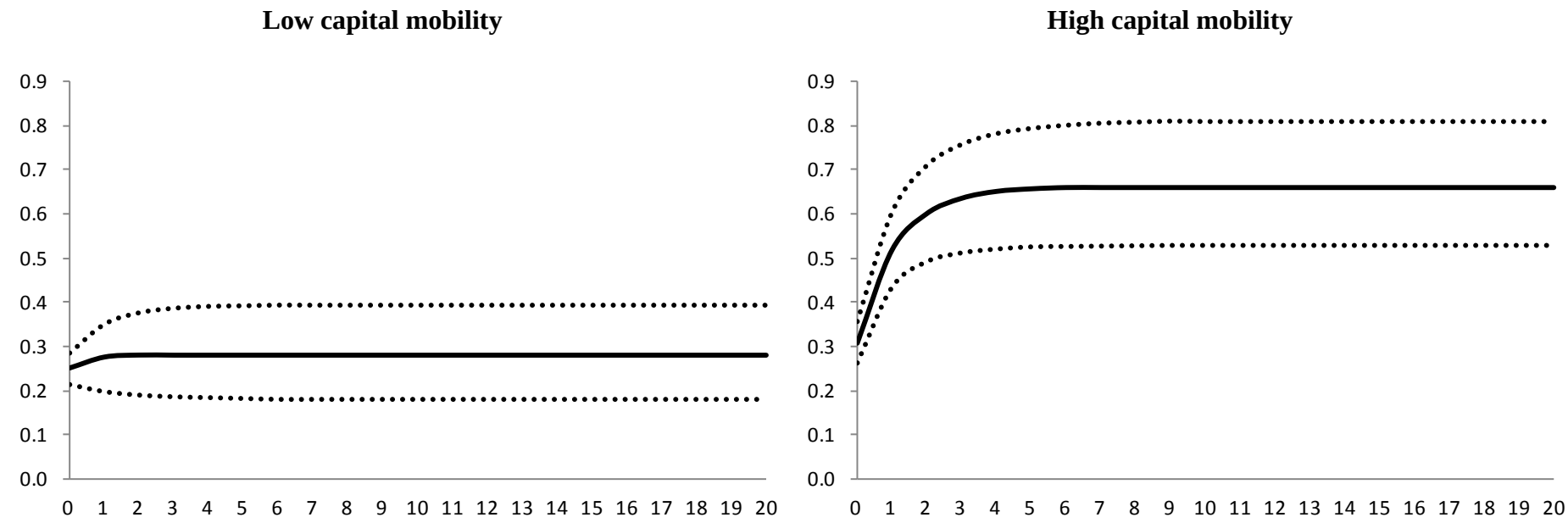
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Definition is based on the World Bank's income classification in 2000. Advanced economies are high-income countries with GNI per capita of $9,266 or more, all others are categorized as developing countries. GNI per capita data available from 1960–2014, obtained from World Development Indicators. Number of observations: Advanced – 986, Developing – 2249.

Fig. 2.D2 Cumulative fiscal multipliers in countries with low and high trade openness (120 country sample); standard SVAR



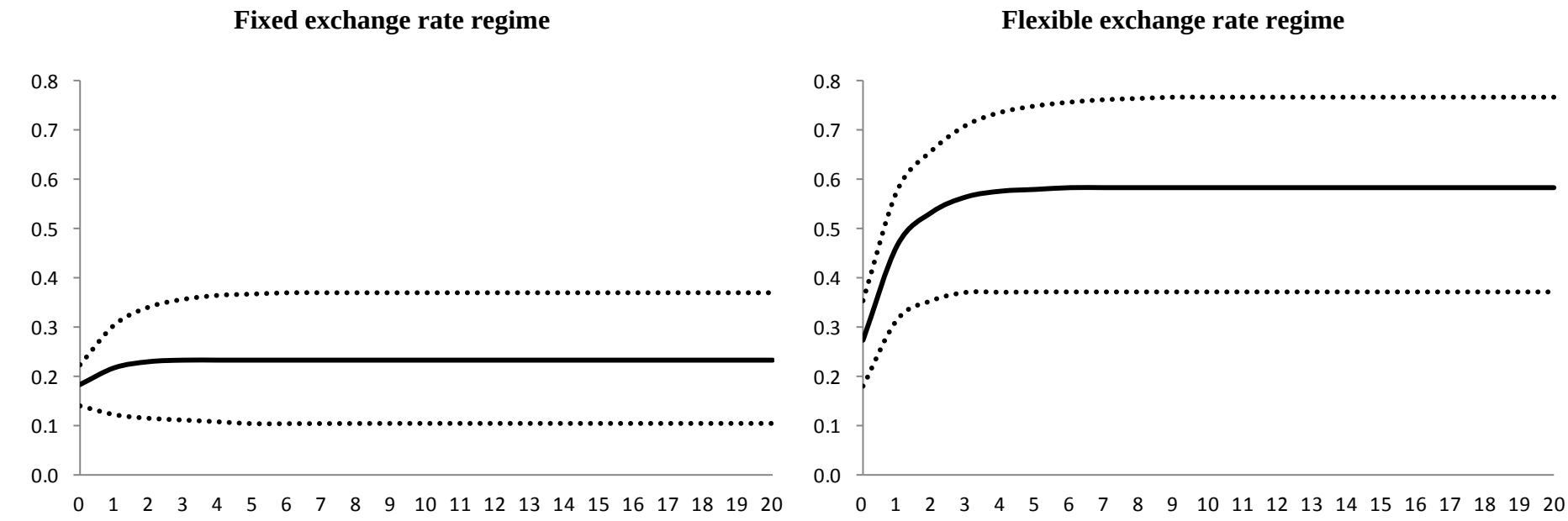
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Countries with an average trade-to-GDP ratio less than 60% are classified as low trade openness, and high trade openness otherwise. Trade-to-GDP data available from 1960–2014, obtained from World Development Indicators. Number of observations: Low trade openness – 1405, High trade openness – 1830.

Fig. 2.D3 Cumulative fiscal multipliers in countries with low and high international capital mobility (120 country sample); standard SVAR



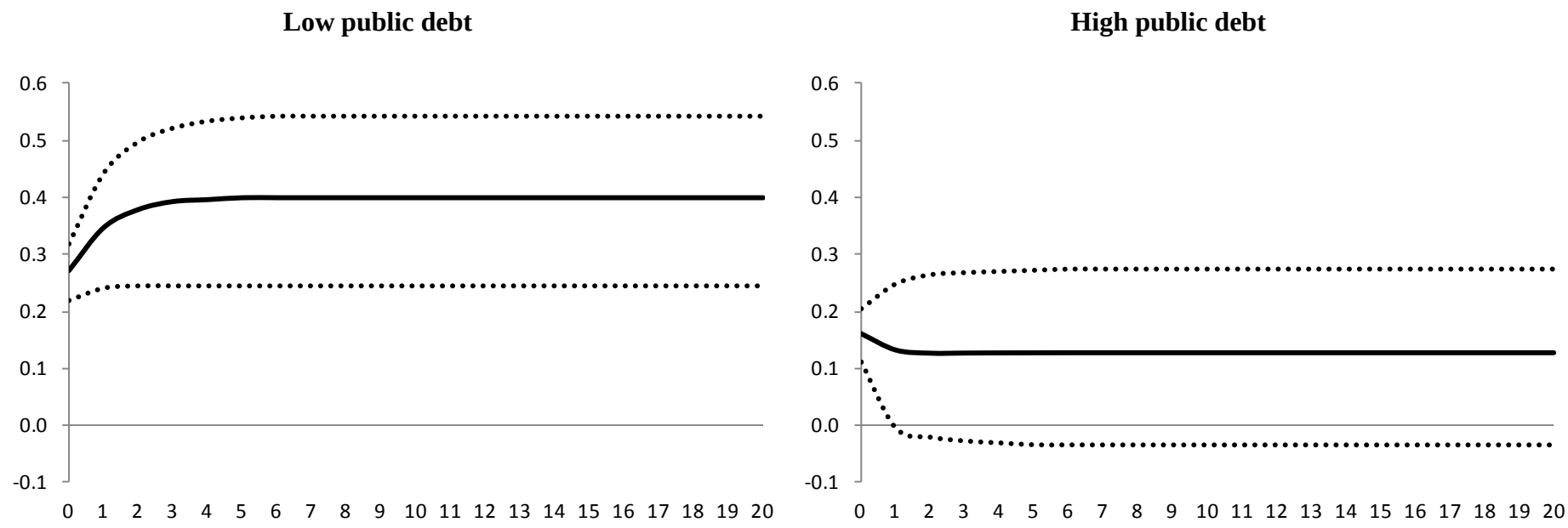
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Countries with an average Chinn-Ito capital account openness index (Chinn and Ito, 2006) lower than the global median are classified as low capital mobility, and high capital mobility otherwise. The Chinn-Ito index data is available from 1970–2014. Number of observations: Low capital mobility – 1161, High capital mobility – 2031.

Fig. 2.D4 Cumulative fiscal multipliers in episodes of de facto fixed and flexible exchange rate regimes (120 country sample); standard SVAR



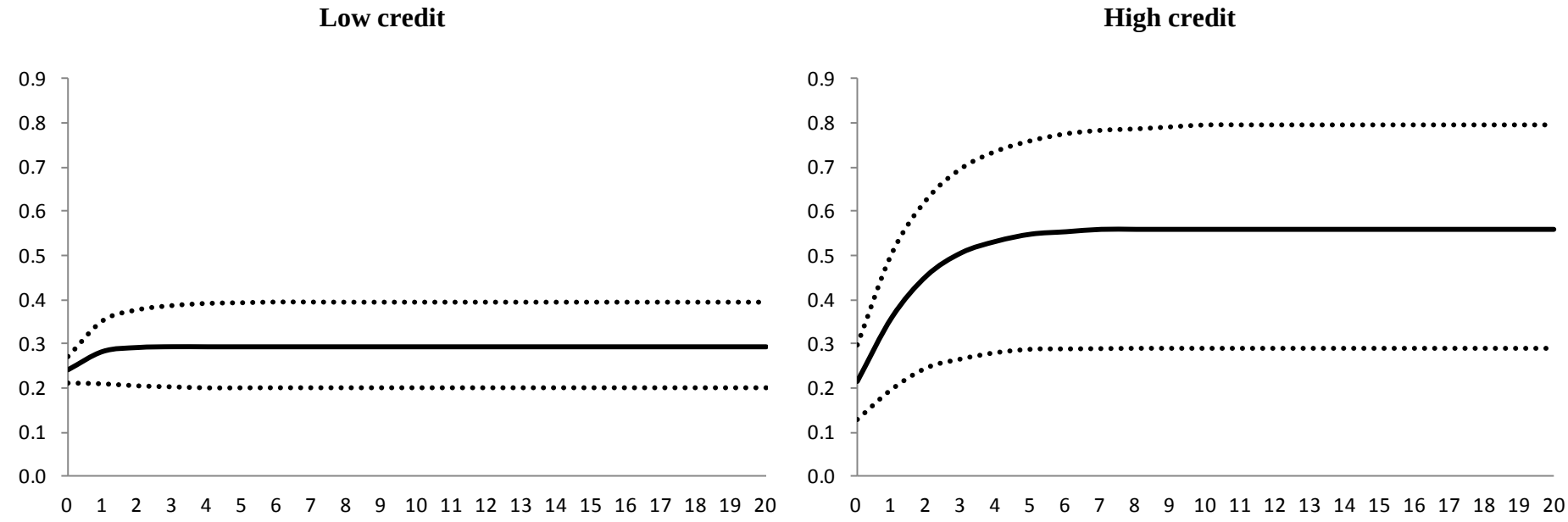
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Episodes coded from 1–8 are classified as fixed regime, and 9–13 as flexible regime. De facto exchange rate regime classification is based on the fine classification in Ilzetzki et al. (2010) with data available from 1960–2010. Number of observations: Fixed regime – 1977, Flexible regime – 711.

Fig. 2.D5 Cumulative fiscal multipliers in episodes of low and high public debt (120 country sample); standard SVAR



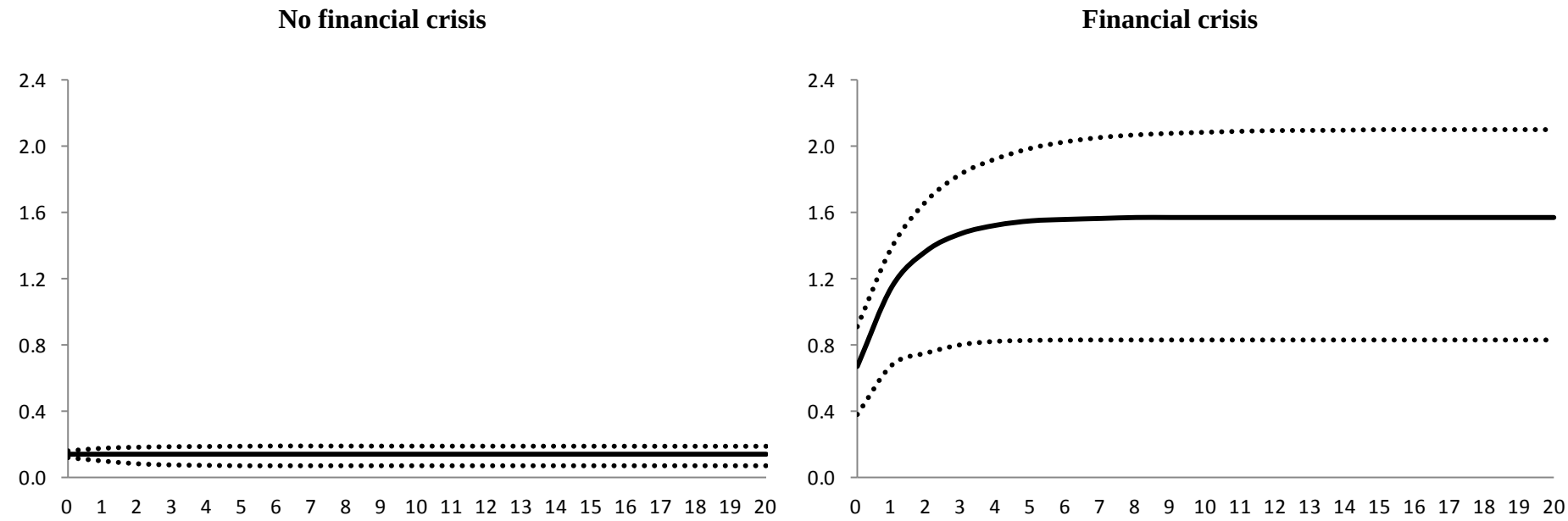
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Episodes with debt-to-GDP ratio exceeding 60% are classified as high debt, and low debt otherwise. Debt-to-GDP data available from 1960–2012, obtained from IMF Historical Public Debt Database. Number of observations: Low debt – 2081, High debt – 890.

Fig. 2.D6 Cumulative fiscal multipliers in episodes of low and high credit (120 country sample); standard SVAR



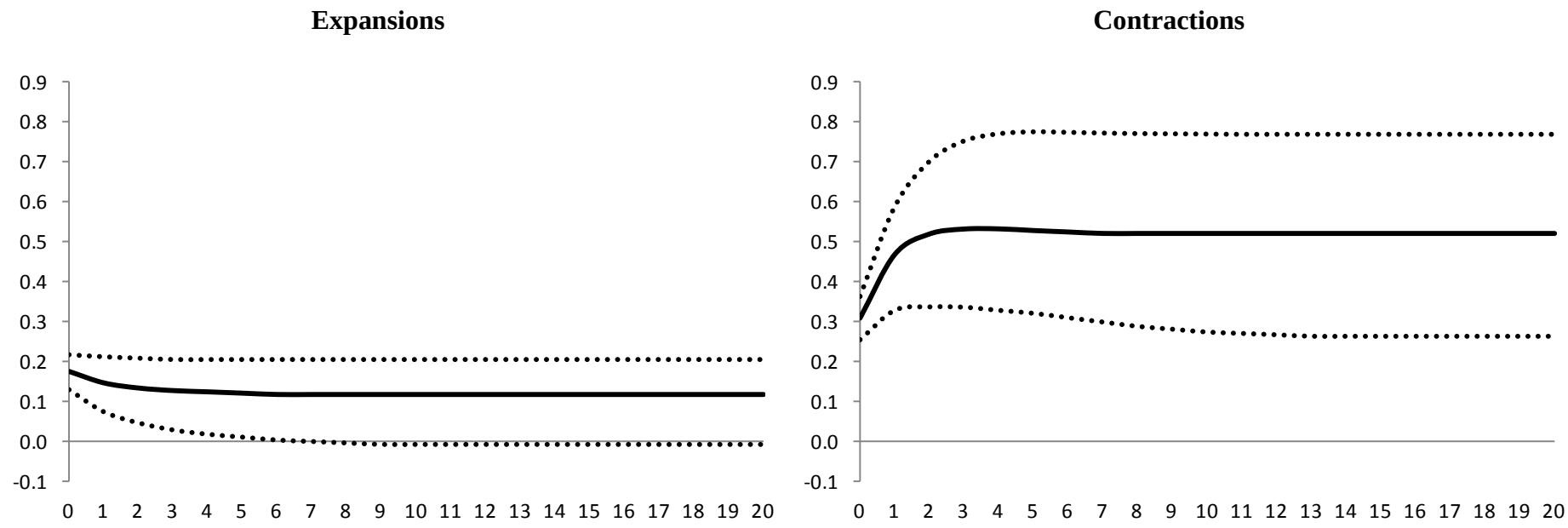
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Episodes with credit-to-GDP ratio exceeding 50% are classified as high credit, and low credit otherwise. Credit-to-GDP data available from 1960–2014, obtained from World Development Indicators. Number of observations: Low credit – 1946, High credit – 1187.

Fig. 2.D7 Cumulative fiscal multipliers in episodes without and with financial crisis (120 country sample); standard SVAR



Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Episodes with financial crisis are obtained from Reinhart (2010), defined as type I and II banking crisis. Data available from 1960–2010 for a smaller subset of countries. Number of observations: No financial crisis – 1493, Financial crisis – 270.

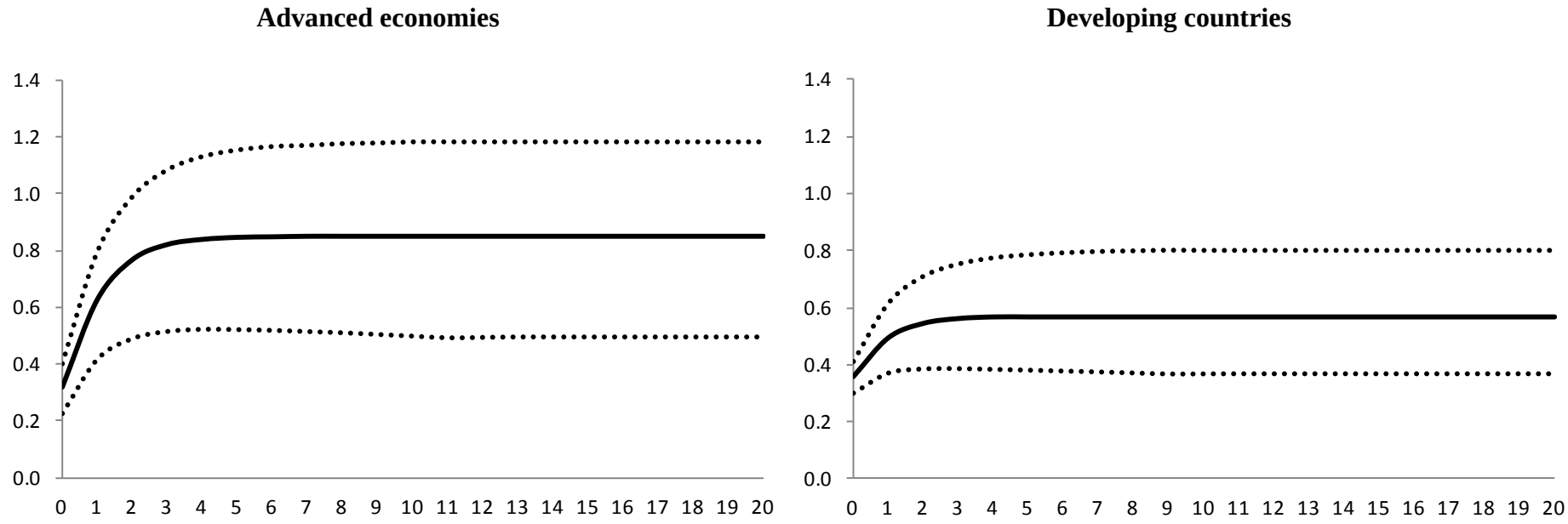
Fig. 2.D8 Cumulative fiscal multipliers in expansionary and recessionary phases of the business cycle (120 country sample); standard SVAR



Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Phases of expansions and contractions obtained from deviation of output from the Hodrick-Prescott trend as a measure of the business cycle. Data available from 1960–2014. Number of observations: Expansions – 1577, Contractions – 1658.

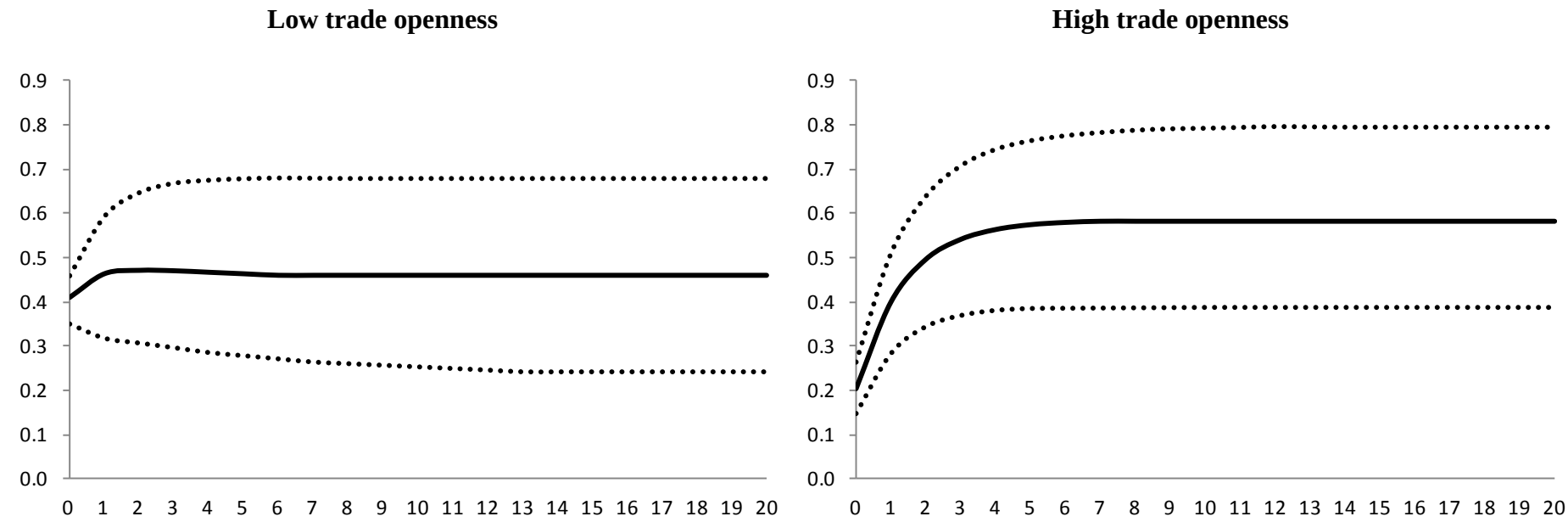
Appendix 2.E – estimated cumulative fiscal multipliers using standard SVAR for 82 countries

Fig. 2.E1 Cumulative fiscal multipliers in advanced and developing countries (82 country sample); standard SVAR



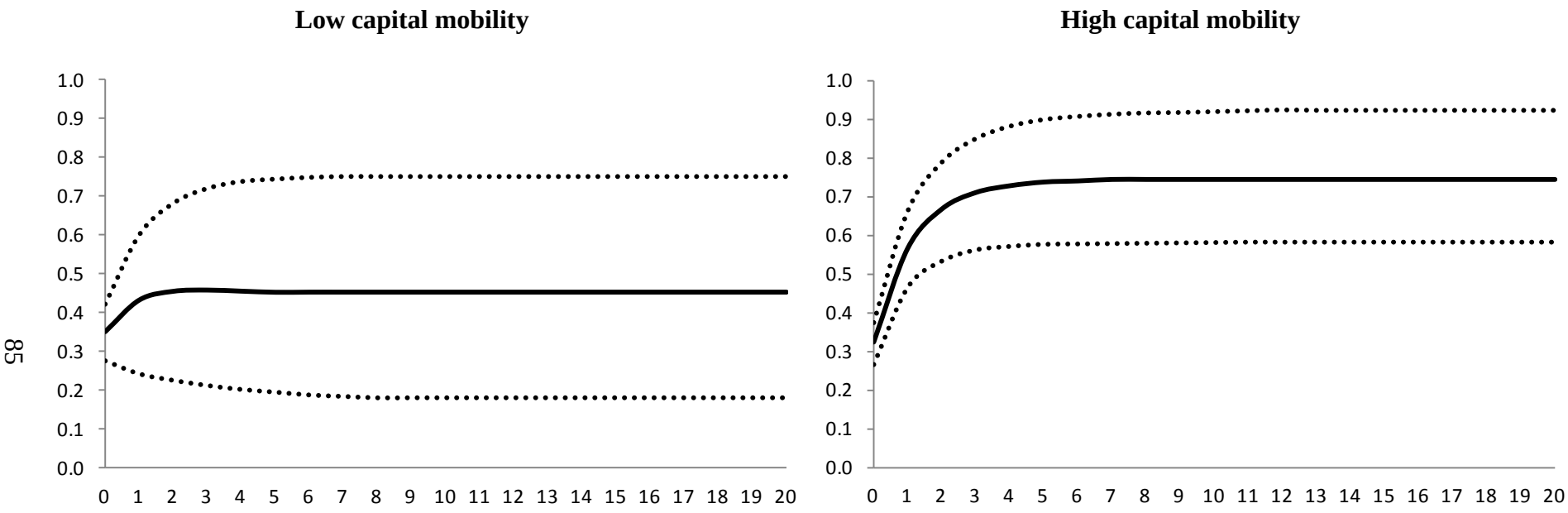
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Definition is based on the World Bank's income classification in 2000. Advanced economies are high-income countries with GNI per capita of $9,266 or more, all others are categorized as developing countries. GNI per capita data available from 1960–2014, obtained from World Development Indicators. Number of observations: Advanced – 855, Developing – 1761.

Fig. 2.E2 Cumulative fiscal multipliers in countries with low and high trade openness (82 country sample); standard SVAR



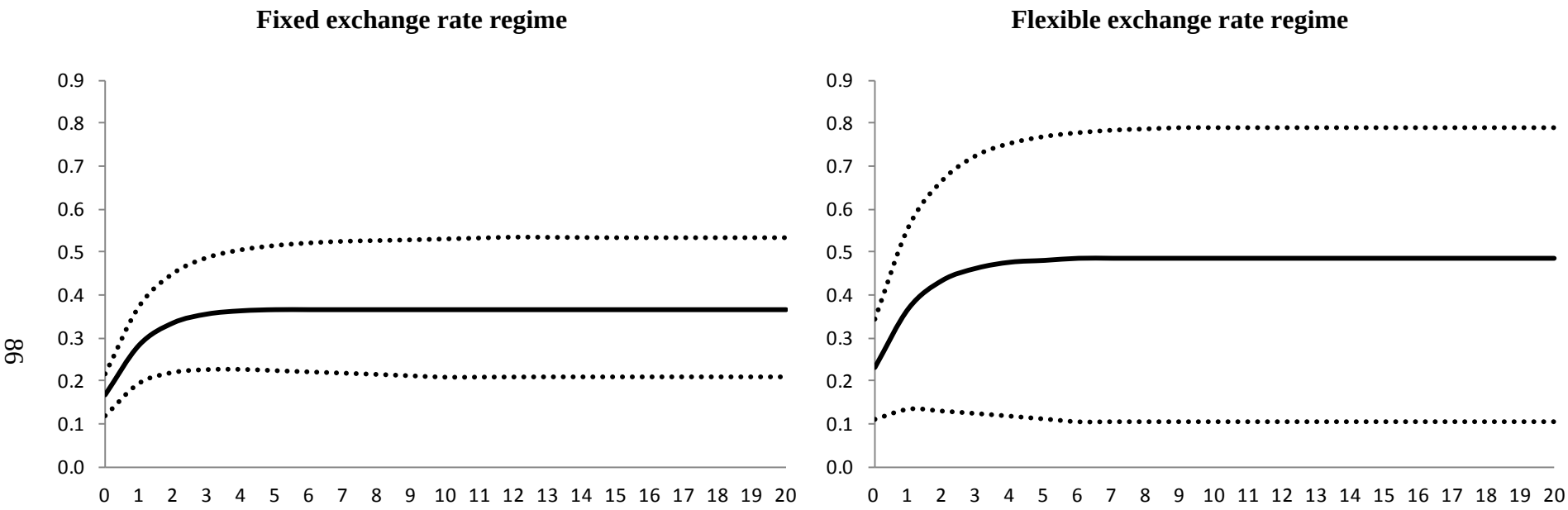
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Countries with an average trade-to-GDP ratio less than 60% are classified as low trade openness, and high trade openness otherwise. Trade-to-GDP data available from 1960–2014, obtained from World Development Indicators. Number of observations: Low trade openness – 1258, High trade openness – 1358.

Fig. 2.E3 Cumulative fiscal multipliers in countries with low and high international capital mobility (82 country sample); standard SVAR



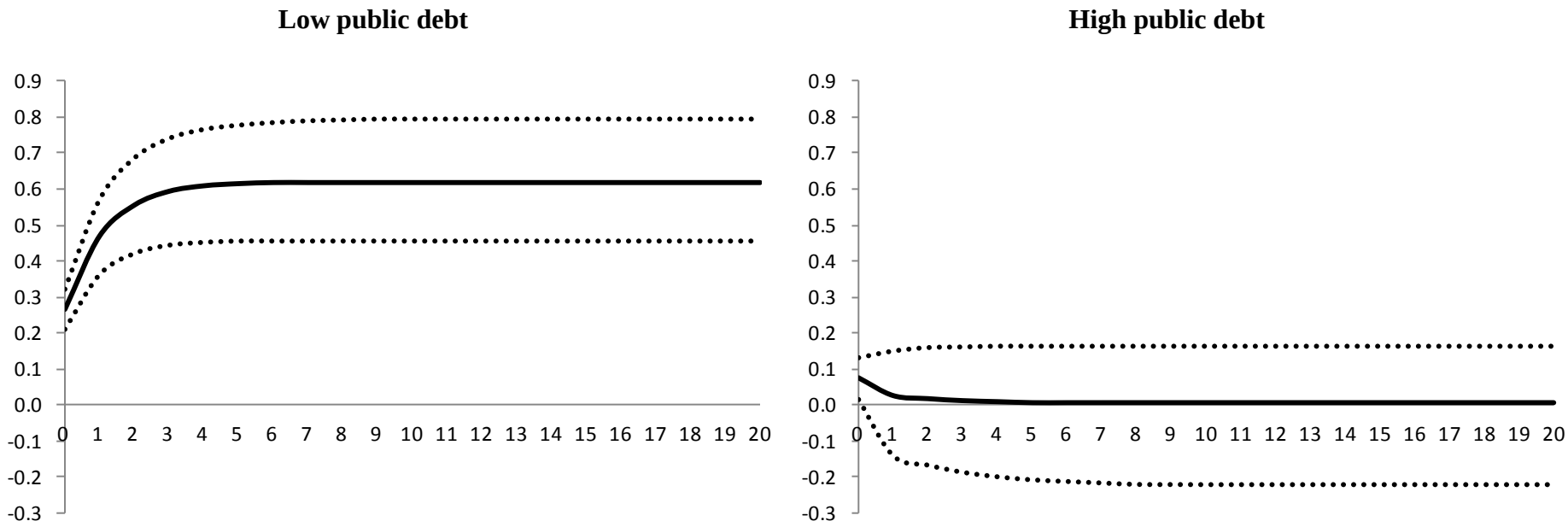
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Countries with an average Chinn-Ito capital account openness index (Chinn and Ito, 2006) lower than the global median are classified as low capital mobility, and high capital mobility otherwise. The Chinn-Ito index data is available from 1970–2014. Number of observations: Low capital mobility – 937, High capital mobility – 1679.

Fig. 2.E4 Cumulative fiscal multipliers in episodes of de facto fixed and flexible exchange rate regimes (82 country sample); standard SVAR



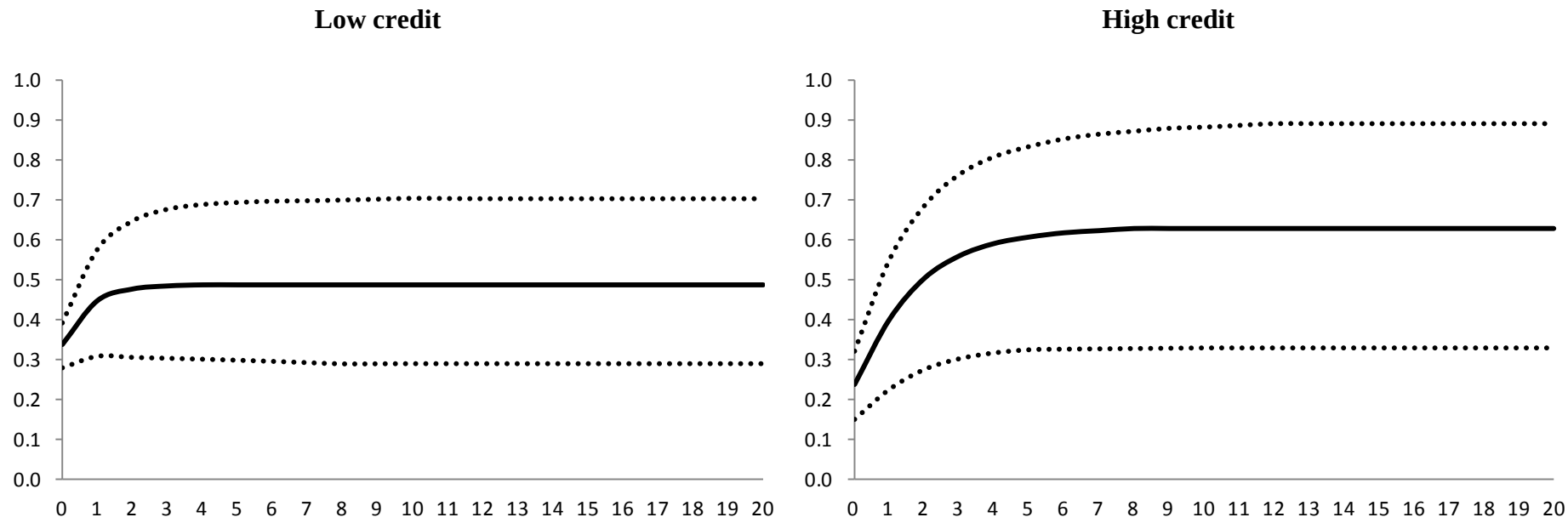
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Episodes coded from 1–8 are classified as fixed regime, and 9–13 as flexible regime. De facto exchange rate regime classification is based on the fine classification in Ilzetzki et al. (2010) with data available from 1960–2010. Number of observations: Fixed regime – 1604, Flexible regime – 591.

Fig. 2.E5 Cumulative fiscal multipliers in episodes of low and high public debt (82 country sample); standard SVAR



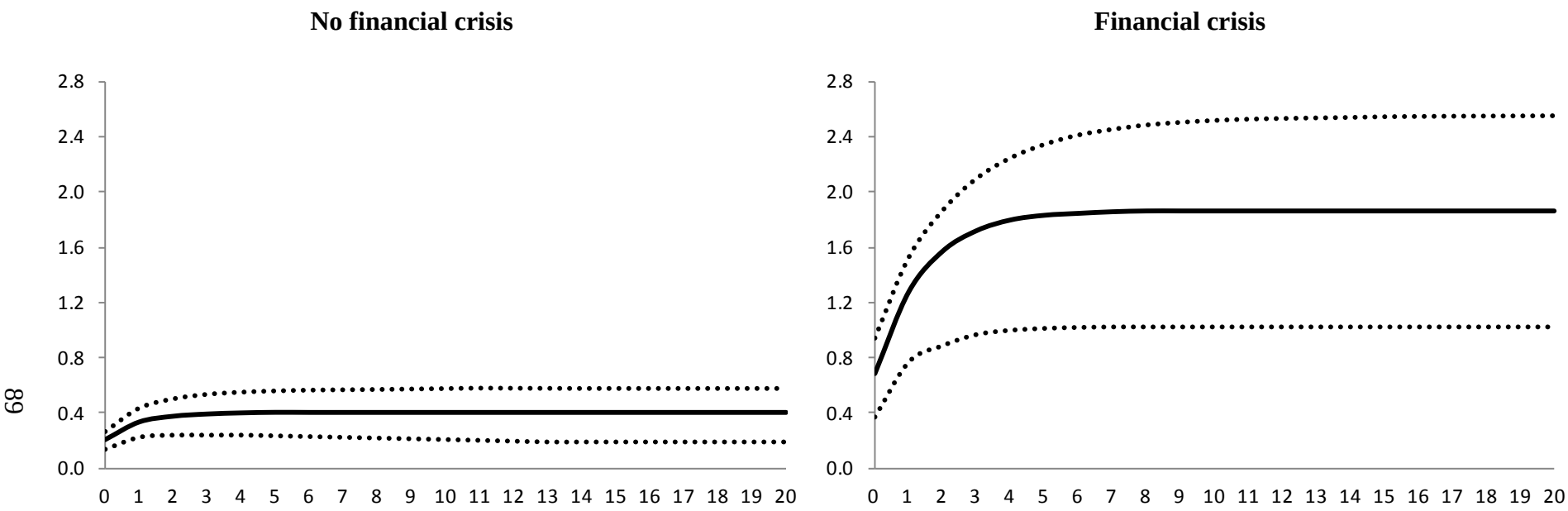
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Episodes with debt-to-GDP ratio exceeding 60% are classified as high debt, and low debt otherwise. Debt-to-GDP data available from 1960–2012, obtained from IMF Historical Public Debt Database. Number of observations: Low debt – 1700, High debt – 691.

Fig. 2.E6 Cumulative fiscal multipliers in episodes of low and high credit (82 country sample); standard SVAR



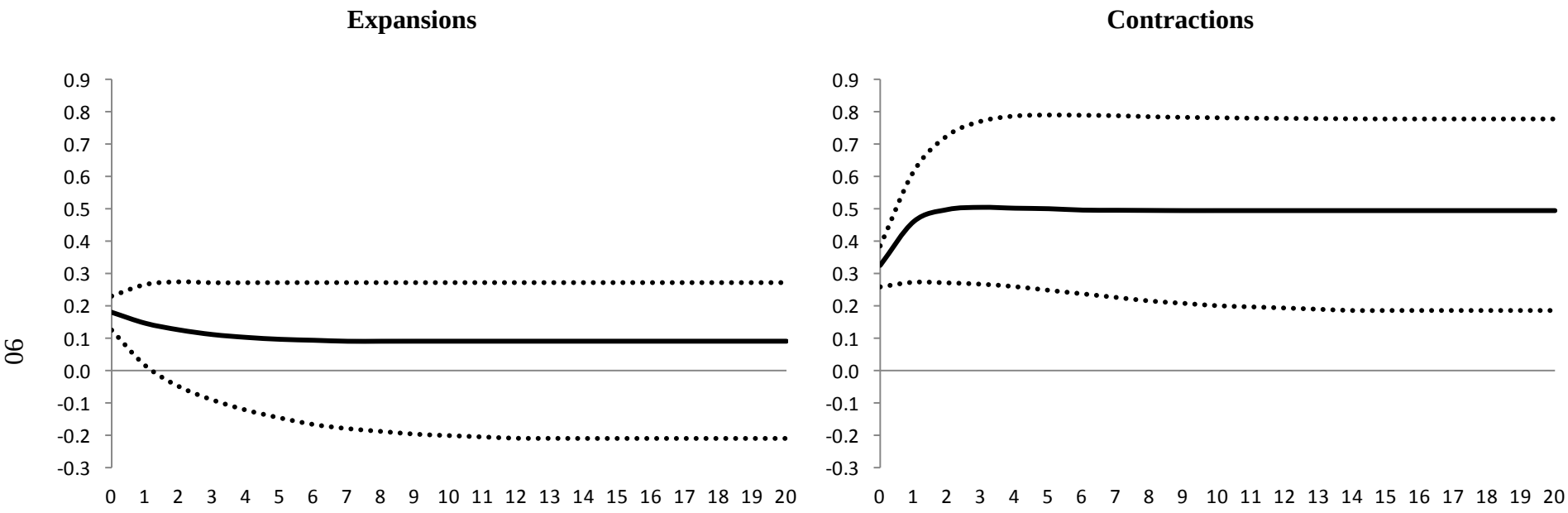
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Episodes with credit-to-GDP ratio exceeding 50% are classified as high credit, and low credit otherwise. Credit-to-GDP data available from 1960–2014, obtained from World Development Indicators. Number of observations: Low credit – 1523, High credit – 1016.

Fig. 2.E7 Cumulative fiscal multipliers in episodes without and with financial crisis (82 country sample); standard SVAR



Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Episodes with financial crisis are obtained from Reinhart (2010), defined as type I and II banking crisis. Data available from 1960–2010 for a smaller subset of countries. Number of observations: No financial crisis – 1319, Financial crisis – 240.

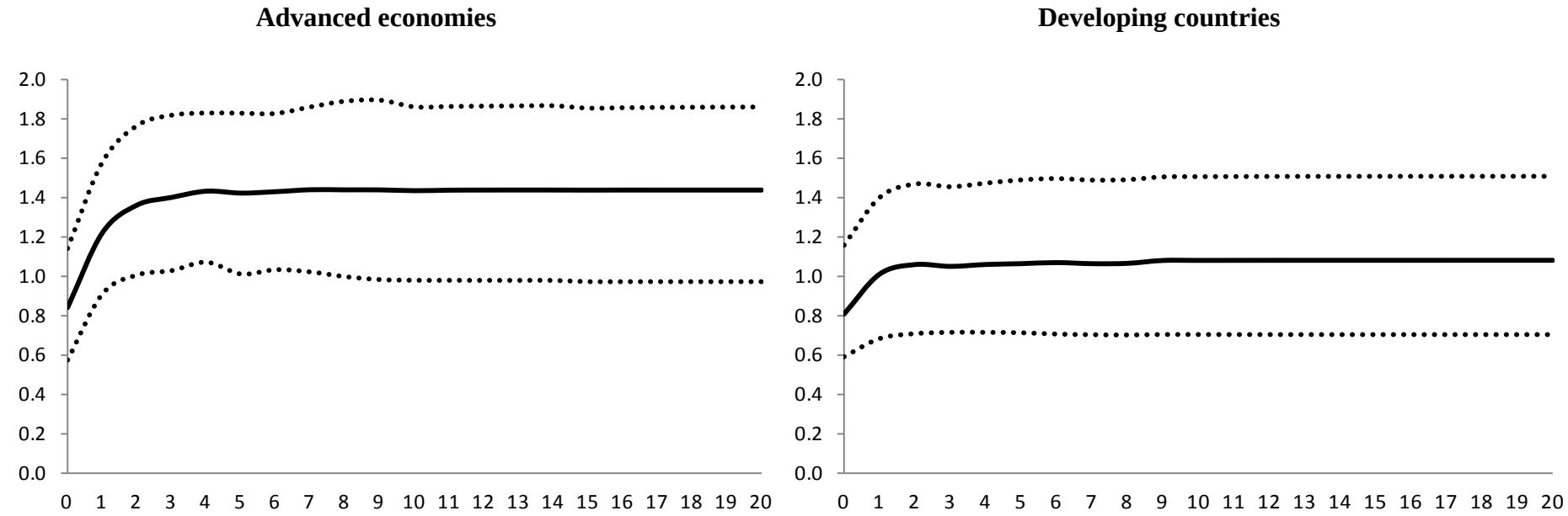
Fig. 2.E8 Cumulative fiscal multipliers in expansionary and recessionary phases of the business cycle (82 country sample); standard SVAR



Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Phases of expansions and contractions obtained from deviation of output from the Hodrick-Prescott trend as a measure of the business cycle. Data available from 1960–2014. Number of observations: Expansions – 1305, Contractions – 1334.

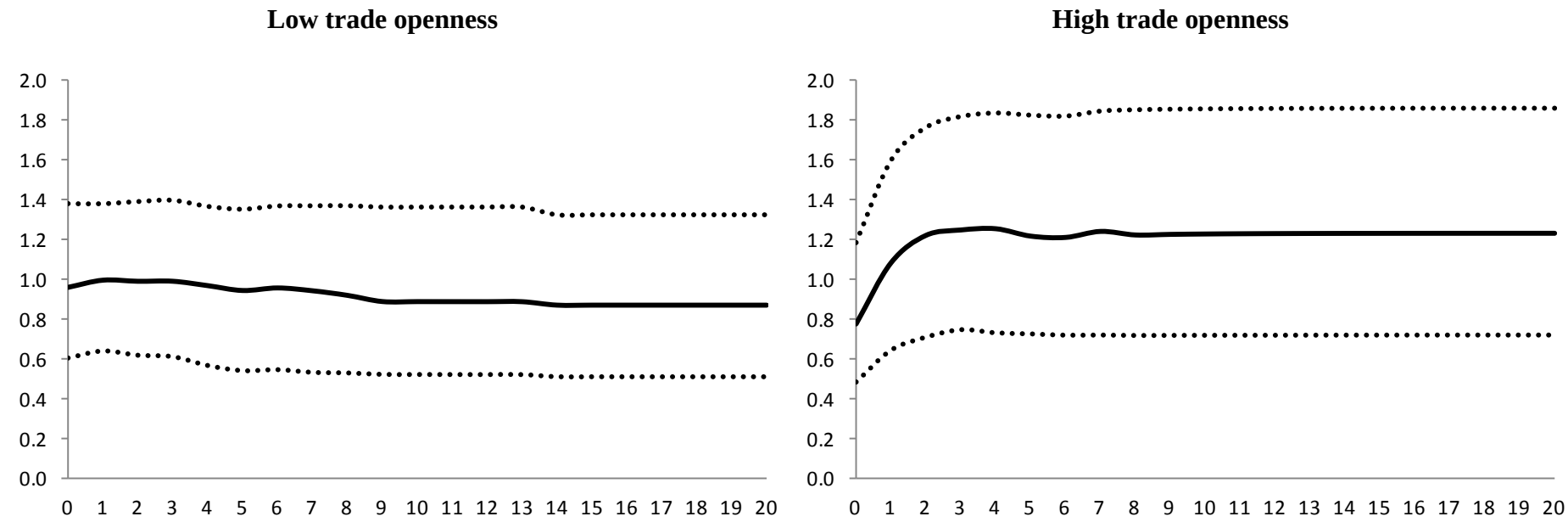
Appendix 2.F – estimated cumulative fiscal multipliers using sign restrictions for 82 countries

Fig. 2.F1 Cumulative fiscal multipliers in advanced and developing countries (82 country sample); sign restrictions



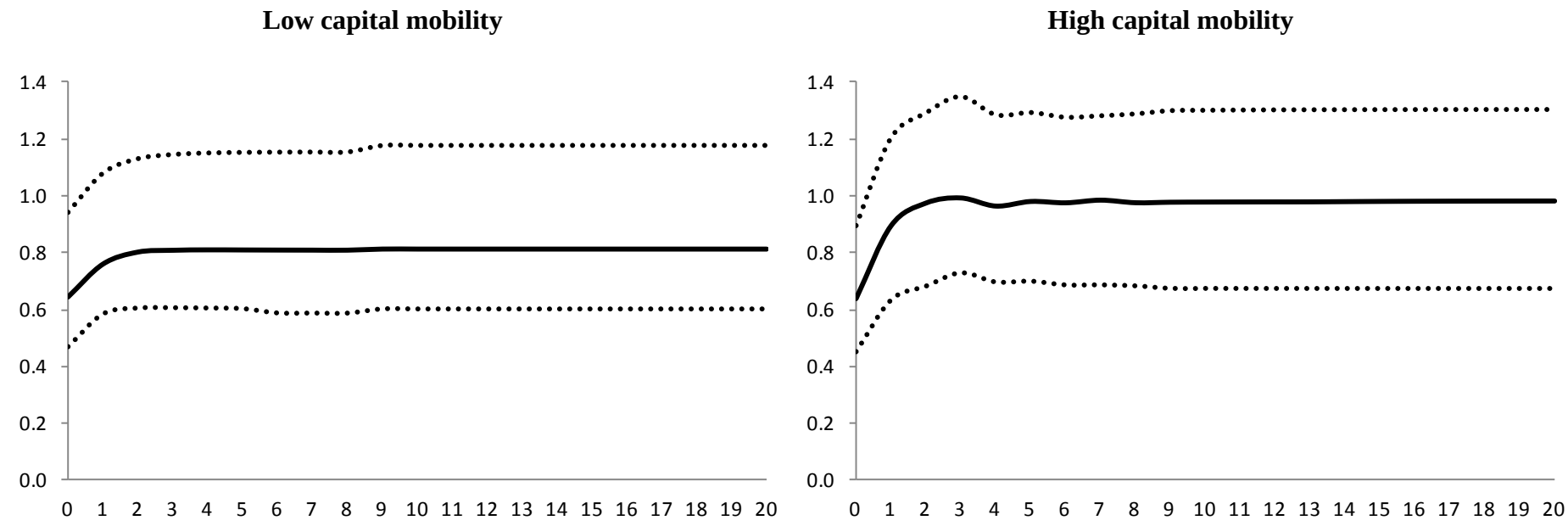
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Definition is based on the World Bank's income classification in 2000. Advanced economies are high-income countries with GNI per capita of $9,266 or more, all others are categorized as developing countries. GNI per capita data available from 1960–2014, obtained from World Development Indicators. Number of observations: Advanced – 855, Developing – 1761.

Fig. 2.F2 Cumulative fiscal multipliers in countries with low and high trade openness (82 country sample); sign restrictions



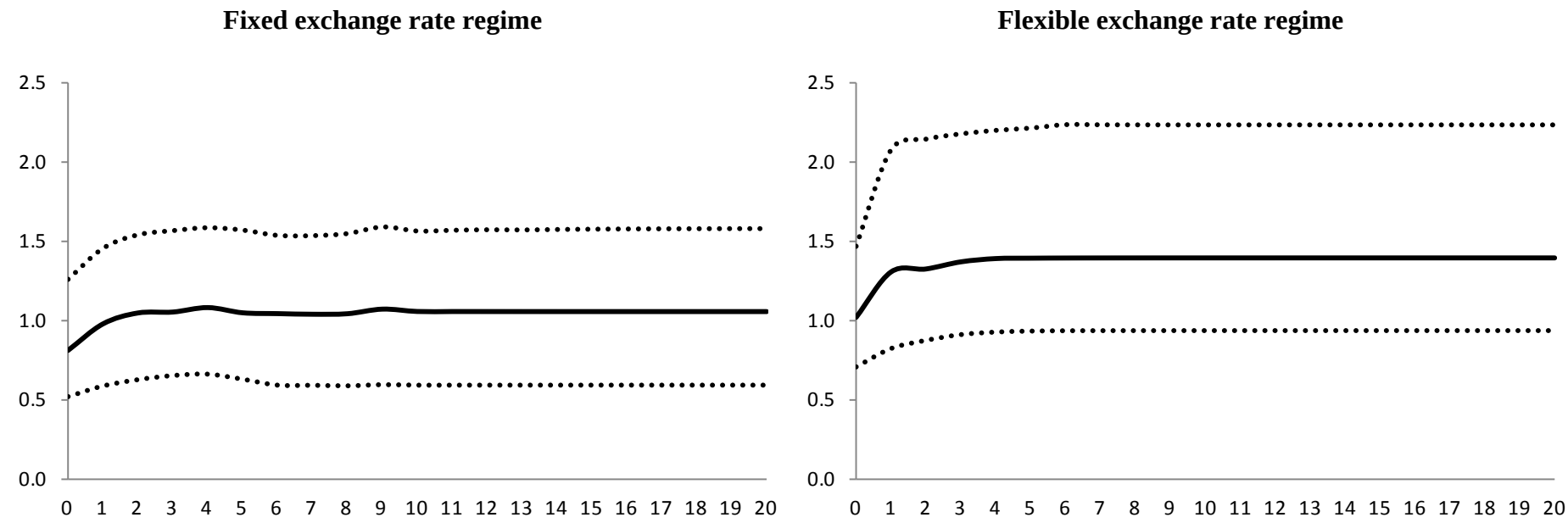
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Countries with trade-to-GDP ratio less than 60% are classified as low trade openness, and high trade openness otherwise. Trade-to-GDP data available from 1960–2014, obtained from World Development Indicators. Number of observations: Low trade openness – 1258, High trade openness – 1358.

Fig. 2.F3 Cumulative fiscal multipliers in countries with low and high international capital mobility (82 country sample); sign restrictions



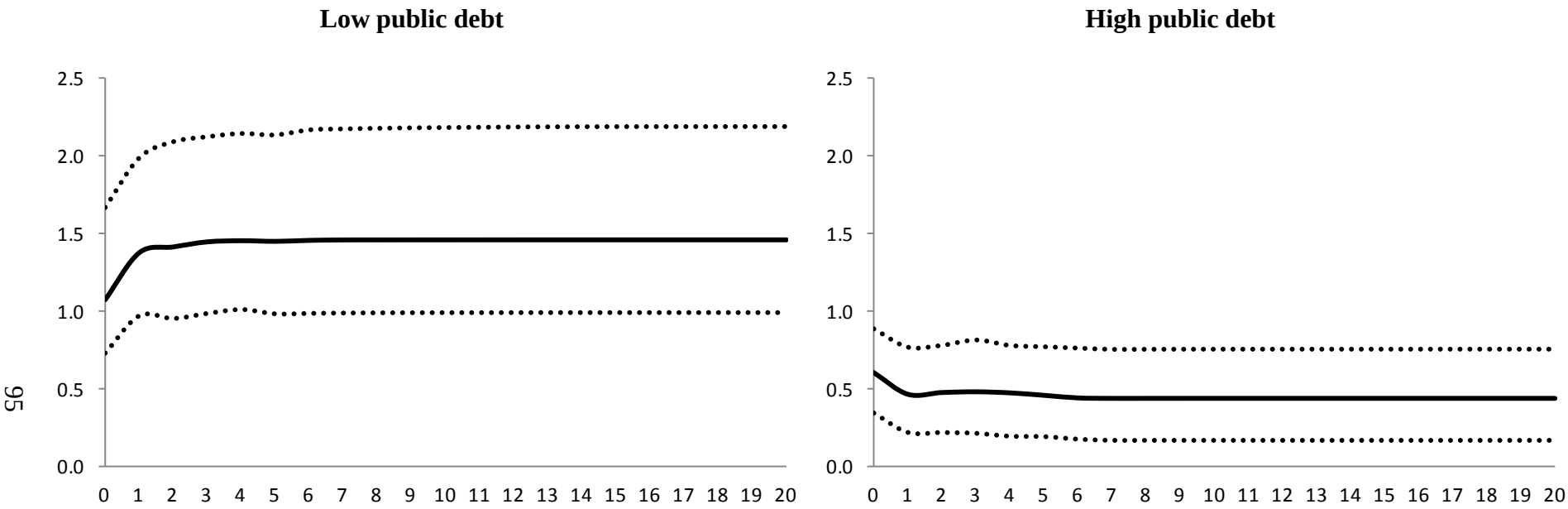
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Countries with a Chinn-Ito capital account openness index (Chinn and Ito, 2006) lower than the global mean are classified as low capital mobility, and high capital mobility otherwise. The Chinn-Ito index data is available from 1970–2014. Number of observations: Low capital mobility – 937, High capital mobility – 1679.

Fig. 2.F4 Cumulative fiscal multipliers in episodes of de facto fixed and flexible exchange rate regimes (82 country sample); sign restrictions



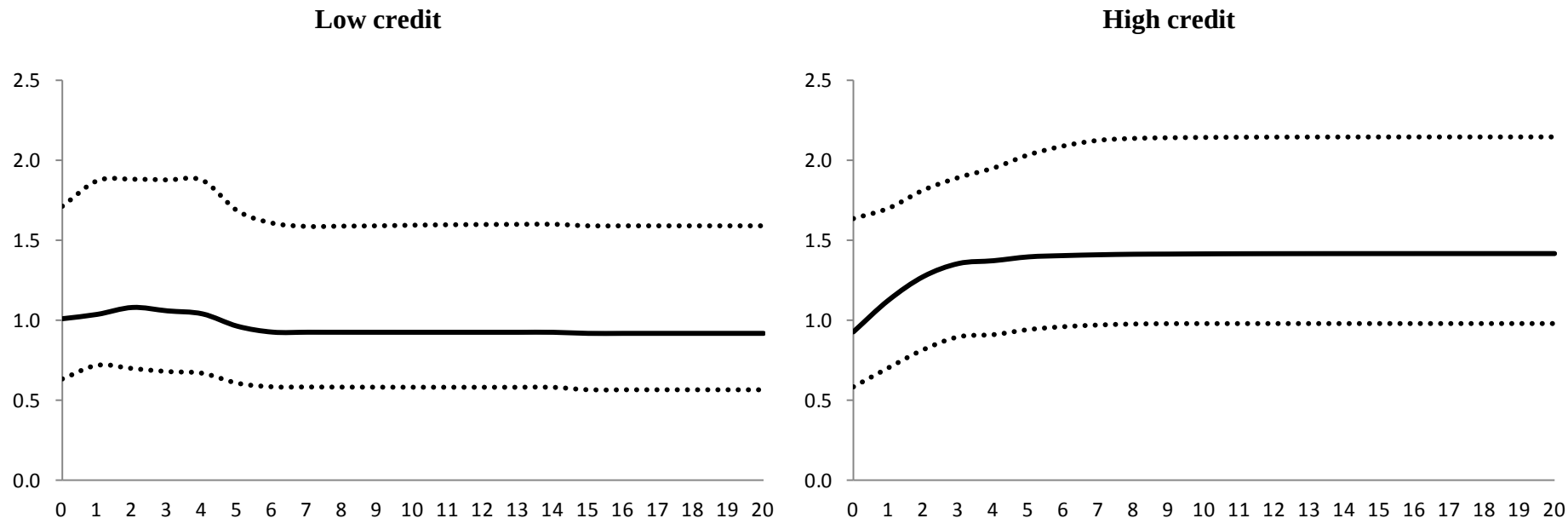
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Episodes coded from 1–8 are classified as fixed regime, and 9–13 as flexible regime. De facto exchange rate regime classification is based on the fine classification in Ilzetzki et al. (2010) with data available from 1960–2010. Number of observations: Fixed regime – 1604, Flexible regime – 591.

Fig. 2.F5 Cumulative fiscal multipliers in episodes of low and high public debt (82 country sample); sign restrictions



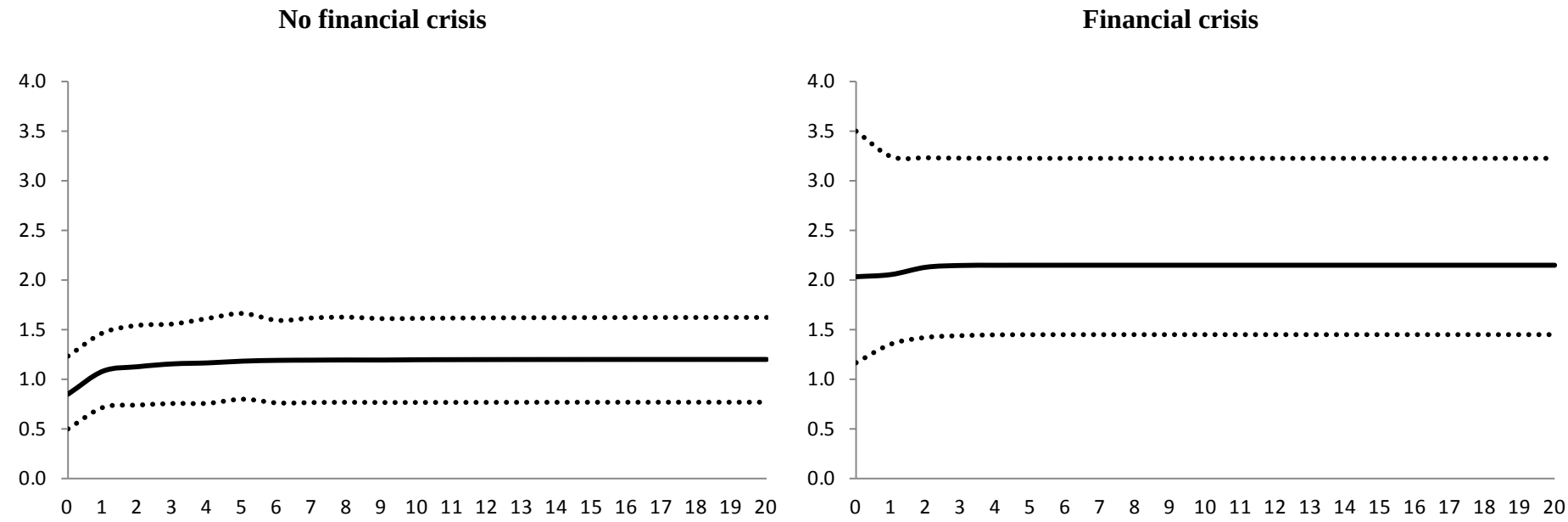
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Episodes with debt-to-GDP ratio exceeding 60% are classified as high debt, and low debt otherwise. Debt-to-GDP data available from 1960–2012, obtained from IMF Historical Public Debt Database. Number of observations: Low debt – 1700, High debt – 691.

Fig. 2.F6 Cumulative fiscal multipliers in episodes of low and high credit (82 country sample); sign restrictions



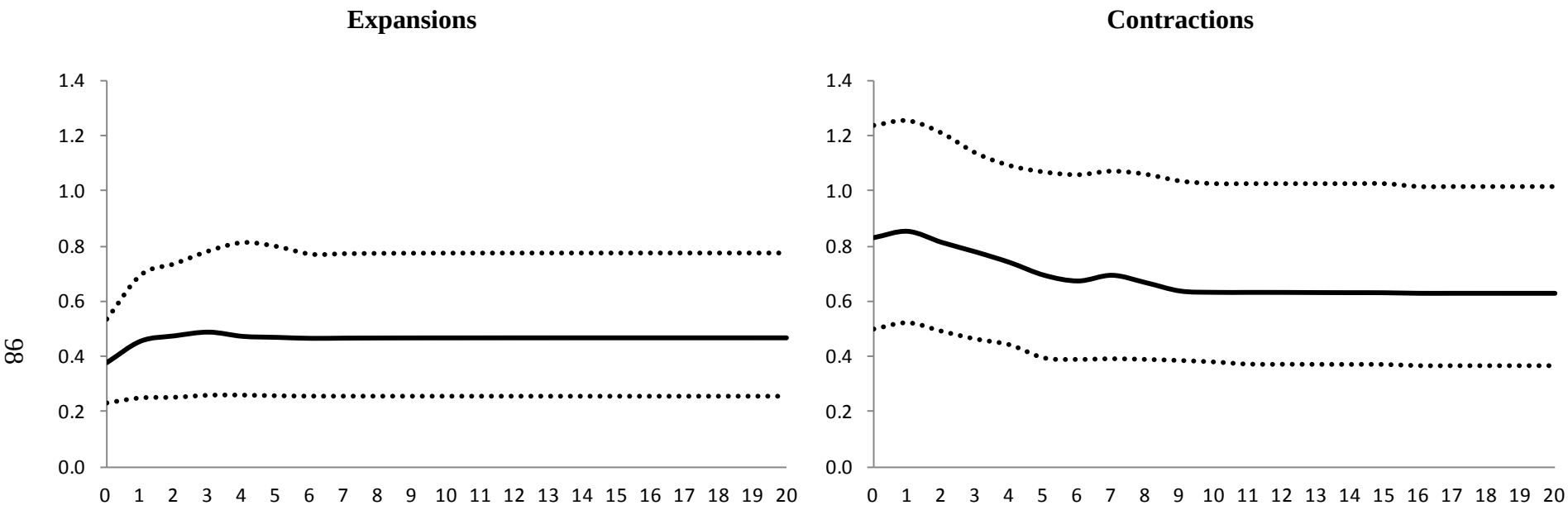
Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Episodes with credit-to-GDP ratio exceeding 50% are classified as high credit, and low credit otherwise. Credit-to-GDP data available from 1960–2014, obtained from World Development Indicators. Number of observations: Low credit – 1523, High credit – 1016.

Fig. 2.F7 Cumulative fiscal multipliers in episodes without and with financial crisis (82 country sample); sign restrictions



Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Episodes with financial crisis are obtained from Reinhart (2010), defined as type I and II banking crisis. Data available from 1960–2010 for a smaller subset of countries. Number of observations: No financial crisis – 1319, Financial crisis – 240.

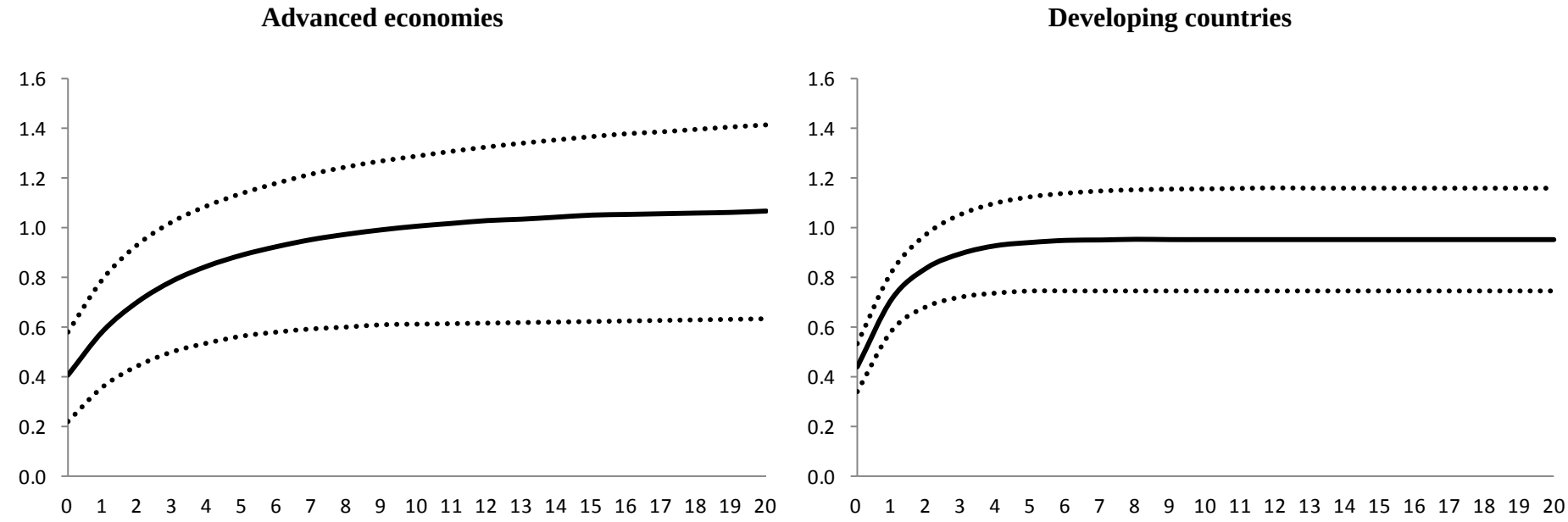
Fig. 2.F8 Cumulative fiscal multipliers in expansionary and recessionary phases of the business cycle (82 country sample); sign restrictions



Notes: Fiscal multipliers are calculated from the impulse responses obtained from an unbalanced panel VAR model with 1,000 sample draws from the posterior distribution satisfying the sign restrictions to identify a fiscal spending shock. The solid line denotes the median fiscal multiplier and the dotted lines are the 16 and 84 percentile values. Phases of expansions and contractions obtained from deviation of output from the Hodrick-Prescott trend as a measure of the business cycle. Data available from 1960–2014. Number of observations: Expansions – 1305, Contractions – 1334.

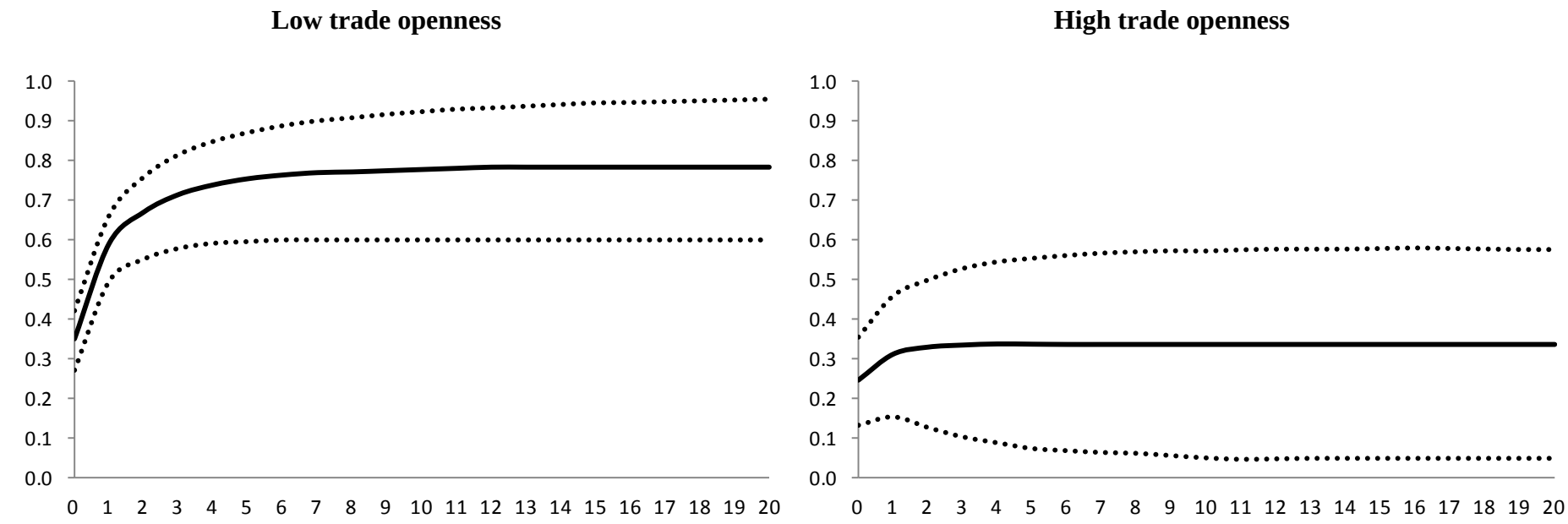
Appendix 2.G – estimated cumulative fiscal multipliers using standard SVAR for 44 countries

Fig. 2.G1 Cumulative fiscal multipliers in advanced and developing countries (Ilzetzki et al.'s (2013) country sample); standard SVAR



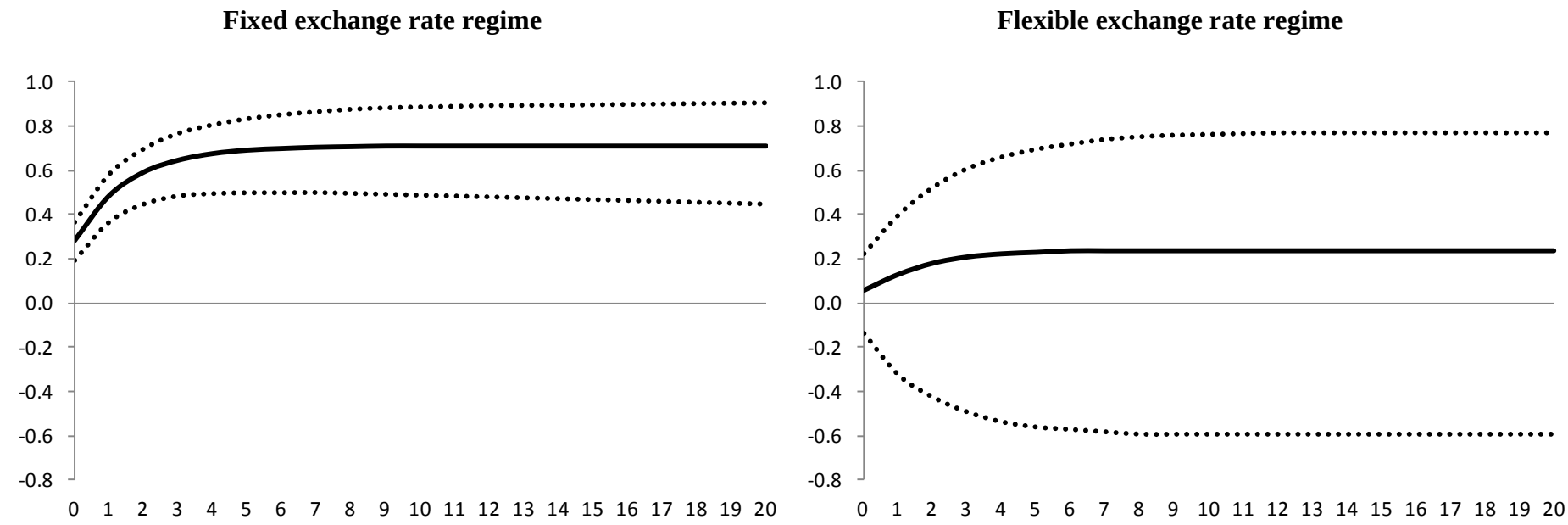
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Definition is based on the World Bank's income classification in 2000. Advanced economies are high-income countries with GNI per capita of $9,266 or more, all others are categorized as developing countries. GNI per capita data available from 1960–2014, obtained from World Development Indicators. Number of observations: Advanced – 635, Developing – 703.

Fig. 2.G2 Cumulative fiscal multipliers in countries with low and high trade openness (Ilzetzki et al.'s (2013) country sample); standard SVAR



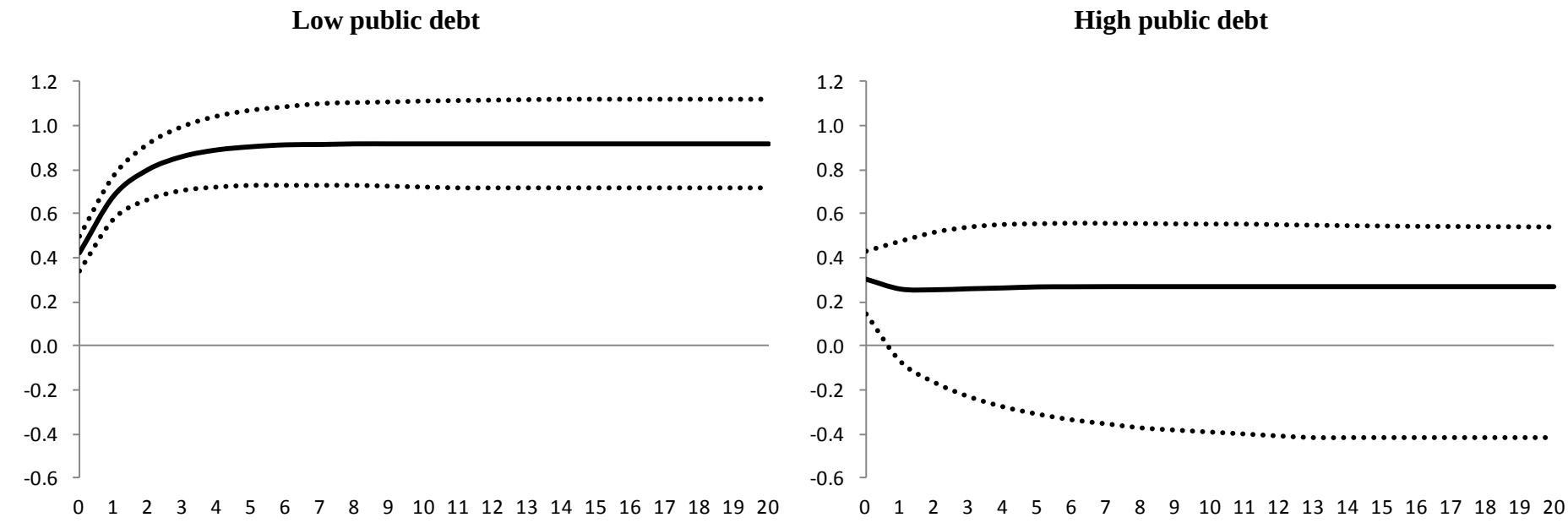
Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Countries with an average trade-to-GDP ratio less than 60% are classified as low trade openness, and high trade openness otherwise. Trade-to-GDP data available from 1960–2014, obtained from World Development Indicators. Number of observations: Low trade openness – 715, High trade openness – 623.

Fig. 2.G3 Cumulative fiscal multipliers in episodes of de facto fixed and flexible exchange rate regimes (Ilzetzki et al.'s (2013) country sample); standard SVAR



Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Episodes coded from 1–8 are classified as fixed regime, and 9–13 as flexible regime. De facto exchange rate regime classification is based on the fine classification in Ilzetzki et al. (2010) with data available from 1960–2010. Number of observations: Fixed regime – 736, Flexible regime – 385.

Fig. 2.G4 Cumulative fiscal multipliers in episodes of low and high public debt (Ilzetzki et al.'s (2013) country sample); standard SVAR



Notes: Fiscal multipliers are calculated from the impulse responses to a government consumption shock obtained from an unbalanced panel VAR model with government consumption ordered before GDP. The solid line denotes the mean fiscal multiplier and the dotted lines are the 95% confidence intervals obtained from 1,000 Monte Carlo repetitions. Episodes with debt-to-GDP ratio exceeding 60% are classified as high debt, and low debt otherwise. Debt-to-GDP data available from 1960–2012, obtained from IMF Historical Public Debt Database. Number of observations: Low debt – 933, High debt – 324.

Chapter 3

Oil price shocks and macroeconomic adjustments in oil-exporting countries

ABSTRACT

This paper examines the macroeconomic effects of an adverse oil price shock under different exchange rate and fiscal policy arrangements in 40 oil-exporting countries from 1973 to 2010 using panel vector autoregression techniques. The results show that output and government consumption fall in response to an oil price decline. However, the output response is significantly smaller and smoother in countries with flexible exchange rate regimes due to a larger and immediate real exchange rate depreciation. There is also less need for contractionary fiscal policy as the real depreciation appears to play a sufficient dampening role. In contrast, countries with fixed exchange rate regimes experience a small and delayed real depreciation, leaving fiscal policy to bear the bulk of the macroeconomic adjustments costs. Nevertheless, the presence of oil funds in these countries is associated with smaller fiscal spending cuts and hence a reduced output fall. These findings highlight the shock-absorbing property of flexible exchange rates and the potential macroeconomic stabilization role of oil funds in insulating against adverse oil price movements, making a case for oil exporters to adopt more flexible exchange rate regimes and establish oil funds as fiscal buffers.

3.1 Introduction

Crude oil prices have fallen from around US$110 per barrel in June 2014 to US$45 per barrel as of September 2016. The sources of this oil price plunge can be attributed to several factors: weak global demand especially from China and Europe; a supply glut following the boom in U.S. shale oil production; relatively little supply disruptions despite geopolitical tensions and sanctions in the Middle East and Russia; OPEC's decision in November 2014 to maintain production levels at 30 million barrels per day; and the appreciation of the U.S. dollar (Baffes et al., 2015). Many oil-exporting countries are vulnerable to oil price declines since oil accounts for a large proportion of total exports and government revenue. These countries are likely to experience significant economic and political pressures from a continuing oil price fall. With projected fiscal break-even prices in 2016 ranging from US$48 per barrel for Kuwait to US$364 per barrel for Yemen (IMF, 2016c), the fiscal deficits necessitate abrupt macroeconomic adjustments in the short term.

The macroeconomic effects of the oil price decline will depend on monetary and fiscal arrangements (see Arezki and Blanchard, 2014). Oil-exporting countries with flexible exchange rate regimes can adjust through currency depreciations, though there are risks of uncontrolled depreciations and persistent high inflation. A case in point is Russia: the Ruble has depreciated by more than 80% against the U.S. dollar between June 2014 and Septermber 2016, partially offsetting the decline in oil prices.[13] For those with rigid exchange rate regimes such as a peg to the U.S. dollar, monetary policy is constrained and fiscal policy therefore bears the burden of macroeconomic stabilization. These countries require substantial fiscal spending cuts particularly if there are insufficient fiscal buffers such as oil funds. For instance, Saudi Arabia's peg to the U.S. dollar amidst falling oil prices will translate to budget deficits; however, it has accumulated a stockpile of foreign currency, which can be used to finance the deficits.

Economic theory dating back to Friedman (1953) and Poole (1970) suggests that a flexible exchange rate regime allows a smoother output adjustment to real shocks through changes in the nominal exchange rate. In contrast, a fixed exchange rate regime

[13] Russia had operated on a managed float since 1999 but transitioned to a free floating regime in November 2014, earlier than originally planned, partly as a result of the sharp fall in oil prices.

requires a contractionary monetary policy to maintain the peg and all adjustment therefore takes place in the real economy at a rate permitted by nominal stickiness. In a related strand of research, the 'commodity currency' literature emphasizes a generally robust exchange rate response to commodity price shocks, especially in countries with a flexible exchange rate (e.g., Chen and Rogoff, 2003; Cashin et al., 2004; Bodart et al., 2012). Several economists have advocated that oil-exporting countries adopt flexible exchange rate regimes to better insulate against oil price shocks (e.g., Frankel, 2005; Setser, 2008). Although the empirical validity of the insulating property of flexible exchange rates has not been specifically assessed for oil-exporting countries, there are a handful of related studies. Broda (2004) and Edwards and Levy Yeyati (2005) examine the impact of terms of trade shocks in developing countries while Hoffmann (2007) focuses on the effects of world interest rate and output shocks; Céspedes and Velasco (2011) examine the effects of commodity price shocks in commodity exporters; Rafiq (2011) analyses the impact of various macroeconomic shocks in GCC countries; Chia et al. (2012) examines the impact of terms of trade and foreign interest rate shocks in Asian countries; and Al-Abri (2013) investigates the effects of oil price shocks in OECD countries. These studies provide evidence of the shock-absorbing property of flexible exchange rates but earlier studies suggest otherwise (e.g., Baxter and Stockman, 1989; Ghosh et al., 1997).

A policy prescription usually advocated for oil exporters to reduce the extent of fiscal procyclicality and macroeconomic volatility is to set up oil funds, which gained popularity from the late 1990s. By channelling surplus oil revenues to the oil funds during booms and running down the funds during cyclical downturns to finance budget deficits, governments can smooth fiscal expenditure and reduce macroeconomic volatility. However, the empirical evidence on the effectiveness of oil funds (or more generally, resource funds) as a macroeconomic stabilization tool is mixed. Davis et al. (2001), Crain and Devlin (2003), and Ossowski et al. (2008) do not find any convincing evidence that these funds are effective; in contrast, Shabsigh and Ilahi (2007), Coutinho et al. (2014), Sugawara (2014), and Asik (2015) conclude that they are useful in reducing fiscal procyclicality and/or macroeconomic volatility.

The objective of this paper is to examine the macroeconomic effects of an adverse oil price shock under different exchange rate (fixed vs. flexible) and fiscal (no oil funds

vs. with oil funds) policy in oil-exporting countries using panel vector autoregression (VAR) techniques. In particular, the main policy questions of interest are whether oil exporters can indeed be better off by adopting a flexible exchange rate, and if establishing oil funds further contribute to smoother output adjustment. In the existing empirical literature, these policy issues are usually treated in isolation—the focus is either on the insulating properties of flexible exchange rate regimes or on the macroeconomic stabilization role of oil funds. A key contribution of this paper is thus to link both exchange rate and fiscal policy in oil-exporting countries in a coherent empirical framework. This paper also includes a more comprehensive coverage of 40 oil-exporting countries and uses a more updated data set covering the post-Bretton Woods period from 1973 to 2010 based on the de facto exchange rate classification by Ilzetzki et al. (2010).

The remainder of this paper is organized as follows. Section 3.2 describes the data and methodology. Section 3.3 presents the empirical results on the macroeconomic effects of an adverse oil price shock in fixed and flexible exchange rate regimes. Section 3.4 extends the analysis to examine the role of oil funds, and Section 3.5 concludes.

3.2 Data and methodology

3.2.1 Classification of exchange rate regimes and oil funds

The sample of oil-exporting countries is selected based on the following criteria: net oil exports of at least 50 thousand barrels per day; or share of oil exports in total exports of at least 30%; or oil exports as a percentage of GDP of at least 20%; or oil rents as a percentage of GDP of at least 20%. This ensures that all significant oil exporters are included, which minimizes selection bias. Table 3.A1 in Appendix 3.A lists the 40 countries, of which 36 are emerging and developing countries.[14]

It is now widely acknowledged that there is considerable disparity between de jure and de facto exchange rate regimes, i.e., between what countries say and what they do (see Calvo and Reinhart, 2002; Levy Yeyati and Sturzenegger, 2005). Empirical

[14] Timor-Leste and Turkmenistan also satisfy the criteria but are excluded as their exchange rate regimes are not properly classified as either fixed or flexible; see Ilzetzki et al. (2010).

analyses using de jure classifications risk yielding misleading results (see Rogoff et al., 2004). There are three well-established approaches to classify a country's de facto exchange rate regime: Ilzetzki et al. (2010), which updates Reinhart and Rogoff (2004) and is largely based on the behaviour of parallel, market-determined exchange rates; Levy Yeyati and Sturzenegger (2005), which uses cluster analysis; and Klein and Shambaugh (2006), which is a modification of Shambaugh (2004) based on whether the official exchange rate stays within a two percent band against the base currency.[15] The main exchange rate regime classification used in this paper is based on Ilzetzki et al. (2010) as the data is updated to 2010; the other two classifications are included as robustness checks.

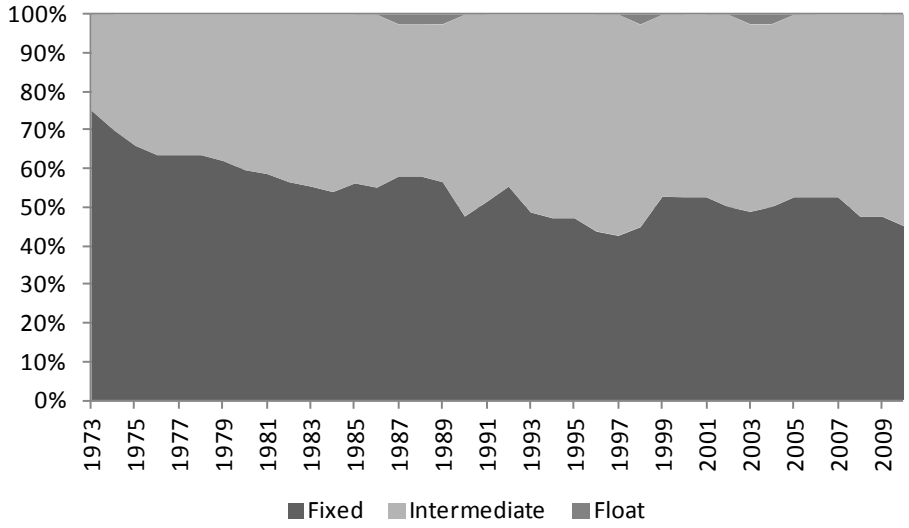
Figure 3.1 displays the distribution of exchange rate regimes in the 40 oil-exporting countries covering the post-Bretton Woods period from 1973 to 2010 based on the coarse classification of Ilzetzki et al. (2010). Most oil exporters either have a fixed or an intermediate exchange rate regime; very few actually float freely. As such, the analysis in this paper is constrained to a fixed versus flexible (intermediate and float) exchange rate regime instead of a more nuanced tripartite regime classification.

Oil funds fall under the umbrella of sovereign wealth funds (SWFs). Data from the Sovereign Wealth Fund Institute shows the total asset size of SWFs to be about US$7.4 trillion as of June 2016, of which 57% are oil and gas funds (SWFI, 2016). Oil funds are typically set up with the objective of either saving for the future to address issues with regards to fiscal sustainability and intergenerational equity, or to smooth fiscal expenditure and stabilize macroeconomic volatility.[16] Table 3.1 lists the oil-exporting countries and their oil funds' establishment year. In 1990 only seven oil exporters have set up oil funds; this number grew to 18 in 2000 and there are now 31 oil-exporting countries with oil funds.

[15] See Tavlas et al. (2008) for a summary of these approaches, and also references on other exchange rate classifications.

[16] Oil funds with a stated savings objective usually also allow discretionary transfers to the budget to smooth expenditures during the down cycle. Most oil funds have dual objectives of savings and stabilization.

Fig. 3.1 Exchange rate regime classifications of oil-exporting countries from 1973 to 2010 based on Ilzetzki et al. (2010)



Notes: Fixed is based on coarse class 1 (hard pegs and de facto peg); Intermediate combines coarse classes 2 and 3 (crawling pegs, bands and managed float); Float is coarse class 4 (freely floating); Coarse classes 5 (freely falling) and 6 (dual market with parallel market data missing) are excluded. See Ilzetzki et al. (2010) for details.

Table 3.1 Oil-exporting countries and oil funds

No oil funds	**With oil funds**		
Argentina	Algeria (2000)	Gabon (1998)	Qatar (2005)
Congo, Rep.	Angola (2012)	Iran, Islamic Rep. (2000)	Russian Federation (2004)
Denmark	Azerbaijan (1999)	Iraq (2003)	Saudi Arabia (1952)
Egypt, Arab Rep.	Bahrain (2006)	Kazakhstan (2000)	Sudan (2002)
Indonesia	Brunei Darussalam (1983)	Kuwait (1953)	Trinidad and Tobago (2000)
Malaysia	Cameroon (1974)	Libya (2006)	United Arab Emirates (1976)
Syrian Arab Rep.	Canada (1976)	Mexico (2000)	Venezuela, RB (1998)
Tunisia	Chad (1999–2006)	Nigeria (2004)	
United Kingdom	Colombia (1995)	Norway (1990)	

Vietnam	Ecuador (2002)	Oman (1980)
Yemen, Rep.	Equatorial Guinea (2002)	Papua New Guinea (2011)

Source: Tsani (2013), SWFI (2016), Truman (2008).

Notes: Establishment year of the oil fund is in parenthesis. The oil fund in Chad was abolished in 2006.

3.2.2 Variables and data sources

Since the primary objective of this paper is to examine the macroeconomic adjustments in oil-exporting countries under different exchange rate regimes and fiscal policy arrangements in response to an adverse oil price shock, the variables of interest and expressed in natural logarithms are the real oil price (o), real GDP (y), real government consumption (g), consumer price (p), and the real exchange rate (q). Annual data covering the post-Bretton Woods period from 1973 to 2010 is used, but data availability varies by country (i.e., the panel is unbalanced). The variables and data sources are summarized in Table 3.A2 in Appendix 3.A.

Government consumption is chosen to characterize a country's fiscal stance following the arguments in Kaminsky et al. (2004) that the fiscal variable should be instruments within policymakers' control. According to Ilzetzki and Végh (2008), there are two key fiscal policy instruments—government consumption (as opposed to government spending, which also includes transfers and debt service) and tax rates (as opposed to tax revenues, which depend on the business cycle). However, tax rates are not readily available for most countries.

Results of the Im-Pesaran-Shin (IPS) panel unit root test (see Im et al., 2003) for the variables are shown in Table 3.2. The test allows for unbalanced panels. The null hypothesis that all panels contain a unit cannot be rejected when the variables are in log levels. However, when taking first log differences, evidence of stationarity is clear. Table 3.3 displays the results of the panel cointegration tests developed by Westerlund (2007). All four tests fail to reject the null hypothesis of no cointegration among the variables. Therefore, based on the panel unit root and cointegration test results, variables in log differences are used in the empirical analysis using panel VAR techniques.

Table 3.2 Im-Pesaran-Shin (IPS) panel unit root test

Variable	Z-t-tilde bar statistic	p-value	Variable	Z-t-tilde bar statistic	p-value
o	8.94	1.00	Δo	-19.59	0.00
y	22.87	1.00	Δy	-14.26	0.00
g	22.13	1.00	Δg	-16.85	0.00
p	20.28	1.00	Δp	-10.47	0.00
q	-0.82	0.21	Δq	-15.46	0.00

Notes: H_o: All panels contain unit roots, H_a: Some panels are stationary.

Table 3.3 Westerlund panel cointegration tests

Variables	Gt		Ga		Pt		Pa	
	Z-value	p-value	Z-value	p-value	Z-value	p-value	Z-value	p-value
o, y, g, p, q	7.62	1.00	9.95	1.00	9.91	1.00	8.35	1.00

Notes: The Gt and Ga statistics test H_o: $\varphi_i = 0$ for all i vs. H_a: $\varphi_i < 0$ for at least i, starting from a weighted average of the individually estimated coefficients φ_i and their t-ratios respectively. Rejection of H_o implies existence of a cointegrating relationship for at least one of the cross-sectional units. The Pt and Pa statistics test H_o: $\varphi_i = 0$ for all i vs. H_a: $\varphi_i < 0$ for all i, using the pooled information over all cross-sectional units. Rejection of H_o is taken as evidence of cointegration for the whole panel. The tests includes a constant and trend. Results are obtained using the Stata codes *xtwest* by Persyn and Westerlund (2008).

3.2.2 Panel VAR estimation

Besides selection bias and selecting the appropriate fiscal policy variable (addressed by including a large sample of oil exporters and using government consumption respectively), other empirical challenges involved in robustly determining the importance of exchange rate regimes and oil funds in the macroeconomic adjustments of oil-exporting countries are unobserved heterogeneity and endogeneity. The choice of exchange rate regime and the decision to establish an oil fund are not random events but could possibly be due to time-invariant country-specific unobserved characteristics. In addition, endogeneity issues could arise, for example, due to potential reverse causality of fiscal policy and GDP. To address these empirical concerns, this paper uses the panel VAR methodology which combines the conventional VAR approach that treats all

variables as endogenous, with the dynamic panel data estimation approach that allows for unobserved heterogeneity, first employed in Holtz-Eakin et al. (1988).

The reduced-form panel VAR specification is of the form:

$$Z_{i,t} = \Gamma_0 + \Gamma_1 Z_{i,t-1} + f_i + \varepsilon_{i,t} \tag{3.1}$$

where $Z_{i,t}$ is the vector of endogenous variables $\left[\Delta o_{i,t}, \Delta y_{i,t}, \Delta g_{i,t}, \Delta p_{i,t}, \Delta q_{i,t}\right]'$ for country i in year t, Γ_0 is the vector of intercepts, Γ_1 is the coefficient matrix of the lagged variables, f_i denotes time-invariant country fixed effects, and $\varepsilon_{i,t}$ is the vector consisting of the error terms that are assumed to be uncorrelated across i and t. In view of the annual data frequency, only one lag is included in the specification; results remain unchanged with two lags.

Implementing the VAR procedure on panel data requires imposing the restriction that the same underlying structure holds for each cross-sectional unit (country), i.e., the coefficients in the matrix Γ_1 are the same for all countries. This constraint is usually violated in practice; a way to overcome this is to introduce fixed effects, which allows for individual heterogeneity (Love and Zicchino, 2006). The conventional mean-difference procedure that is commonly used to remove fixed effects might lead to biased coefficient estimates since the fixed effects are correlated with the lagged dependent variables, which gives rise to the problem of 'dynamic panel bias' (Nickell, 1981), and hence ordinary least squares (OLS) estimation is inappropriate. A solution to the problem is to take the first differences of each equation in the model in eq. (3.1), which removes both the constant term and the individual effect. However, the differenced lagged dependent variables are still correlated with the error terms. But with the fixed effects swept out, a straightforward method is to construct instrument variables using the twice lagged dependent variables and estimate using two-stage least squares (2SLS) (see Anderson and Hsiao, 1982).

However, a problem with the first-difference approach in the case of the application in this paper is that it magnifies gaps in unbalanced panels (Roodman, 2009). For instance, if $y_{i,t}$ is missing in the data, then $\Delta y_{i,t}$ and $\Delta y_{i,t+1}$ are also missing in the transformed data. A procedure known as the Helmert transformation of forward mean-differencing, or forward orthogonal deviations, is applied to avoid this problem (see

Arellano and Bover, 1995). Instead of subtracting the previous observation of a variable in the first-difference approach, the Helmert procedure subtracts the average of all the future observations and thus preserves the sample size in panels with gaps.

More specifically, let $\bar{z}_{i,t} = \sum_{s=t+1}^{T_i} \frac{z_{i,s}}{(T_i - t)}$ denote the means obtained from the future values of $z_{i,t}$, which is a variable in the vector $Z_{i,t}$, and T_i is the last year of a country's time series. The transformed variable is thus:

$$z_{i,t}^{*} = c_{i,t}(z_{i,t} - \bar{z}_{i,t}) \tag{3.2}$$

where $c_{i,t} = \sqrt{\frac{T_i - t}{T_i - t + 1}}$ is the weight used to equalize variances. The error term $\varepsilon_{i,t}$ also undergoes a similar transformation:

$$\varepsilon_{i,t}^{*} = c_{i,t}(\varepsilon_{i,t} - \bar{\varepsilon}_{i,t}) \tag{3.3}$$

The final transformed panel VAR takes the form:

$$Z_{i,t}^{*} = \Gamma_1 Z_{i,t-1}^{*} + \varepsilon_{i,t}^{*} \tag{3.4}$$

This procedure also preserves the orthogonality between the transformed variables and the lagged regressors. Since the lagged observations do not enter the formula, they can be used as instruments to estimate the coefficients consistently by generalized method of moments (GMM).

In a panel VAR context, the focus is on the dynamic impulse responses of the variables in response to shocks. Specifically in this paper, the interest is in the macroeconomic adjustments in response to an adverse oil price shock. The key identification assumption is that domestic variables do not have an immediate influence on global oil prices. This assumption might be challenged by some based on the premise that the OPEC is an effective cartel in controlling oil prices by coordinating oil production. However, there is no evidence of OPEC demonstrating such influence (Kilian, 2014).[17] It is important to note that domestic variables can affect the global oil price after a lag, which differs from the exogeneity assumption imposed in studies on

[17] According to Kilian (2009), oil price shocks have historically been driven mainly by global aggregate demand and precautionary demand shocks rather than oil supply shocks.

terms of trade shocks (e.g., Broda, 2004; Chia et al., 2012). The variables are therefore recursively ordered as follows: changes in real oil price (Δo) is ordered first, followed by real GDP growth (Δy), real government consumption growth (Δg), inflation (Δp), and real exchange rate changes (Δq). As the analysis focuses on the effects of oil price shocks, the ordering of the other variables is immaterial.

3.3 Flexible exchange rates as shock absorbers

3.3.1 Dynamic impulse responses to an adverse oil price shock

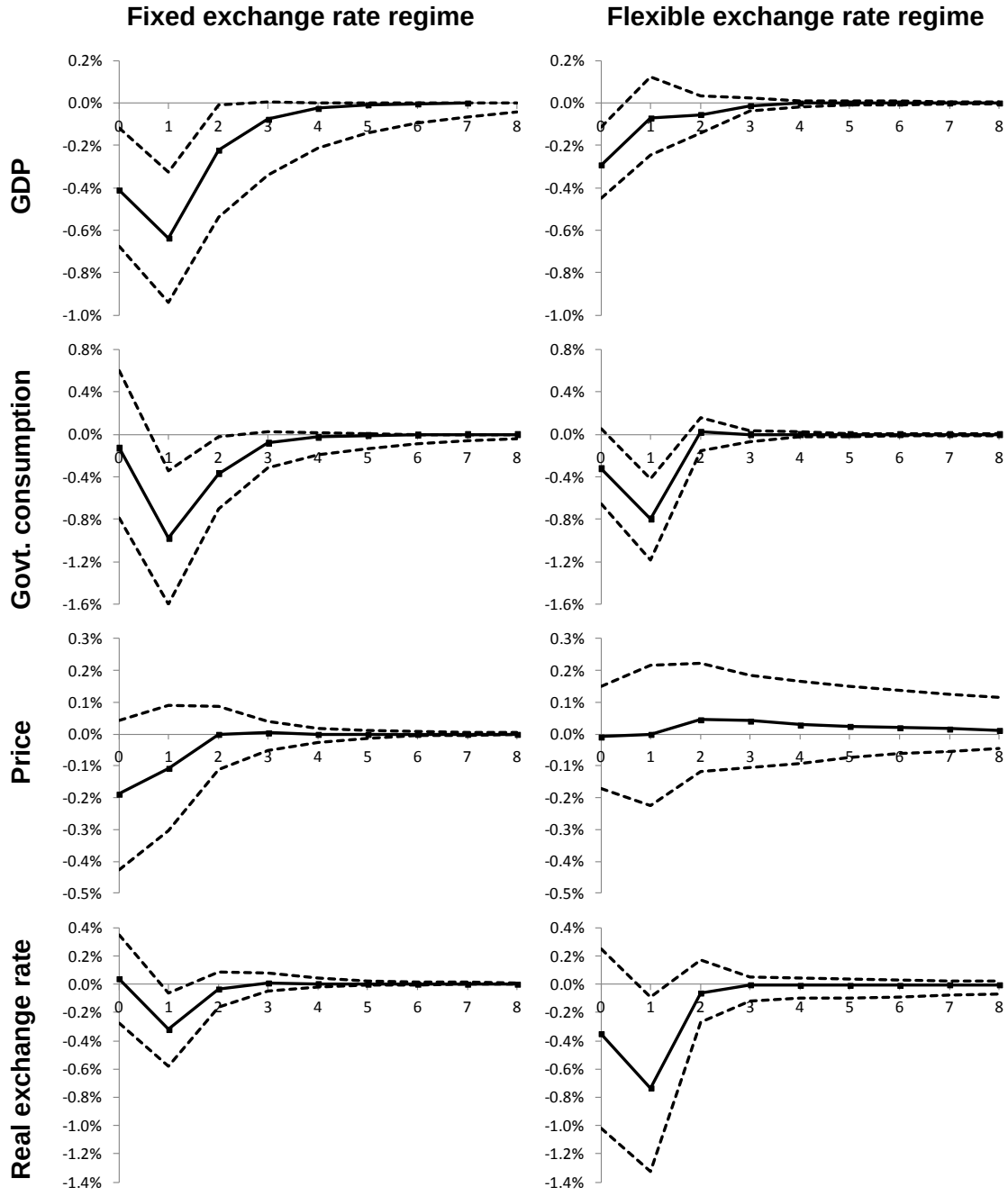
To examine whether the macroeconomic adjustments in oil-exporting countries differ across exchange rate regimes in response to an adverse oil price shock, the country-year observations are split into two groups: one in which the countries operate under a fixed exchange rate regime and the other under a flexible exchange rate regime.[18] Therefore the coefficients of the variables in the panel VAR estimation, Γ_1 in eq. (3.1), are allowed to differ across exchange rate regimes. In addition, to avoid the influence of changing exchange rate regimes, only observations with the same exchange rate regime over at least three consecutive years are included. This is a standard rule of thumb in the literature (e.g., Broda, 2004; Hoffmann, 2007).

Figure 3.2 displays the dynamic impulse responses of the variables under fixed and flexible exchange rate regimes following an oil price shock normalized to negative 10% to allow comparison between the two groups and also for ease of interpretation of the results. The solid lines are the impulse responses while the dotted lines represent two standard deviation error bands. In response to an adverse oil price shock, real GDP falls under both fixed and flexible exchange rate regimes, but the magnitudes and adjustment speeds are clearly different. Under a fixed regime, real GDP falls by 0.4% on impact and reaches a peak of more than 0.6% after the first year before the effect gradually dissipates. In contrast, real GDP contracts by 0.3% under a flexible regime and the negative effect is statistically significant only on impact. Real government consumption falls under both exchange rate regimes, by 1% in with fixed exchange rates at its peak after a year and by and 0.8% for flexible exchange rates, as governments cut back fiscal

[18] This is akin to assigning dummy variables for fixed and flexible regimes in the panel VAR specification.

spending in response to lower accrued oil revenues, indicating procyclical fiscal policy as documented in other studies on oil-exporting countries (e.g., Erbil, 2011).

Fig. 3.2 Impulse responses to a -10% oil price shock under fixed and flexible exchange rate regimes



Notes: Solid lines are the point estimates of the impulse responses. Dotted lines represent error bands of two standard deviations (5th and 95th percentile) generated using Monte Carlo with 1,000 replications. Exchange rate classification is based on Ilzetzki et al. (2010); sample period 1973–2010.

The differences in the output response across the exchange rate regimes can be explained by the response of the real exchange rate. With a fixed exchange rate regime, nominal exchange rates remain unchanged and the small real depreciation of 0.3%, after a one period lag, is achieved through a decrease in domestic prices. However, with flexible exchange rate regimes, the real exchange rate depreciates immediately by 0.4% and peaks at 0.8% after a year through a nominal depreciation, which partially offsets the adverse effects of an adverse oil price shock that necessitates a reduction in real government consumption. This finding is evidence of the shock-absorbing property of flexible exchange rates.

Table 3.4 shows the statistical tests (t-test) of the null hypothesis that the coefficients of (negative) oil price changes are equal under both fixed and flexible exchange rate regimes.[19] The different macroeconomic adjustments in the responses of real GDP and the real exchange rate are confirmed in the statistical test results.

Table 3.4 Coefficients of oil price changes (negative) under fixed and flexible exchange rate regimes in various classifications

Classification	Regime	Δy	Δg	Δp	Δq
IRR	Fixed	-0.0488	-0.0640	-0.0063	-0.0279
	Flexible	0.0006***	-0.0803	-0.0008	-0.0736^
LYS	Fixed	-0.0381	-0.0560	-0.0128	0.0033
	Flexible	-0.0114^	-0.0530	0.0283	-0.1418**
KS	Fixed	-0.0442	-0.0629	-0.0044	0.0089
	Flexible	-0.0336	-0.0734	0.0109	-0.1572***

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal. ***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively. IRR – Ilzetzki et al. (2010), sample period 1973–2010; LYS – Levy Yeyati and Sturzenegger (2005), sample period 1973–2004; KS – Klein and Shambaugh (2006), sample period 1973–2004.

[19] Since the panel VAR estimation consists of only one lag, a t-test can be used to test the null hypothesis that the coefficients under fixed and flexible exchange rate regimes are the same. For two or more lags, a F-test or Wald test can be used to test the null hypothesis that the coefficients in all the lags are the same.

3.3.2 Alternative exchange rate regimes

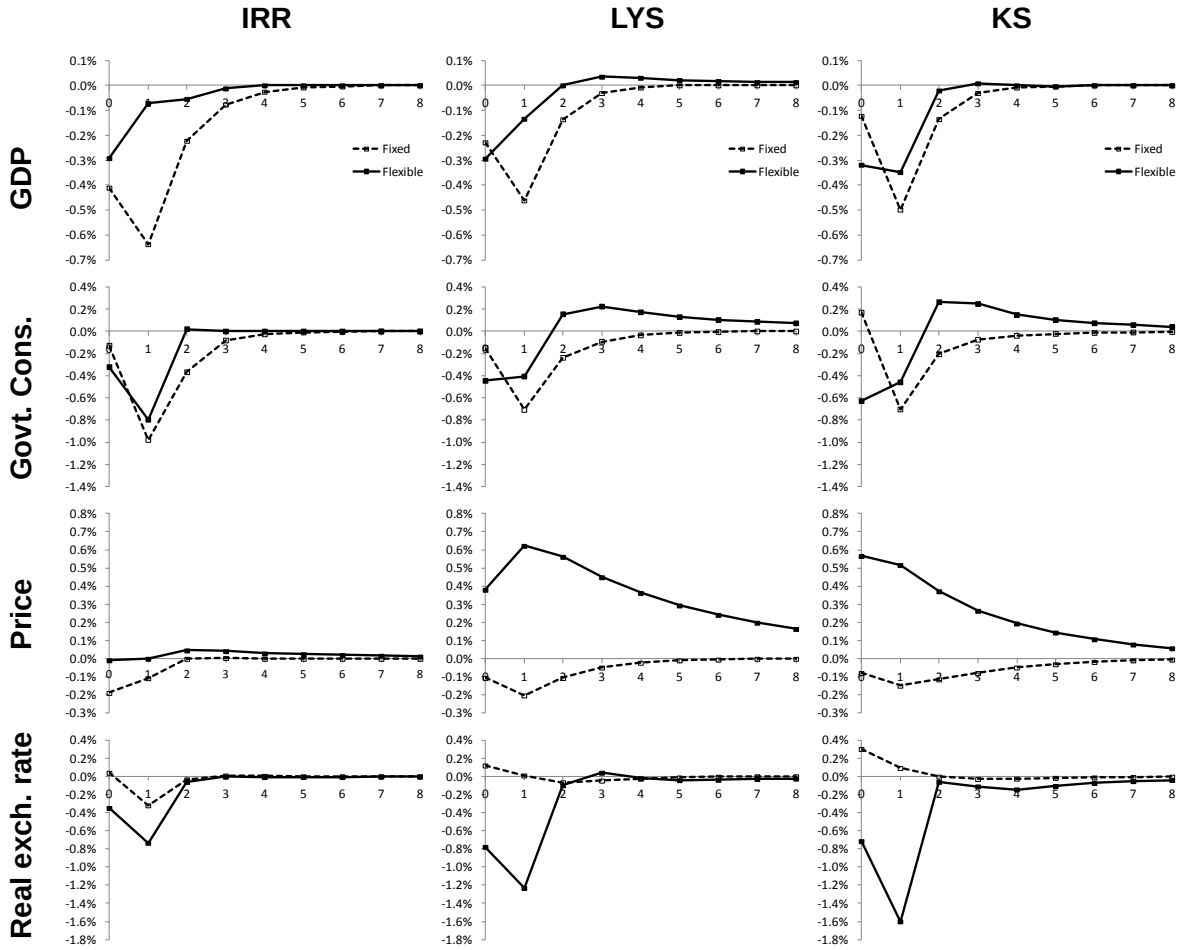
Since exchange rate regimes are classified according to various approaches, there can be considerable differences in the assignment of a country-year observation even among de facto schemes. Klein and Shambaugh (2010) note that the degree of agreement among the classifications of Reinhart and Rogoff (2004), Levy Yeyati and Sturzenegger (2005), and Shambaugh (2004) range between 73% and 86%. In this section, the panel VAR model is estimated using the exchange rate classifications of Levy Yeyati and Sturzenegger (2005) and Klein and Shambaugh (2006) to assess if the findings in Section 3.3.1 based on Ilzetzki et al. (2010) are robust. These classifications will be referred to as LYS, KS, and IRR, respectively.

Figure 3.3 displays the impulse responses for the alternative exchange rate classifications in response to an oil price shock normalized to negative 10%. The impulse responses based on the IRR classification in Section 3.3.1 are also included for comparison purposes. The dotted lines represent the impulse responses under a fixed exchange rate regime while the solid lines are the impulse responses under a flexible regime. It is clear that output contraction is smaller with flexible exchange rates across all the classifications with a range of 0.2% to 0.3%, and the macroeconomic adjustment is faster and less volatile. This can be attributed to the relatively large real depreciation between 0.8% and 1.6%, depending on the exchange rate classification, offsetting the impact of the decrease in real government consumption. While prices remain relatively unchanged in the IRR classification, they are evidently higher in the LYS and KS classifications plausibly due to the larger real exchange rate depreciation, which results in higher import prices passing through to domestic prices. With fixed exchange rates, real GDP falls by about 0.5% to 0.7% at its peak after a year. There is relatively little real depreciation since nominal exchange rates remain fixed and prices do not fall much. The bulk of the output contraction is due to fiscal spending cuts. This finding illustrates the burden of fiscal policy to bear most of the macroeconomic adjustment costs with a fixed exchange rate policy, which limits the ability of monetary policy to play an important stabilization role.

The statistical test results of the differences in the responses of real GDP and real exchange rate in the LYS and KS classifications are summarized in Table 3.4. The

ability of flexible exchange rates to soften the impact of an adverse oil price shock in oil-exporting countries on output is therefore robust to the choice of de facto exchange rate classifications.

Fig. 3.3 Impulse responses to a -10% oil price shock under alternative exchange rate regime classifications



Notes: Dotted and solid lines are the point estimates of the impulse responses under a fixed and flexible exchange rate regime, respectively. Exchange rate classification: IRR – Ilzetzki et al. (2010), sample period 1973–2010; LYS – Levy Yeyati and Sturzenegger (2005), sample period 1973–2004; KS – Klein and Shambaugh (2006), sample period 1973–2004.

3.3.3 Shock asymmetry

The results in Section 3.3.1 are based on the assumption that oil price shocks are symmetric, i.e., the coefficient matrix Γ_1 in eq. (3.1) is of equal magnitude but with opposite signs in response to positive and negative shocks. This section examines whether the previous findings are robust to asymmetric oil price shocks, i.e., the

coefficients are allowed to vary depending on whether the shock is positive or negative. Following Mork (1989), positive and negative oil price shocks are defined as:

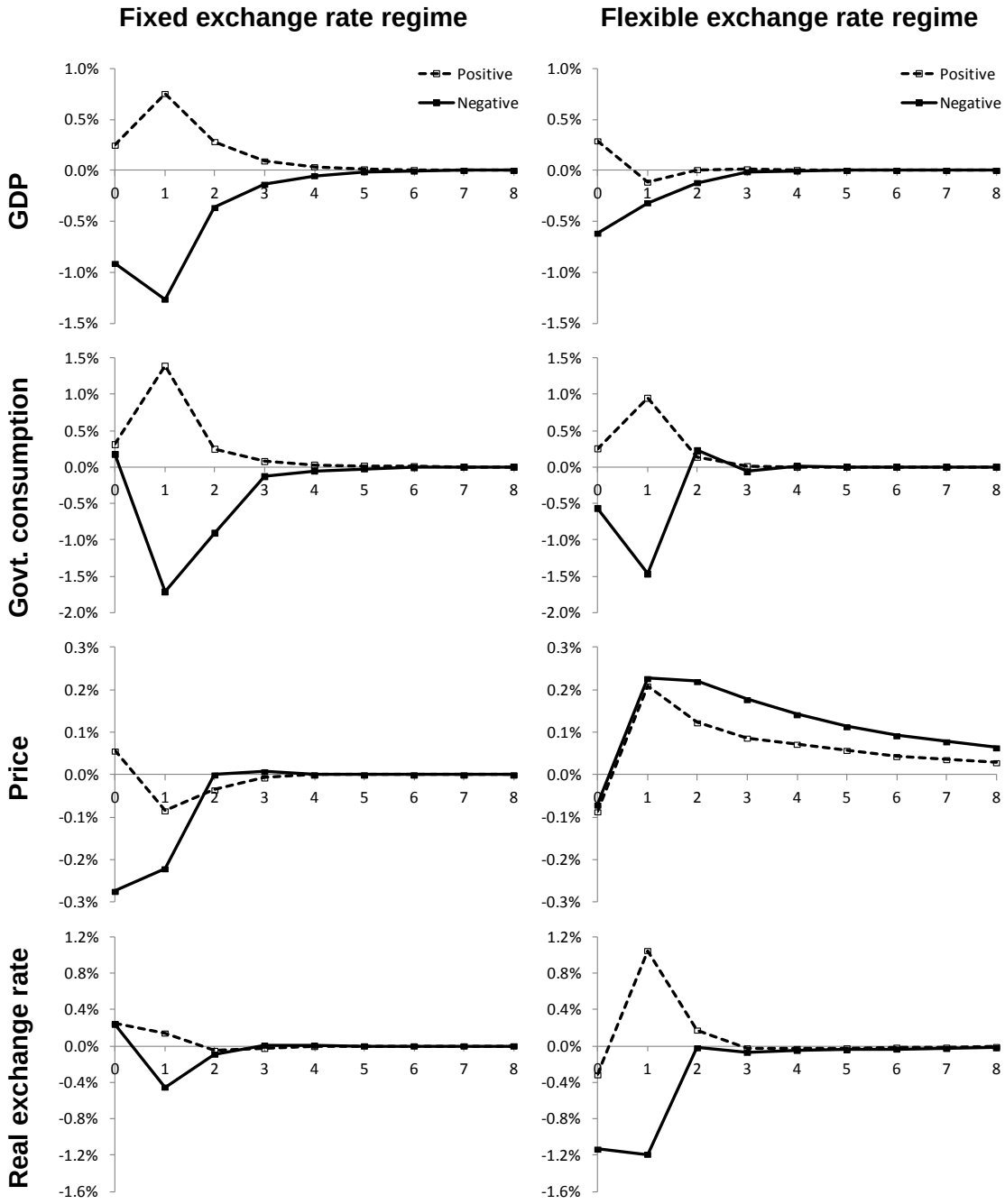
$$\Delta o_t^+ = \max(0, \Delta o_t) \tag{3.5}$$

$$\Delta o_t^- = \min(0, \Delta o_t) \tag{3.6}$$

Figure 3.4 displays the impulse responses of the variables to asymmetric oil price shocks normalized to 10%. The dotted lines correspond to the responses to a positive shock while the solid lines are the responses to a negative shock. In response to a positive oil price shock, real GDP increases under both fixed and flexible exchange rate regimes but the magnitudes and adjustment speeds are clearly different. In a similar but opposite fashion, real GDP falls in response to a negative oil price shock as expected; again the effects are different across the exchange rate regimes. In either case, the output response and its corresponding adjustment are more muted under a flexible regime. Procyclical fiscal policy is also evident from the impulse responses, as real government consumption increases in booms and decreases in busts. The differences in the output response can be explained by the response of the real exchange rate. In response to a positive oil price shock, there is a relatively large real exchange rate appreciation under a flexible regime, which tends to limit current account surpluses and offset the expansionary fiscal policy. Therefore, real GDP does not increase by as much as that in a fixed exchange rate regime. Likewise, there is a large real exchange rate depreciation in response to a negative oil price shock under a flexible regime, which tends to reduce current account deficits and also offset the fiscal spending cuts. Real GDP is thus less severely affected compared to that in a fixed exchange rate regime.

The findings here again highlight the macroeconomic stabilization role of flexible exchange rates, even when oil price shocks are allowed to be asymmetric. The statistical test results of the difference in the responses of real GDP and real exchange rate under asymmetric oil price shocks are summarized in Table 3.5. Therefore, regardless of the nature of the shock (i.e., linear or asymmetric) or the choice of de facto exchange rate classification (IRR, LYS, or KS), the shock-absorbing property of flexible exchange rates is evidently robust.

Fig. 3.4 Impulse responses to asymmetric oil price shocks of 10% under fixed and flexible exchange rate regimes



Notes: Dotted and solid lines are the point estimates of the impulse responses under a positive and negative oil price shock, respectively. Exchange rate classification is based on Ilzetzki et al. (2010); sample period 1973–2010.

Table 3.5 Coefficients of asymmetric oil price changes under fixed and flexible exchange rate regimes

Oil price shock	Regime	Δy	Δg	Δp	Δq
Positive	Fixed	0.0660	0.1199	-0.0084	0.0107
	Flexible	-0.0176*	0.0995	0.0245	0.1022^
Negative	Fixed	-0.0963	-0.0904	-0.0308	-0.0348
	Flexible	-0.0168**	-0.1477	0.0232^	-0.1238^

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal. ***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively. Exchange rate classification is based on Ilzetzki et al. (2010); sample period 1973–2010.

3.4 Oil funds as a macroeconomic stabilization tool

3.4.1 Dynamic impulse responses to an adverse oil price shock

The results in Section 3.3 provide empirical evidence that flexible exchange rates can stabilize output in oil-exporting countries in the face of adverse oil price shocks. Output contraction under flexible exchange rate regimes is significantly lower and the responses are smoother than in fixed regimes. However, fiscal policy also plays an important role in oil-exporting countries, especially in those with fixed exchange rates, which renders monetary policy ineffective.[20]

This section explores the role of oil funds in macroeconomic stabilization by extending the analysis in the previous section to examine the effects of an adverse oil price shock under different exchange rate and fiscal policy arrangements. The strategy is to segregate the data into four groups: (i) fixed exchange rate regime without oil funds; (ii) fixed exchange rate with oil funds; (iii) flexible exchange rate regime without oil funds; and (iv) flexible exchange rate regime with oil funds. For example, data for Gabon prior to the establishment of its oil fund in 1998 are in the 'fixed exchange rate and no oil funds' group, while data from 1998 onwards are in the 'fixed exchange rate with oil funds' group. For Norway, whose oil fund was established in 1990, the data prior to 1990 are in the 'flexible exchange rate and no oil funds' group and data

[20] The policy trilemma in international economics posits that it is impossible to have fixed exchange rates, free capital mobility, and independent monetary policy at the same time.

thereafter in the 'flexible exchange rate with oil funds' group. There is therefore a clear distinction between periods with fixed and flexible exchange rate regimes, as well as between periods with and without oil funds. In essence, Γ_1 in eq. (3.1) differs across the four groups.

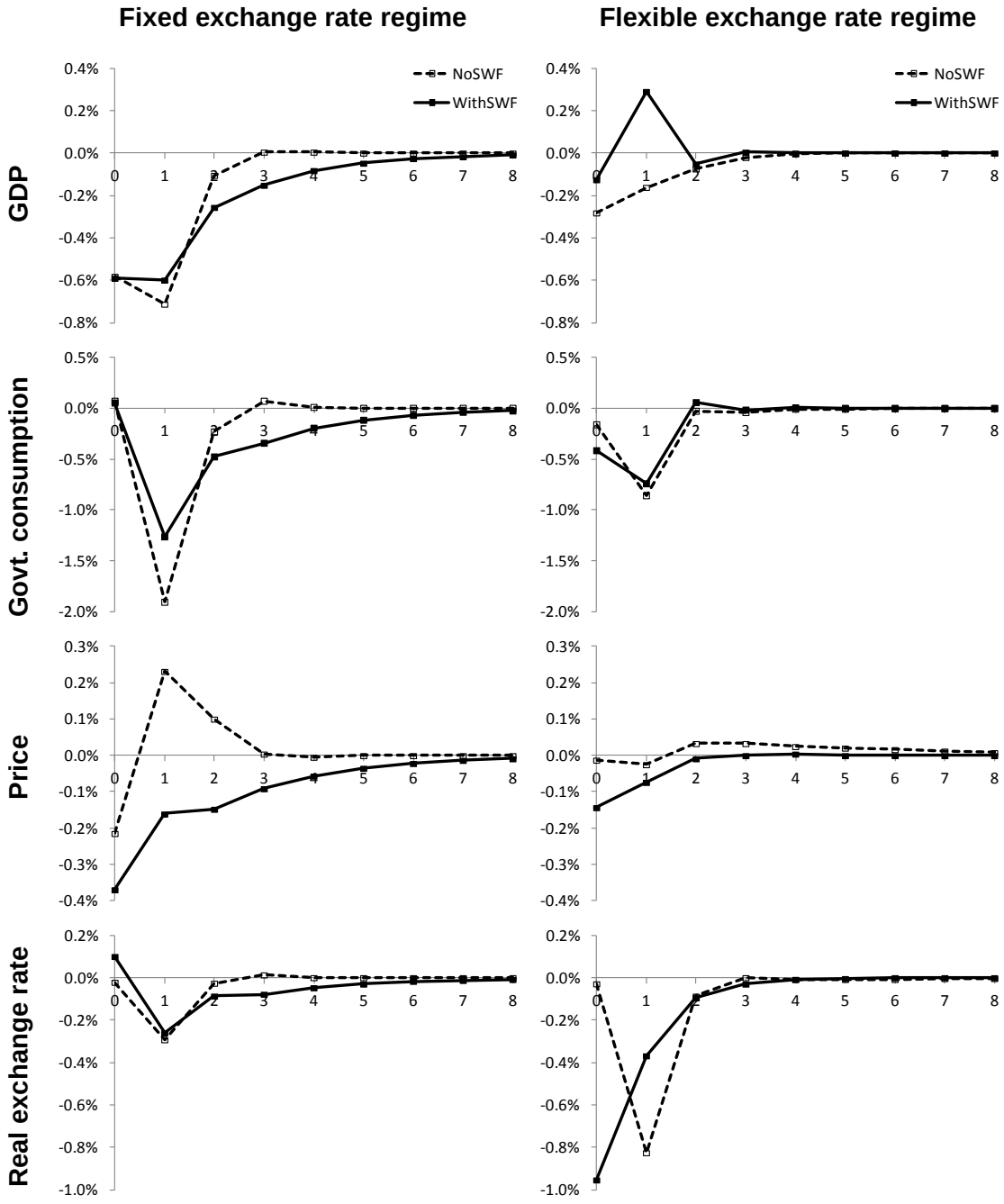
Figure 3.5 displays the impulse responses to an oil price shock normalized to negative 10%. Under fixed exchange rate regimes, real GDP and real government consumption decrease in response to an adverse oil price shock; however, there is a notable difference in the responses depending on whether there are oil funds in place.

The output contraction appears more muted and less volatile in the presence of oil funds as there are fiscal buffers to prevent a drastic reduction in fiscal spending. Real government consumption falls by 1.2% at its peak after a year with oil funds but the decline is 1.9% in the absence of oil funds. However, this difference is not significant from a statistical viewpoint as shown in the second row of panels in Table 3.6, owing to the relatively small sample size.[21] Nevertheless, the findings here still suggest the potency of oil funds in cushioning the impact of adverse oil price shocks in oil-exporting countries with a fixed exchange rate regime, albeit weak statistical evidence. As will be seen in Section 3.4.2, all the sensitivity tests show that oil funds help to reduce the extent of fiscal spending cuts and hence output contraction, though again the statistical significance suffers due to small sample size. Despite the lack of strong statistical support, the consistency of the various sensitivity tests is positive indication of the importance of oil funds in macroeconomic stabilization.

With flexible exchange rate regimes, there is no marked difference in the response of real government consumption even in the presence of oil funds. However, this observation should not be taken to imply that oil funds are ineffective in countries with flexible exchange rates. Instead, it points to the shock-absorbing property of flexible exchange rates, thus relieving fiscal policy from bearing a large proportion of the adjustment costs. Therefore oil funds need not play a major macroeconomic stabilization role in countries with flexible exchange rates. The apparent smaller output contraction in the case with oil funds can be explained by the relatively larger real exchange rate depreciation on impact.

[21] Recall that the proliferation of oil funds only began in the late 1990s.

Fig. 3.5 Impulse responses to a -10% oil price shock under different exchange rate and fiscal policy arrangements



Notes: Dotted lines are the point estimates of the impulse responses without oil funds (NoSWF), while solid lines represent those with oil funds (WithSWF). Exchange rate classification is based on Ilzetzki et al. (2010); sample period 1973–2010.

Table 3.6 Coefficients of oil price changes (negative) under different exchange rate and fiscal policy arrangements

Regime	**Oil funds**	Δy	Δg	Δp	Δq
Fixed	No	-0.0655	-0.1271	0.0181	-0.0210
Flexible	No	-0.0084*	-0.0793	-0.0035	-0.0906^
Fixed	No	-0.0655	-0.1271	0.0181	-0.0210
Fixed	Yes	-0.0276	-0.0726	0.0069	-0.0055
Flexible	No	-0.0084	-0.0793	-0.0035	-0.0906
Flexible	Yes	0.0311^	-0.0663	-0.0041	-0.0750
Fixed	Yes	-0.0276	-0.0726	0.0069	-0.0055
Flexible	Yes	0.0311**	-0.0663	-0.0041	-0.0750*

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal. ***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively. Exchange rate classification is based on Ilzetzki et al. (2010); sample period 1973–2010.

These important findings provide three key insights to the macroeconomic adjustments in oil-exporting countries in the face of adverse oil price shocks. First, oil exporters with flexible exchange rates experience less severe output contraction with smoother responses as the real exchange rate depreciation helps to cushion the negative effects. Second, with flexible exchange rates there is less need for contractionary fiscal policy as the macroeconomic adjustments take place via the immediate real exchange rate depreciation. While fiscal buffers such as oil funds can help, the automatic real depreciation appears to play a sufficient dampening role. Third, in oil exporters with fixed exchange rates, oil funds are a potentially useful stabilization tool to prevent large fiscal spending cuts which can amplify the business cycle.

The empirical results thus lend support to the case for oil-exporting countries to adopt more flexible exchange rate policies since they are vulnerable to oil price shocks, given their high dependence on oil for exports and government revenue. For oil-exporting countries that have a ‘fear of floating’, establishing oil funds to provide sufficient fiscal space is important for macroeconomic stabilization so that government spending does not have to be dependent on volatile oil revenues.

3.4.2 Robustness checks

This section examines the robustness of the main results to various sensitivity tests. First, the data period is restricted to 1990–2010 whereby the panel data is less unbalanced. Second, advanced economies (i.e., Canada, Denmark, Norway, and the United Kingdom) are excluded. Third, national real oil prices (oil price converted to national currency and deflated by CPI) are used instead of a common real oil price series. Fourth, institutional quality is added as a control variable, given that various studies highlight the importance of institutions in reducing fiscal procyclicality and macroeconomic volatility (e.g., Ossowski et al., 2008; Sugawara, 2014).[22] Finally, fifth, money supply is included as a proxy of the domestic monetary policy stance since a related strand of research focuses on the endogenous response of monetary policy to oil price shocks, which can have indirect effects on output (e.g., Bernanke et al., 1997).[23]

The results of the sensitivity tests in Tables 3.B1 to 3.B5 in Appendix 3.B highlight that the qualitative findings of Section 3.4.1 are not altered. In oil-exporting countries with fixed exchange rate regimes, the presence of oil funds is associated with a smaller reduction in real GDP and real government consumption, as seen in the coefficients in the second row of panels in Tables 3.B1 to 3.B5. Despite the lack of statistical significance at conventional levels due to small sample size, the consistency of the various sensitivity tests provide some indication that oil funds are a potential useful stabilization tool. The larger real exchange rate depreciation and smaller output contraction under flexible exchange rate regimes are also evident in all the tests (see the first and fourth row of panels), highlighting the insulating property of flexible exchange rates.

3.5 Conclusion

Oil prices have been plummeting since June 2014, causing many oil exporters to face immense economic and political pressures. As a consequence, the fiscal deficits in oil-

[22] Institutional quality data is taken from Kunčič (2014), using the average of legal, political, and economic institutions. The data is from 1990 to 2010.

[23] Money supply (M2) is used since interest rate data is not available for many of the oil-exporting countries. Interest rate is also not the core monetary policy instrument in most of these countries.

exporting countries necessitate abrupt macroeconomic adjustments, the extent to which depends on exchange rate and fiscal policies. Economic theory postulates that oil-exporting countries with flexible exchange rates can adjust better when faced with adverse oil price shocks; in addition, those with adequate fiscal buffers such as oil funds can prevent a drastic reduction in government spending. The objective of this paper is to examine the empirical validity of these economic arguments.

Applying panel vector autoregression techniques to 40 oil-exporting countries in the post-Bretton Woods period from 1973 to 2010, the results show that output and government consumption fall in response to an adverse oil price shock. However, the output response is significantly smaller and smoother in oil exporters with flexible exchange rates due to the immediate real exchange rate depreciation, which partially offsets the fiscal spending cuts. In contrast, oil-exporting countries under fixed exchange rate regimes see a small and delayed real exchange rate depreciation achieved via a fall in domestic prices. The bulk of the macroeconomic adjustments therefore take place through fiscal contractions. However, the fall in output and government consumption in countries with oil funds is more muted as these funds provide fiscal space to finance budget deficits, albeit weak statistical evidence due to small sample size. These findings highlight the shock-absorbing property of flexible exchange rates as well as the potency of oil funds as a macroeconomic stabilization tool to insulate oil exporters from adverse oil price shocks. There is therefore a case to be made in favour of oil-exporting countries to adopt more flexible exchange rate regimes and establish oil funds as fiscal buffers.

A few caveats are in order. There is also a need to take into account the role of fixed exchange rate regimes in anchoring expectations about an oil exporter’s exchange rate. A small change in the confidence of a currency, especially in developing countries, can quickly lead to a downward spiral of its value as well as persistent inflation, as evidenced by the currency crises episodes in Asia and Latin America in the 1990s. It is also worthwhile to note that the partial equilibrium nature of the analysis in this paper does not take into account the potential endogenous responses to oil price declines in oil-importing countries, which could have spillover effects. For example, an oil price-induced monetary policy adjustment in the U.S. has a direct impact on oil-exporting countries that peg to the U.S. dollar. In addition, oil price declines also result in lower

savings by oil exporters, which could affect global interest rates and global imbalances; for instance, through a reduction in petrodollar recycling (see e.g., Arezki and Hasanov, 2013; Belke and Gros, 2014). These potentially important channels are not explicitly considered in the reduced-form econometric analysis in this paper, but are implicitly incorporated in the estimated effects. In addition, oil funds are not a panacea and their effectiveness could also depend on the country's institutional quality and operational aspects governing the funds.

An area for future research is to examine how oil price declines driven by supply and demand in the global crude oil market affect oil-exporting countries. This is important as the unfolding of supply-driven and demand-driven oil price shocks are inherently different. For instance, Cashin et al. (2014) find that a supply-driven oil price shock has a significant impact on oil-exporting countries that possess large proven oil reserves but the effect is muted for those with limited reserves. Interestingly, such cross-country differences are absent in a demand-driven oil price shock. Habib et al. (2016) find that oil-exporting countries with floating currencies experience a nominal exchange rate depreciation following oil demand shocks, but not oil supply shocks. These results illustrate the importance of the source of oil price fluctuations and policymakers would have to pay close attention to international developments to design appropriate policy responses according to the nature of the oil price decline.

Appendix 3.A

Table 3.A1 List of oil-exporting countries

Country	Group[a]	Net oil exports[b]	Oil exports % Exports[c]	Oil exports % GDP[c]	Oil rents % GDP[c]
Algeria	DEV	954.3	92.5	37.9	17.4
Angola	DEV	1,359.9	93.0	69.2	53.5
Argentina	DEV	128.5	12.4	2.8	3.7
Azerbaijan	DEV	495.2	82.7	44.7	43.9
Bahrain	DEV	-225.4	59.7	54.1	18.0
Brunei Darussalam	DEV	171.1	85.5	62.3	30.5
Cameroon	DEV	36.1	35.9	9.8	8.6
Canada	ADV	1,039.0	15.4	5.3	2.3
Chad	DEV	96.5	78.3	37.5	34.3
Colombia	EME	337.9	28.1	4.8	6.2
Congo, Rep.	DEV	251.8	83.8	67.5	64.2
Denmark	ADV	151.9	6.0	3.0	1.9
Ecuador	DEV	324.6	46.2	13.5	18.5
Egypt, Arab Rep.	EME	75.0	18.4	4.5	8.7
Equatorial Guinea	DEV	295.6	97.4	100.8	74.8
Gabon	DEV	237.5	79.9	46.8	45.0
Indonesia	EME	80.8	9.7	3.0	4.2
Iran, Islamic Rep.	DEV	2,289.0	85.0	22.0	29.4
Iraq	DEV	1,740.6	N/A	42.6	53.7
Kazakhstan	DEV	911.0	52.4	26.1	30.1
Kuwait	DEV	1,520.9	81.5	49.6	50.3
Libya	DEV	1,184.2	100	59.4	49.5

Malaysia	EME	172.4	7.2	7.4	6.7
Mexico	EME	1,703.6	12.4	3.5	5.7
Nigeria	DEV	2,162.1	97.7	38.5	28.3
Norway	ADV	2,235.8	30.6	13.2	12.0
Oman	DEV	731.3	81.0	45.4	37.8
Papua New Guinea	DEV	30.3	22.4	12.5	15.5
Qatar	EME	875.8	87.4	53.6	22.2
Russian Federation	EME	4,571.6	41.0	13.5	15.5
Saudi Arabia	DEV	6,888.5	83.9	42.9	44.1
Sudan	DEV	294.0	79.8	13.8	16.9
Syrian Arab Rep.	DEV	168.5	34.4	12.5	22.8
Timor-Leste	DEV	59.4	N/A	N/A	N/A
Trinidad and Tobago	DEV	-23.4	32.7	21.6	12.1
Turkmenistan	DEV	44.5	75.0	37.0	28.8
Tunisia	DEV	47.8	9.6	4.5	3.6
United Arab Emirates	EME	2,113.9	40.6	27.8	19.4
United Kingdom	ADV	88.2	6.2	1.8	1.1
Venezuela, RB	DEV	1,767.2	82.7	25.0	28.0
Vietnam	DEV	294.0	15.3	10.3	8.4
Yemen, Rep.	DEV	252.4	79.0	27.5	28.4

Notes: [a] Advanced economies (ADV) are based on the classification in IMF World Economic Outlook (WEO), October 2016; Emerging economies (EME) are those included in the Morgan Stanley Capital International (MSCI) Emerging Markets Index; Developing countries (DEV) are the remaining unclassified countries.

Source: [b] Thousand barrels per day, U.S. Energy Information Administration (EIA); 2000–2012 average.

[c] Oil exports from IMF World Economic Outlook (WEO); Total exports, oil rents and GDP from World Bank World Development Indicators (WDI); 2000–2012 average. N/A denotes not available.

Table 3.A2 Variables and data sources

Variables[a]	**Definition**	**Symbol**	**Source**[b]
Real oil price	Crude oil price (U.S. dollars per barrel) deflated using U.S. CPI	o	IFS
Real GDP	GDP (constant local currency in billions)	y	WDI, WEO
Real government consumption	Government consumption expenditure (current local currency in billions) deflated using national CPI	g	WDI, IFS
Prices	Consumer price index (CPI)	p	WDI, IFS, WEO
Real exchange rate	Real effective exchange rate (REER)	q	Darvas (2012)

Notes: [a] All variables are expressed in natural logarithm.

[b] IFS – IMF International Financial Statistics, WDI – World Bank World Development Indicators, WEO – IMF World Economic Outlook. The primary source of the domestic variables is WDI, but if a longer time series is available in IFS or WEO, the alternative database is used. CPI for United Arab Emirates is obtained from the UAE National Bureau of Statistics.

Appendix 3.B

Table 3.B1 Coefficients of oil price changes (negative) under different exchange rate and fiscal policy arrangements; data period 1990–2010

Regime	Oil funds	Δy	Δg	Δp	Δq
Fixed	No	-0.0484	-0.1794	0.0234	-0.0542
Flexible	No	-0.0005^	-0.0766	0.0209	-0.1151
Fixed	No	-0.0484	-0.1794	0.0234	-0.0542
Fixed	Yes	-0.0149	-0.0851	0.0163	-0.0125
Flexible	No	-0.0005	-0.0766	0.0209	-0.1151
Flexible	Yes	0.0207	-0.0837	0.0025	-0.1180
Fixed	Yes	-0.0149	-0.0851	0.0163	-0.0125
Flexible	Yes	0.0207^	-0.0837	0.0025	-0.1180^

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal. ***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Table 3.B2 Coefficients of oil price changes (negative) under different exchange rate and fiscal policy arrangements; advanced economies excluded

Regime	Oil funds	Δy	Δg	Δp	Δq
Fixed	No	-0.0697	-0.1426	0.0199	-0.0237
Flexible	No	-0.0125*	-0.0955	-0.0015	-0.1116^
Fixed	No	-0.0697	-0.1426	0.0199	-0.0237
Fixed	Yes	-0.0276	-0.0726	0.0069	-0.0055
Flexible	No	-0.0125	-0.0955	-0.0015	-0.1116
Flexible	Yes	0.0513^	-0.1182	0.0019	-0.0952
Fixed	Yes	-0.0276	-0.0726	0.0069	-0.0055
Flexible	Yes	0.0513*	-0.1182	0.0019	-0.0952^

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal. ***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Table 3.B3 Coefficients of oil price changes (negative) under different exchange rate and fiscal policy arrangements; national real oil price series

Regime	Oil funds	Δy	Δg	Δp	Δq
Fixed	No	-0.0422	-0.0946	-0.0002	-0.0250
Flexible	No	-0.0021^	-0.0530	0.0037	-0.0568
Fixed	No	-0.0422	-0.0946	-0.0002	-0.0250
Fixed	Yes	0.0018*	-0.0067	0.0051	0.0001
Flexible	No	-0.0021	-0.0530	0.0037	-0.0568
Flexible	Yes	0.0252	-0.0686	0.0002	-0.0211
Fixed	Yes	0.0018	-0.0067	0.0051	0.0001
Flexible	Yes	0.0252	-0.0686	0.0002	-0.0211

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal. ***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Table 3.B4 Coefficients of oil price changes (negative) under different exchange rate and fiscal policy arrangements; control for institutional quality

Regime	Oil funds	Δy	Δg	Δp	Δq
Fixed	No	-0.0592	-0.1300	0.0064	-0.0485
Flexible	No	0.0048**	-0.0921	0.0344	-0.1271
Fixed	No	-0.0592	-0.1300	0.0064	-0.0485
Fixed	Yes	-0.0162	-0.0776	0.0140	-0.0098
Flexible	No	0.0048	-0.0921	0.0344	-0.1271
Flexible	Yes	-0.0083	-0.0269	0.0067	-0.0692
Fixed	Yes	-0.0162	-0.0776	0.0140	-0.0098
Flexible	Yes	-0.0083	-0.0269	0.0067	-0.0692^

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal. ***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Table 3.B5 Coefficients of oil price changes (negative) under different exchange rate and fiscal policy arrangements; including money supply

Regime	**Oil funds**	Δy	Δg	Δm	Δp	Δq
Fixed	No	-0.0620	-0.1008	0.0020	0.0144	-0.0177
Flexible	No	-0.0099*	-0.0912	-0.0142	0.0042	-0.0833^
Fixed	No	-0.0620	-0.1008	0.0020	0.0144	-0.0177
Fixed	Yes	-0.0156	-0.0665	-0.0866	0.0135	-0.0040
Flexible	No	-0.0099	-0.0912	-0.0142	0.0042	-0.0833
Flexible	Yes	-0.0033	-0.0107**	-0.1249*	-0.0019	-0.0127
Fixed	Yes	-0.0156	-0.0665	-0.0866	0.0135	-0.0040
Flexible	Yes	-0.0033	-0.0107	-0.1249	-0.0019	-0.0127

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal. ***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Chapter 4

Fiscal policy in oil-exporting countries: the roles of oil funds and institutional quality

ABSTRACT

Oil-exporting countries face challenges in the conduct of fiscal policy due to volatile oil revenues, especially in countries with weak institutions. Many oil exporters have established oil funds to delink government expenditure from oil revenues; however, their effectiveness remains unresolved. This paper examines the roles of oil funds and institutional quality in reducing fiscal procyclicality and macroeconomic volatility in 42 oil-exporting countries from 1960 to 2014 using panel vector autoregression techniques. The results show that oil funds are effective in reducing fiscal procyclicality in countries with high institutional quality. There is also a reduction in the procyclical bias in those with low institutional quality but the statistical evidence is weak. Nevertheless, oil funds are associated with reduced volatility of government consumption and the real exchange rate in countries with low institutional quality. These findings give credence to the macroeconomic stabilization role of oil funds but also reinforce the importance of good institutions.

4.1 Introduction

In spite of the potential benefits that natural resource endowments could bring to resource-rich countries, the underperformance of economic growth and unsatisfactory development outcomes are well documented (e.g., Sachs and Warner, 1995; Auty, 2001). This phenomenon is being referred to as the 'resource curse'.[24] There are five main explanations of the resource curse: the 'Dutch Disease' hypothesis (Corden and Neary, 1982); volatile international resource prices that cause macroeconomic uncertainty (Lane, 2003); unproductive spending on 'white elephant' projects (Gelb, 1986) and underinvestment in human capital (Gylfason, 2001); procyclical fiscal policies and inappropriate monetary policy frameworks (Frankel, 2011); and political economy arguments of resource abundance (e.g., Easterly and Levine, 1997; Tornell and Lane, 1999; Acemoglu et al., 2001). These problems are even more severe in oil-exporting countries owing to the fact that oil is a 'point-source' and 'lootable' resource and hence conflict, corruption, and rent-seeking are more likely compared with diffuse resources (Mehlum et al., 2006; Arezki and Brückner, 2009).[25] In addition, oil exporters are subject to larger terms of trade shocks and, to some extent, the high macroeconomic volatility in these countries can be attributed to procyclical fiscal policies that amplify the boom-bust cycle.[26]

Among the policy prescriptions advocated to reduce the dependence on volatile oil revenues to alleviate fiscal procyclicality, macroeconomic volatility, and limit Dutch disease symptoms in oil-exporting countries is to set up oil funds, which gained popularity from the late 1990s.[27] Oil funds fall under the umbrella of sovereign wealth funds (SWFs). Data from the Sovereign Wealth Fund Institute shows the total asset size of SWFs to be about US$7.4 trillion as of June 2016, of which 57% are oil and gas funds (SWFI, 2016). Oil funds are typically set up with the objective of either saving for the future to address issues with regards to fiscal sustainability and intergenerational

[24] van der Ploeg (2011) provides a survey of the literature on the resource curse.

[25] Oil-exporting countries have more authoritarian governments and they stay in power longer compared to their non-oil counterparts.

[26] Oil prices are at least twice as volatile as other minerals or agricultural products.

[27] Other policy options include economic diversification, conservative oil price budget forecasts, hedging oil price risk, and fiscal rules (see Devlin and Lewin, 2005).

equity, or to smooth fiscal expenditure and stabilize the economy.[28] As the economic argument goes, governments can smooth expenditures and prevent excessive macroeconomic volatility by channelling surplus oil revenues to the oil funds during booms and finance budget deficits during cycle downturns by transfers from these funds.[29] They are therefore related to a broader literature on fiscal procyclicality.[30] The fact that fiscal policy is procyclical in developing countries has been documented in many studies (e.g., Gavin and Perotti, 1997; Kaminsky et al., 2004; Talvi and Végh, 2005; Ilzetzki and Végh, 2008; Carneiro and Garrido, 2015).[31] The same result holds when narrowing the sample to resource-rich countries (Céspedes and Velasco, 2014) and oil-exporting developing countries (Erbil, 2011). In the political economy context, Arezki et al. (2011) find that procyclical government spending in resource-rich countries is moderated by the quality of political institutions. More generally, Frankel et al. (2013) find that a third of the developing world have 'graduated' from fiscal procyclicality over the past decade, and the key determinant is institutional quality. Interestingly, about half of this graduation cohort comprises of oil exporters, the period that coincides with the proliferation of oil funds (see Fig. 1.3 in Chapter 1).

There are only a handful of papers that quantitatively investigate the importance of oil funds (or natural resource funds) and institutions on the conduct of fiscal policy.[32] The findings of existing studies are somewhat mixed. Davis et al. (2001) find that resource funds do not have a significant impact on government spending and are largely redundant based on 12 selected countries (11 oil exporters and Chile) from 1965 to

[28] Oil funds with a stated savings objective usually also allow discretionary transfers to the budget to smooth expenditures during the down cycle. Most oil funds have dual objectives of savings and stabilization.

[29] There are also political economy arguments for oil funds, e.g., governments have strong political incentives to overspend and oil funds can potentially tie the hands of the government (see Humphreys and Sandhu, 2007).

[30] Lane (2003) discusses why procyclical fiscal policy is not optimal from either Keynesian or neoclassical theoretical considerations. Halland and Bleaney (2011) review the causes of fiscal procyclicality in developing countries.

[31] Fiscal policy in advanced economies is countercyclical or at worst acyclical (see Arreaza et al., 1998; Lane, 2003).

[32] While Fasano (2000) does not use econometric techniques, he looks at case studies of in six countries and finds that oil funds are generally successful in Kuwait and Norway but not in Venezuela.

1999. Crain and Devlin (2003) find that resource funds can in fact increase fiscal spending volatility, particularly in oil-exporting countries. Ossowski et al. (2008) use a larger panel data set of 31 countries from 1992 to 2005 and conclude that fiscal outcomes are not due to oil funds but they find that higher institutional quality is associated with lower correlation between government revenue and expenditure. Likewise, Bova et al. (2016) do not find evidence that adopting fiscal rules and resource funds have reduced the procyclical bias in non-renewable commodity exporters; however, they find that better institutional quality reduces procyclicality.

In contrast, Shabsigh and Ilahi (2007) use a panel data set of 15 oil-exporting countries from 1973 to 2003 and find that oil funds are negatively correlated with volatility of money, prices, and to a lesser extent real exchange rates. Coutinho et al. (2014) provide evidence of fiscal procyclicality in resource-rich countries but the effect is lower when there is a resource fund and also in more democratic regimes. Sugawara (2014) finds that resource funds contribute to smoothing government expenditure volatility but political institutions is also a significant factor. Asik (2015) provides evidence in favour of oil funds in reducing fiscal procyclicality and volatility of fiscal expenditures in 29 oil-exporting countries from 1980 to 2012 but she does not find any statistically significant association between fiscal performance and institutional quality.

The lack of consensus in the empirical literature is perhaps not surprising since studies on oil funds are usually plagued with several problems—choosing the appropriate fiscal policy variable, sample selection bias, unobserved heterogeneity, and endogeneity. The novelty of this paper and its contribution are: (i) using a more comprehensive coverage of 42 oil-exporting countries over the period 1960–2014, which is the largest data set compiled to date; (ii) employing panel vector autoregression (VAR) techniques to address these empirical issues; and (iii) investigate both the roles of oil funds and institutional quality in reducing fiscal procyclicality and macroeconomic volatility in a coherent empirical framework.[33]

[33] Existing papers on oil or natural resource funds typically use traditional panel data methods and regress changes of a fiscal variable on GDP growth and other control variables. They also focus only either on fiscal procyclicality or macroeconomic volatility. To my knowledge, this paper is the first to use panel VAR methods to investigate the effectiveness of oil funds. It also differs from panel VAR studies on the

The remainder of this paper is organized as follows. Section 4.2 discusses the empirical challenges and the econometric approach. Section 4.3 presents the results on the roles of oil funds and institutional quality. Section 4.4 explores further issues pertaining to fiscal cyclicality. Section 4.5 subjects the empirical results to a battery of robustness checks, and Section 4.6 concludes.

4.2 Data and methodology

4.2.1 Empirical issues

Fiscal policy is defined to be procyclical if it is expansionary in booms and contractionary in recessions (Kaminsky et al., 2004). In general, existing studies typically regress government consumption growth on GDP growth; a statistically significant positive coefficient indicates evidence of procyclical fiscal policy. Similarly, existing studies regress measures of macroeconomic volatility on selected explanatory variables. Oil funds enter these regressions as a dummy variable interacted with GDP growth and the statistical significance of the coefficient on the interaction term determines its effectiveness.

Among the main empirical challenges in establishing a robust relationship between oil funds and fiscal outcomes are using the appropriate discretionary fiscal policy variable, sample selection bias, unobserved heterogeneity, and endogeneity. The first issue in analysing fiscal policy is to decide which variable is most appropriate to characterize a country's fiscal stance. Kaminsky et al. (2004) emphasize that if one is interested in macroeconomic policy, then the focus should be on instruments within policymakers' control. According to Ilzetzki and Végh (2008), there are two key fiscal policy instruments—government consumption (as opposed to government spending, which also includes transfers and debt service) and tax rates (as opposed to tax revenues, which depend on the business cycle). However, tax rates are not readily available for most countries and are therefore not useful in cross-country studies. Another related issue is whether to scale fiscal variables with GDP. Kaminsky et al. (2004) and Ilzetzki and Végh (2008) criticize that fiscal variable ratios to GDP include

effects of oil price shocks in oil-exporting countries which do not examine the importance of oil funds and institutions (e.g., Omojolaibi and Egwaikhide, 2014).

business cycle movements and hence interpretation of the results on fiscal procyclicality is difficult. For instance, during boom times GDP will increase. Using a fiscal variable scaled to GDP will tend to underestimate the extent of procyclical fiscal policy. For the above reasons, the fiscal policy variable in this paper focuses on government consumption expenditure.

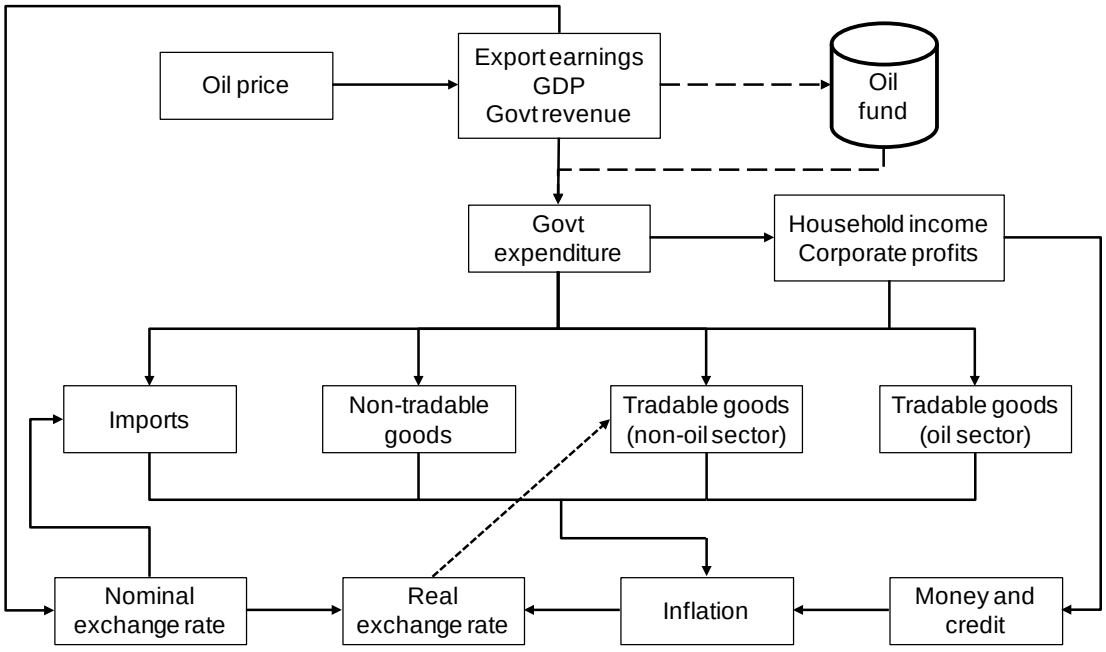
Selection bias is also a drawback in existing studies, whereby only a subset of oil exporters is included. The findings of these panel studies are therefore not necessarily representative of the average experience of oil-exporting countries as a group. This paper covers 42 oil-exporting countries and includes those with and without oil funds. The countries selected satisfy at least one of the following criteria: net oil exports of at least 50 thousand barrels per day; share of oil exports in total exports of at least 30%; oil exports as a percentage of GDP of at least 20%; and oil rents as a percentage of GDP of at least 20%. This ensures that all significant oil exporters are included, which minimizes selection bias. Table 4.A1 in Appendix 4.A lists the 42 countries, of which 38 are emerging and developing countries.

The decision to establish an oil fund is not a random event but could possibly be due to time-invariant country-specific unobserved characteristics. To overcome this problem, existing studies use the fixed effects estimator to purge the impact of time-invariant variables. Endogeneity issues arise due to potential reverse causality of fiscal policy and GDP. The literature on fiscal procyclicality is based on the premise that fiscal policy responds to output and hence exacerbates the business cycle, but as Jaimovich and Panizza (2007) argue, causality can also run in the opposite direction. A solution that is frequently employed is to instrument GDP growth but an associated problem is in finding appropriate instrument variables. The methodology used in this paper is based on panel VAR techniques, which offer several advantages: they combine the conventional VAR approach that treats all variables as endogenous, with the dynamic panel data estimation approach that allows for unobserved heterogeneity, first employed in Holtz-Eakin et al. (1988). Details on the panel VAR estimation are discussed in Section 4.2.3.

4.2.2 Variables and data sources

It is timely to take a brief digression to discuss the expected effects oil funds have on the macroeconomy. Figure 4.1 shows a highly stylized transmission mechanism of oil windfalls in oil-exporting countries. When oil prices increase, there is a boom as export earnings, GDP, and government revenue increase. Fiscal policy is typically the main mechanism in which oil price shocks are transmitted into the economy (Husain et al., 2008) and with procyclical fiscal policy there is increased demand for both imports and domestic goods. The associated monetary expansion can lead to higher inflation. There is also a real exchange rate appreciation either through a nominal appreciation in the case of a floating exchange rate regime or via inflation in the case of a fixed exchange rate regime. The real exchange rate appreciation can also have Dutch disease effects on the non-oil tradable sector. Conversely, when oil prices decrease, government spending is cut back and this boom-bust cycle induces macroeconomic volatility. The oil fund comes in as a vehicle to stabilize the economy, by saving excess revenue in booms and funding the deficit during downturns so that government spending does not have to depend on the direction of oil prices. If oil funds are successful, one should expect to see less procyclical fiscal policy and lower macroeconomic volatility.

Fig. 4.1 Stylized transmission of oil windfalls



Using the panel VAR approach, the analysis in this paper therefore focuses on the direction and magnitude of the impulse responses of government consumption (to gauge fiscal procyclicality), as well as the standard deviation of the impulse responses (as a measure of volatility) of the domestic macroeconomic variables. Annual data from 1960 to 2014 is used but data availability varies by country (i.e., the panel is unbalanced). The variables included in the panel VAR and expressed in natural logarithms are real oil price (o), real GDP (y), real government consumption (g), price (p), money supply (m), and the real exchange rate (q). The variables and data sources are summarized in Table 4.A2 in Appendix 4.A.

Results of the Im-Pesaran-Shin (IPS) panel unit root test (see Im et al., 2003) for the variables are shown in Table 4.1. This test allows for unbalanced panels. The null hypothesis that all panels contain a unit cannot be rejected when the variables are in log levels. However, evidence of stationarity is clear when taking first log differences, which approximates growth rates. Table 4.2 shows the results of the four panel cointegration tests developed by Westerlund (2007). All four tests fail to reject the null hypothesis of no cointegration among the variables. Therefore, based on the panel unit root and cointegration test results, variables in log differences are used in the empirical analysis.

Table 4.1 Im-Pesaran-Shin (IPS) panel unit root test

Variable	Z-t-tilde bar statistic	p-value	Variable	Z-t-tilde bar statistic	p-value
o	1.36	0.91	Δo	-22.69	0.00
y	24.29	1.00	Δy	-16.91	0.00
g	18.34	1.00	Δg	-18.74	0.00
p	27.95	1.00	Δp	-11.63	0.00
m	44.45	1.00	Δm	-17.25	0.00
q	-1.45	0.07	Δq	-18.72	0.00

Notes: H_o: All panels contain unit roots, H_a: Some panels are stationary.

Table 4.2 Westerlund panel cointegration tests

Variables	Gt		Ga		Pt		Pa	
	Z-value	**p-value**	**Z-value**	**p-value**	**Z-value**	**p-value**	**Z-value**	**p-value**
$o, y, g, p, \mathrm{m}, q$	6.51	1.00	10.53	1.00	8.70	1.00	8.76	1.00

Notes: The Gt and Ga statistics test H_o: $\varphi_i = 0$ for all i vs. H_a: $\varphi_i < 0$ for at least i, starting from a weighted average of the individually estimated coefficients φ_i and their t-ratios respectively. Rejection of H_o implies existence of a cointegrating relationship for at least one of the cross-sectional units. The Pt and Pa statistics test H_o: $\varphi_i = 0$ for all i vs. H_a: $\varphi_i < 0$ for all i, using the pooled information over all cross-sectional units. Rejection of H_o is taken as evidence of cointegration for the whole panel. The tests includes a constant and trend. Results are obtained using the Stata codes *xtwest* by Persyn and Westerlund (2008).

4.2.3 Panel VAR estimation

The reduced-form panel VAR specification is of the form:

$$Z_{i,t} = \Gamma_0 + \Gamma_1 Z_{i,t-1} + f_i + \varepsilon_{i,t} \tag{4.1}$$

where $Z_{i,t}$ is the vector of endogenous variables $[\Delta o_{i,t}, \Delta y_{i,t}, \Delta g_{i,t}, \Delta p_{i,t}, \Delta m_{i,t}, \Delta q_{i,t}]'$ for country i in year t, Γ_0 is the vector of intercepts, Γ_1 is the coefficient matrix of the lagged variables, f_i denotes time-invariant country fixed effects, and $\varepsilon_{i,t}$ is the vector consisting of the error terms that are assumed to be uncorrelated across i and t. In view of the annual data frequency, only one lag is included in the specification.

Implementing the VAR procedure on panel data requires imposing the restriction that the same underlying structure holds for each cross-sectional unit (country), i.e., the coefficients in the matrix Γ_1 are the same for all countries. This constraint is usually violated in practice; a way to overcome this is to introduce fixed effects, which allows for individual heterogeneity (Love and Zicchino, 2006). The conventional mean-difference procedure that is commonly used to remove fixed effects might lead to biased coefficient estimates since the fixed effects are correlated with the lagged dependent variables, which gives rise to the problem of 'dynamic panel bias' (Nickell, 1981), and hence ordinary least squares (OLS) estimation is inappropriate. Taking the first difference of each equation in the model in eq. (4.1) removes both the constant term and

the individual effect; however, the differenced lagged dependent variables are still correlated with the error terms. But with the fixed effects swept out, a straightforward method is to construct instrument variables using the twice lagged dependent variables and estimate using two-stage least squares (2SLS) (see Anderson and Hsiao, 1982).

However, a problem with the first-difference approach in the case of the application in this paper is that it magnifies gaps in unbalanced panels (Roodman, 2009). For instance, if $y_{i,t}$ is missing in the data, then $\Delta y_{i,t}$ and $\Delta y_{i,t+1}$ are also missing in the transformed data. A procedure known as the Helmert transformation of forward mean-differencing, or forward orthogonal deviations, is applied to avoid this problem (see Arellano and Bover, 1995). Instead of subtracting the previous observation of a variable in the first-difference approach, the Helmert procedure subtracts the average of all the future observations and thus preserves the sample size in panels with gaps.

More specifically, let $\bar{z}_{i,t} = \sum_{s=t+1}^{T_i} \frac{z_{i,s}}{(T_i - t)}$ denote the means obtained from the future values of $z_{i,t}$, which is a variable in the vector $Z_{i,t}$, and T_i is the last year of a country's time series. The transformed variable is thus:

$$z_{i,t}^{*} = c_{i,t}(z_{i,t} - \bar{z}_{i,t}) \tag{4.2}$$

where $c_{i,t} = \sqrt{\frac{T_i - t}{T_i - t + 1}}$ is the weight used to equalize variances. The error term $\varepsilon_{i,t}$ also undergoes a similar transformation:

$$\varepsilon_{i,t}^{*} = c_{i,t}(\varepsilon_{i,t} - \bar{\varepsilon}_{i,t}) \tag{4.3}$$

The final transformed panel VAR takes the form:

$$Z_{i,t}^{*} = \Gamma_1 Z_{i,t-1}^{*} + \varepsilon_{i,t}^{*} \tag{4.4}$$

This procedure also preserves the orthogonality between the transformed variables and the lagged regressors; hence they can be used as instruments to estimate the coefficients consistently by generalized method of moments (GMM).

To compute the impulse responses, the Cholesky decomposition is used to identify the shocks in the panel VAR system. The recursive ordering of the variables in the

system is such that a variable does not react contemporaneously to other variables below it but reacts to those above it. After one period (year), all variables react to all the shocks. Changes in real oil price (Δo) is ordered first as it is assumed that domestic variables do not have an immediate influence on global oil prices. This assumption might be challenged by some based on the premise that OPEC is an effective cartel in controlling oil prices by coordinating oil production. However, there is no evidence of OPEC demonstrating such influence (Kilian, 2014).

The domestic variables are ordered next in the order: real GDP growth (Δy), real government consumption growth (Δg), inflation (Δp), money supply growth (Δm), and real exchange rate changes (Δq). With annual data, it is debatable whether GDP or government consumption should be ordered first. The standard ordering using quarterly data follows Blanchard and Perotti (2002) by assuming output does not contemporaneously affect government spending due to implementation lags. However, this identifying assumption becomes less credible with annual data. For instance, government spending can react to output changes after a quarter and the effects will thus be captured in the annual data. In panel VAR studies of oil-exporting countries, Husain et al. (2008) order output before government spending whereas the reverse is specified in Espinoza and Prasad (2012). In the baseline specification here, GDP is ordered before government consumption.[34] The ordering of the remaining variables is standard in the VAR literature.

4.3 Empirical results

4.3.1 Overview of fiscal cyclicality and macroeconomic volatility in oil-exporting countries

Before turning to the estimation results, it is worthwhile to explore the data for possible insights into fiscal cyclicality and macroeconomic volatility in oil-exporting countries. It is instructive to segregate the sample into periods before and after the establishment of oil funds, as well as by countries with high and low institutional quality (IQ), since this demarcation is also used in the econometric analysis. Table 4.3 lists the countries

[34] Reversing the order does not change the main results. See Section 4.5 on robustness checks.

Table 4.3 Oil-exporting countries and oil funds

No oil funds	With oil funds		
Argentina	Algeria (2000)	Gabon (1998)	Qatar (2005)
Congo, Rep.	Angola (2012)	Iran, Islamic Rep. (2000)	Russian Federation (2004)
Denmark	Azerbaijan (1999)	Iraq (2003)	Saudi Arabia (1952)
Egypt, Arab Rep.	Bahrain (2006)	Kazakhstan (2000)	Sudan (2002)
Indonesia	Brunei Darussalam (1983)	Kuwait (1953)	Timor-Leste (2005)
Malaysia	Cameroon (1974)	Libya (2006)	Trinidad and Tobago (2000)
Syrian Arab Rep.	Canada (1976)	Mexico (2000)	Turkmenistan (2008)
Tunisia	Chad (1999–2006)	Nigeria (2004)	United Arab Emirates (1976)
United Kingdom	Colombia (1995)	Norway (1990)	Venezuela, RB (1998)
Vietnam	Ecuador (2002)	Oman (1980)	
Yemen, Rep.	Equatorial Guinea (2002)	Papua New Guinea (2011)	

Source: Tsani (2013), SWFI (2016), Truman (2008).

Notes: Establishment year of the oil fund is in parenthesis. The oil fund in Chad was abolished in 2006.

with and without oil funds, including the years in which the funds were set up. Table 4.4 splits the countries by IQ. IQ data is obtained from the World Institutional Quality Ranking data set by Kunčič (2014), who computes the latent quality of legal, political, and economic institutions for 197 countries using factor analysis on a large number of institutional proxy variables.[35] The scores across the three dimensions are then averaged. Countries with IQ scores higher (lower) than the global median are classified

[35] A popular institutional quality database is the International Country Risk Guide (ICRG) data set, e.g., used in Frankel et al. (2013). However, data for some of the countries included in this paper are not available in ICRG. For consistency reasons, this paper uses Kunčič (2014), which covers all countries.

as high (low) IQ.[36] There are more oil-exporting countries with low IQ scores compared to high scores.

Table 4.4 Oil-exporting countries and institutional quality score

High institutional quality		**Low institutional quality**		
Argentina (0.528)	Oman (0.573)	Algeria (0.374)	Equatorial Guinea (0.211)	Saudi Arabia (0.433)
Bahrain (0.590)	Papua New Guinea (0.547)	Angola (0.345)	Gabon (0.435)	Sudan (0.247)
Brunei Darussalam (0.562)	Qatar (0.523)	Azerbaijan (0.405)	Indonesia (0.445)	Syrian Arab Rep. (0.349)
Canada (0.871)	Trinidad and Tobago (0.661)	Cameroon (0.371)	Iran, Islamic Rep. (0.362)	Timor-Leste (0.503)
Denmark (0.901)	United Arab Emirates (0.568)	Chad (0.252)	Iraq (0.262)	Tunisia (0.482)
Kuwait (0.582)	United Kingdom (0.864)	Colombia (0.476)	Kazakhstan (0.432)	Turkmenistan (0.130)
Malaysia (0.547)		Congo, Rep. (0.344)	Libya (0.290)	Venezuela, RB (0.360)
Mexico (0.569)		Ecuador (0.454)	Nigeria (0.408)	Vietnam (0.366)
Norway (0.843)		Egypt, Arab Rep. (0.444)	Russian Federation (0.415)	Yemen, Rep. (0.378)

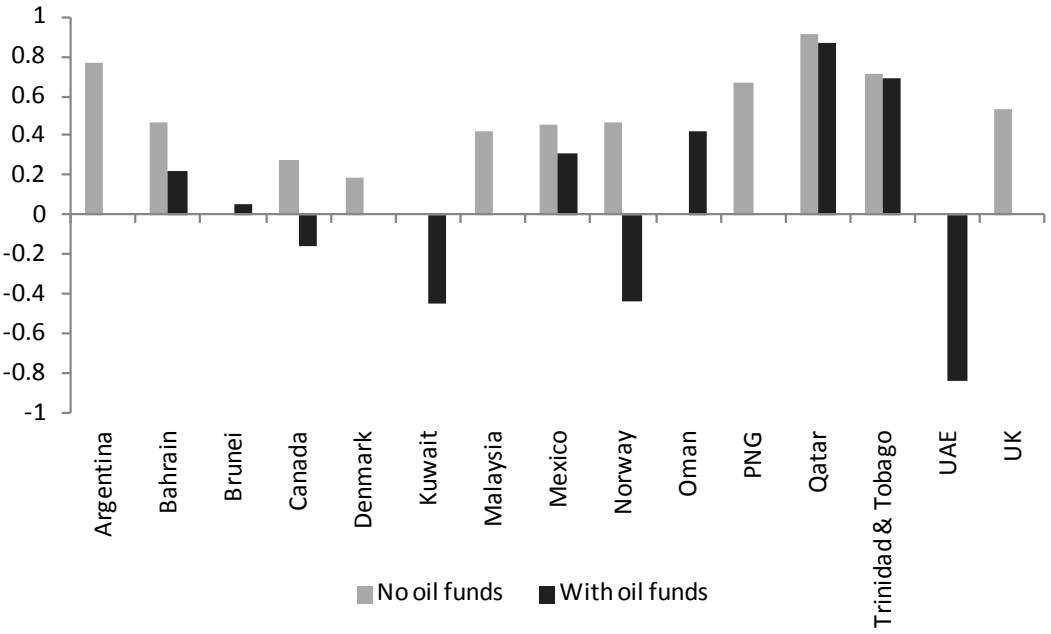
Source: Kunčič (2014), 2000–2010 average of legal, political and economic institutions.

Notes: Numbers in parenthesis are the institutional quality scores. The scores range from a minimum of 0 to a maximum of 1; higher scores indicate better institutional quality.

[36] It can be argued that the countries in the high IQ group defined here should only be confined to the advanced economies and the remainder classified as medium IQ. A robustness check in Section 4.5 shows that the main results remain unchanged after excluding the advanced economies. Section 4.4.2 treats IQ as a continuous variable and hence avoids splitting countries into subsamples.

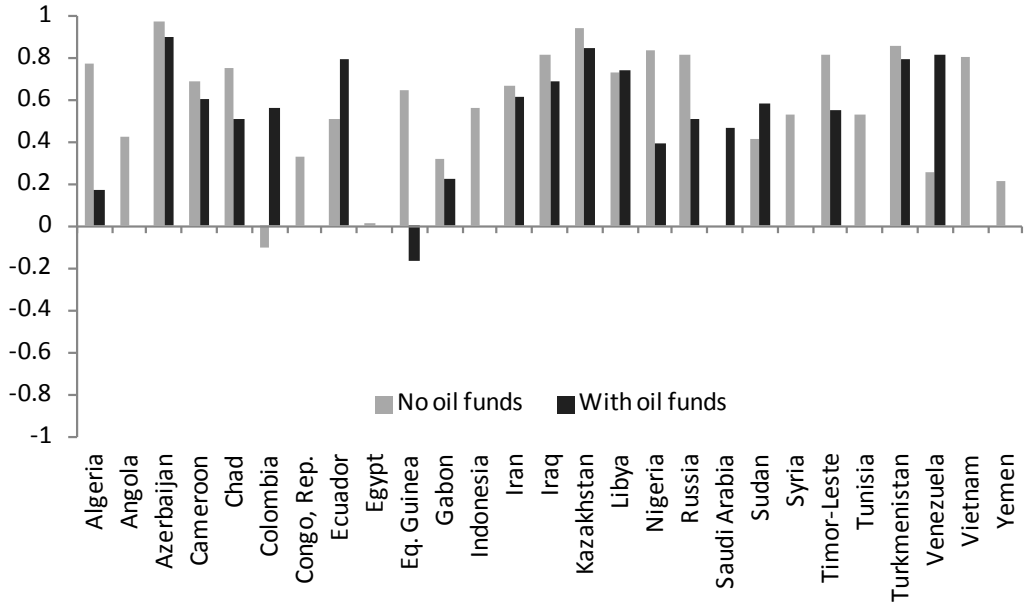
Figures 4.2a and 4.2b plot the correlation of the cyclical components of GDP and government consumption in high and low IQ countries respectively.[37] The cyclical components are extracted using the Hodrick-Prescott filter. The light-coloured bars correspond to the correlation in the periods without oil funds while the dark-coloured bars represent the correlation in the periods with oil funds. Comparing the two figures, an immediate observation is that fiscal policy tends to be less procyclical in high IQ countries, in both the periods with or without oil funds, as seen by the height of the bars. This clearly demonstrates a link between institution quality and the conduct of fiscal policy.

Fig. 4.2a Correlation of the cyclical components of GDP and government consumption in high IQ countries



[37] Similar plots are obtained using simple correlation of GDP growth and government consumption growth instead of the cyclical components of GDP and government consumption. To be consistent with the literature (e.g., Kaminsky et al., 2004; Frankel et al., 2013), the correlations of the cyclical components are presented.

Fig. 4.2b Correlation of the cyclical components of GDP and government consumption in low IQ countries



Focusing on high IQ countries, an interesting observation in Fig. 4.2a is that fiscal policy is even less procyclical during periods with oil funds. The case that stands out most is Norway, often cited for the success of integrating its oil fund into the country's overall macroeconomic policy framework. Fiscal policy turned from a procylical to a countercyclical stance after its oil fund was established in 1990. Other countries that also run countercyclical fiscal policy with oil funds in place are Canada, Kuwait, and the United Arab Emirates. Although fiscal policy is still procyclical in the rest of the high IQ countries, there is noticeably some improvement in reducing this bias during periods with oil funds. This is a positive indication on the effectiveness of oil funds.

However, the picture is not as vivid in low IQ countries. While fiscal procyclicality has reduced considerably in some countries during periods with oil funds (e.g., Algeria, Russia), there are others in which this bias has worsened (e.g., Ecuador, Venezuela). Nevertheless, by comparing the periods with and without oil funds in Fig. 4.2b, there appears to be an overall reduction in fiscal procyclicality in low IQ countries as a group.

Turning to macroeconomic volatility, Tables 4.5a and 4.5b show the standard deviation of the growth rates of the variables in high and low IQ countries respectively. Comparing the two groups, it is clear that volatility is smaller in high IQ countries

regardless whether there are oil funds or not. This again points to the importance of good institutions. In high IQ countries there is some reduction in macroeconomic volatility in the presence of oil funds, but the improvement is relatively mild since volatility is already considerably low even without oil funds. The volatility reduction is more pronounced in low IQ countries during periods with oil funds, demonstrating their usefulness in macroeconomic stability.

Table 4.5a Standard deviation of the growth rates of variables in high IQ countries

Country	y		g		p		m		q	
	No SWF	**With SWF**	**No SWF**	**With SWF**	**No SWF**	**With SWF**	**No SWF**	**With SWF**	**No SWF**	**With SWF**
Argentina	0.06		0.27		0.76		0.66		0.28	
Bahrain	0.05	0.02	0.05	0.05	0.06	0.01	0.19	0.09	0.08	0.04
Brunei Darussalam		0.02		0.11		0.01		0.11		0.02
Canada	0.02	0.02	0.03	0.02	0.03	0.03	0.05	0.15	0.02	0.05
Denmark	0.02		0.04		0.03		0.08		0.03	
Kuwait		0.13		0.14		0.03		0.09		0.07
Malaysia	0.03		0.07		0.03		0.14		0.05	
Mexico	0.04	0.03	0.11	0.02	0.22	0.01	0.20	0.05	0.13	0.06
Norway	0.02	0.01	0.03	0.01	0.03	0.01	0.04	0.04	0.02	0.03
Oman		0.05		0.07		0.04		0.09		0.06
Papua New Guinea	0.05		0.07		0.04		0.14		0.07	
Qatar	0.09	0.07	0.10	0.12	0.02	0.06	0.10	0.09	0.06	0.05
Trinidad and Tobago	0.05	0.05	0.14	0.07	0.05	0.02	0.10	0.08	0.08	0.03
United Arab Emirates		0.06		0.12		0.03		0.09		0.07
United Kingdom	0.02		0.03		0.02		0.14		0.05	
Average	*0.03*	*0.03*	*0.06*	*0.05*	*0.09*	*0.02*	*0.12*	*0.06*	*0.06*	*0.03*

Notes: NoSWF – without oil funds; WithSWF – with oil funds.

Variables: y - real GDP; g - real government consumption; p – price; m - money supply; q - real exchange rate.

Table 4.5b Standard deviation of the growth rates of variables in low IQ countries

Country	y		g		p		m		q	
	No SWF	With SWF	No SWF	With SWF	No SWF	With SWF	No SWF	With SWF	No SWF	With SWF
Algeria	0.06	0.02	0.06	0.10	0.07	0.02	0.07	0.08	0.13	0.04
Angola	0.07	0.01	0.32	0.28	0.30	0.01	0.28	0.06	0.07	0.05
Azerbaijan	0.15	0.08	0.36	0.15	1.31	0.06	1.16	0.20	0.86	0.08
Cameroon	0.01	0.06	0.07	0.11	0.04	0.06	0.04	0.12	0.05	0.11
Chad	0.07	0.10	0.19	0.07	0.10	0.07	0.18	0.15	0.10	0.07
Colombia	0.02	0.02	0.13	0.05	0.10	0.07	0.18	0.15	0.08	0.08
Congo, Rep.	0.05		0.17		0.05		0.18		0.14	
Ecuador	0.03	0.02	0.33	0.04	0.16	0.03	0.22	0.07	0.13	0.05
Egypt, Arab Rep.	0.03		0.06		0.06		0.08		0.18	
Equatorial Guinea	0.25	0.11	0.26	0.17	0.11	0.01	0.40	0.18	0.13	0.05
Gabon	0.11	0.05	0.18	0.14	0.08	0.02	0.22	0.08	0.46	0.36
Indonesia	0.04		0.10		0.08		0.10		0.16	
Iran, Islamic Rep.	0.10	0.04	0.17	0.10	0.10	0.06	0.22	0.08	0.46	0.36
Iraq		0.04		0.23		0.16		0.11		0.16
Kazakhstan	0.06	0.03	0.17	0.09	1.03	0.03	0.72	0.15	0.25	0.06
Libya	0.10	0.01	0.19	0.13	0.07	0.04	0.13	0.14	0.17	0.04
Nigeria	0.08	0.07	0.19	0.23	0.14	0.03	0.15	0.15	0.32	0.06
Russia	0.07	0.05	0.19	0.06	0.45	0.03	0.29	0.09	0.26	0.07
Saudi Arabia		0.07		0.12		0.07		0.13		0.08
Sudan	0.06	0.04	0.19	0.17	0.25	0.09	0.19	0.08	0.34	0.07
Syrian Arab Rep.	0.07		0.14		0.09		0.07		0.19	
Timor-Leste	0.02	0.06	0.01	0.24	0.04	0.04	0.20	0.10	0.00	0.05
Tunisia	0.02		0.05		0.03		0.04		0.03	
Turkmenistan	0.10	0.03	0.35	0.17	1.05	0.06	0.73	0.26	0.22	0.12
Venezuela, RB	0.04	0.07	0.19	0.12	0.18	0.06	0.14	0.14	0.14	0.17
Vietnam	0.01		0.05		0.05		0.09		0.06	
Yemen, Rep.	0.04		0.15		0.16		0.08		0.29	

Average	*0.06*	*0.04*	*0.16*	*0.10*	*0.22*	*0.04*	*0.22*	*0.09*	*0.18*	*0.07*

Notes: NoSWF – without oil funds; WithSWF – with oil funds.

Variables: y - real GDP; g - real government consumption; p – price; m - money supply; q - real exchange rate.

4.3.2 The roles of oil funds and institutional quality

In a VAR framework, the response of government consumption to an unanticipated increase in GDP determines the extent of fiscal cyclicality (see Ilzetzki and Végh, 2008). Macroeconomic volatility can be measured by the standard deviation of the impulse responses to a structural shock (e.g., oil price shock) over a time horizon (see Husain et al., 2008). To investigate both the roles of oil funds and institutional quality in reducing fiscal procyclicality and macroeconomic volatility, the empirical strategy is to classify the country-year observations into four groups and estimate the panel VAR model in eq. (4.1) separately: (i) no oil funds and high IQ; (ii) no oil funds and low IQ; (iii) with oil funds and high IQ; and (iv) with oil funds and low IQ. For example, data for Norway prior to 1990 are in the 'no oil funds and high IQ' group, and data from 1990 onwards are in the 'with oil funds and high IQ' group. For Nigeria, which is classified as a country with low institutional quality and whose oil fund was established in 2004, the data prior to 2004 are in the 'no oil funds and low IQ' group and data thereafter in the 'with oil funds and low IQ' group. There is therefore a clear distinction between low and high IQ countries, as well as between periods with and without oil funds. In essence, the coefficients of the variables in the panel VAR model, Γ_1 in eq. (4.1), are allowed to differ across the four groups. The differences in the impulse responses across the groups determine whether oil funds and/or institutional quality are important or not.

It is worth stating that oil funds are heterogeneous in many aspects—stated objectives, transparency and governance, asset size, investment strategy, and operational rules. One might argue that the size of the oil funds matters: countries with large accumulated funds should be in a better position to manage oil price shocks compared to those with small funds. However, fund size is not used as a control since panel data is not available. Besides, many low IQ countries (e.g., Iran, Libya) have larger oil funds than high IQ countries (e.g., Canada, Mexico), but their macroeconomic performance

appears to be worse (see Figs 4.2a and 4.2b). This is why the literature emphasizes the importance of institutions rather than fund size.

4.3.2.1 Macroeconomic volatility

Figure 4.3 displays the impulse responses of the macroeconomic variables following an oil price shock normalized to 10% to allow comparison across the groups and also for ease of interpretation of the results.[38] The impulse volatility calculations and the results of the hypothesis tests that the variances are equal are shown in Table 4.6; these results are based on standard variance ratio F-tests.

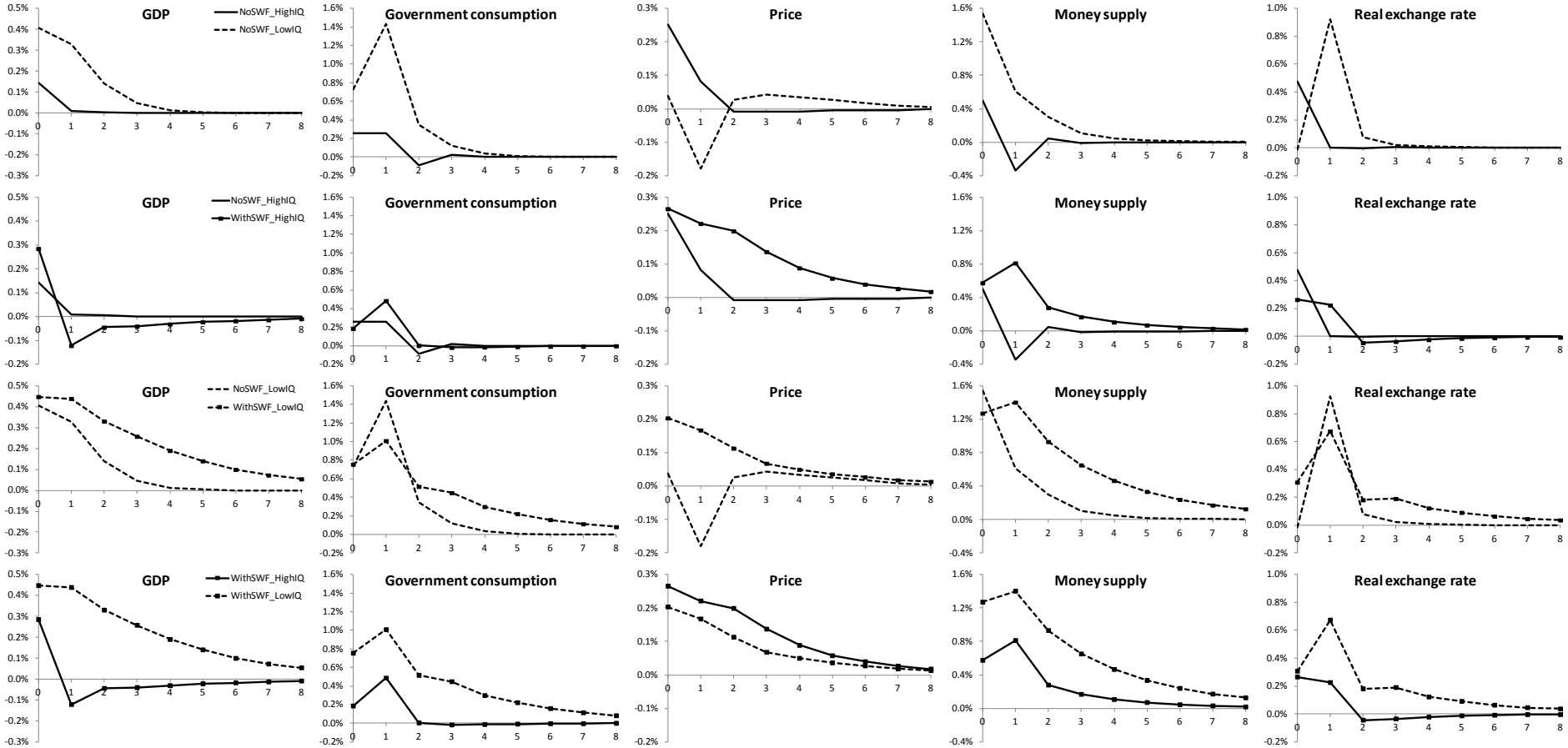
The first row of panels shows the responses during periods without oil funds in high and low IQ countries. As is expected for oil-exporting countries, real GDP increases in response to an oil windfall. The response of real government consumption is positive, suggesting that fiscal policy is procyclical. There is an expansion in money supply and an increase in domestic prices.[39] The real exchange rate also appreciates, displaying Dutch disease symptoms. It is clear from the figure that these responses are sharper in low IQ countries, i.e., higher macroeconomic volatility, which is confirmed statistically in the first row in Table 4.6. This constitutes evidence that institutional quality plays an important role in macroeconomic stability.

The second row of panels compares the volatility performance in periods with and without oil funds in high IQ countries. There is no statistically significant difference in volatility reduction with oil fund as shown in the second row in Table 4.6; however, this does not mean oil funds are ineffective. A more logical reasoning is that volatility in

[38] The results presented are based on a positive oil price shock. With the plunge in oil prices since June 2014, one might be interested in a negative oil price shock. Given the linearity of the model, the effects of positive and negative shocks are symmetric, i.e., the responses are of equal magnitude but with opposite signs.

[39] Interestingly, the response of domestic price is smaller in low IQ countries in the first two periods. A plausible reason is the composition of the CPI basket. The nominal appreciation of the exchange rate in response to an oil price shock implies that imports become cheaper in local currency terms. If this effect dominates the general price increase of the other components of the CPI basket (which could also be price-sticky), the result would be an overall price decline.

Fig. 4.3 Impulse responses of macroeconomic variables to a 10% oil price shock



Notes: NoSWF_HighIQ – high institutional quality without oil funds; NoSWF_LowIQ – low institutional quality without oil funds; WithSWF_HighIQ – high institutional with oil funds; WithSWF_LowIQ – low institutional quality with oil funds.

Table 4.6 Impulse volatility (over 8 periods) in response to a 10% oil price shock

	Δy	Δg	Δp	Δm	Δq
No oil funds and high IQ	0.05***	0.12***	0.09	0.21**	0.16**
No oil funds and low IQ	0.16	0.49	0.09	0.51	0.30
No oil funds and high IQ	0.05	0.12	0.09	0.21	0.16
With oil funds and high IQ	0.09	0.17	0.09	0.28	0.12
No oil funds and low IQ	0.16	0.49	0.09	0.51	0.30
With oil funds and low IQ	0.15	0.32^	0.09	0.48	0.20^
With oil funds and high IQ	0.09	0.17*	0.09	0.28*	0.12*
With oil funds and low IQ	0.15	0.32	0.09	0.48	0.20

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal. ***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

high IQ countries is already considerably low due to sound macroeconomic policies and therefore the scope for further volatility reduction through oil funds is limited.[40] A key point to note from the figure is that there is some indication of countercyclical fiscal policy during periods with oil funds in high IQ countries—GDP and government consumption move in opposite directions after the impact period.

The third row of panels compares the volatility performance in periods with and without oil funds in low IQ countries. An important observation is that oil funds are associated with reduced macroeconomic volatility of all the variables, and the difference is statistically significant for government consumption and the real exchange rate as

[40] The response of domestic prices appears to be larger during periods with oil funds. This should not be immediately taken to say that oil funds cause higher inflation. A cursory look at data on oil price changes and inflation in oil-exporting countries shows a higher correlation from the 1990s. This could be due to relatively loose monetary conditions (either domestic or imported). Since many oil funds were set up in the late 1990s, higher inflation might be picked up in the oil funds group.

shown in the third row in Table 4.6. This highlights the potency of oil funds in volatility reduction.

The last row of panels shows the responses during periods with oil funds in high and low IQ countries. It is clear that institutional quality is important as even in the presence of oil funds, volatility is still smaller in high IQ countries as seen in the last row of Table 4.6. The importance of oil funds is also obvious, as the volatility difference between low and high IQ countries is much smaller with oil funds in place.

4.3.2.2 Fiscal cyclicality

Based on the definition of fiscal policy procyclicality and the discussion in Section 4.2.1, the extent of fiscal procyclicality is determined by examining the response of real government consumption to a GDP shock. The impulse responses of real government consumption to a GDP shock normalized to 1% are displayed in Fig. 4.4. The results of the hypothesis tests that the coefficients of (lagged) GDP growth are equal are shown in Table 4.7; these are based on standard t-tests.[41]

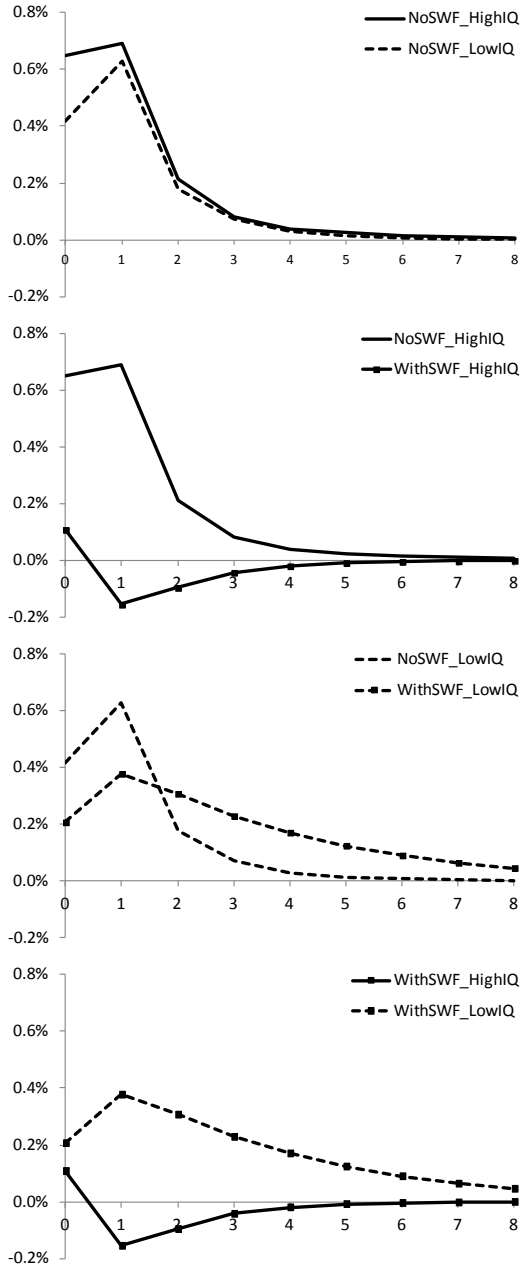
The first row of panels in Fig. 4.4 and Table 4.7 show that there is no statistically significant difference in fiscal procyclicality in low and high IQ countries during periods without oil funds, i.e., oil exporters tend to run procyclical fiscal policy on average before the establishment of oil funds regardless of institutional quality.[42] The success of oil funds in reducing the extent of procyclical fiscal policy is revealed in the second row of panels—the response of government consumption to a GDP shock is negative during periods with oil funds in high IQ countries, which indicates countercyclical fiscal policy, and this is statistically validated in the hypothesis test (the negative sign of the coefficient indicates countercyclicality).

The third row of panels displays the responses of the low IQ groups: one with oil funds and the other without. The responses of government consumption suggest that

[41] Since the panel VAR estimation consists of only one lag, a t-test can be used to test the null hypothesis that the responses of government consumption in the two groups are the same. For two or more lags, a F-test or Wald test can be used to test the null hypothesis that the coefficients in all the lags are the same.

[42] However, macroeconomic volatility is smaller in high IQ countries without oil funds (see the first row of panels in Table 4.6) as they have better institutions that presumably foster economic stability.

Fig. 4.4 Impulse response of government consumption to a 1% GDP shock



Notes: NoSWF_HighIQ – high institutional quality without oil funds; NoSWF_LowIQ – low institutional quality without oil funds; WithSWF_HighIQ – high institutional with oil funds; WithSWF_LowIQ – low institutional quality with oil funds.

fiscal policy is procyclical in both groups, but the response is more muted during periods with oil funds. The coefficient in Table 4.7 likewise indicates that fiscal procyclicality is lower in the oil funds group, though from a statistical point of view there is no difference at conventional significance levels. As will be seen in Section 4.5, this procyclical bias is also smaller in all the robustness checks, pointing to the potency

of oil funds. It would be interesting to see if stronger evidence emerges as more data becomes available. The last row of panels compares the periods with oil funds in high and low IQ countries. It is clear that institutional quality matters even after controlling for the presence of oil funds—fiscal policy is still significantly less procyclical in high IQ countries.

Table 4.7 Hypothesis testing of the difference in the response of government consumption to a GDP shock

Groups	**Coefficient of Δy**	**t statistic**
No oil funds and high IQ	0.435	0.330
No oil funds and low IQ	0.534	
No oil funds and high IQ	0.435	2.139**
With oil funds and high IQ	-0.183	
No oil funds and low IQ	0.534	1.368
With oil funds and low IQ	0.250	
With oil funds and high IQ	-0.183	2.240**
With oil funds and low IQ	0.250	

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal. ***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

4.4 Further issues

4.4.1 Measurement of fiscal cyclicality

Some studies use the cyclical components of GDP and government consumption (e.g., Frankel et al., 2013) in their regression equations instead of GDP growth and government consumption growth (e.g., Woo, 2009) to test whether fiscal policy is procyclical. As Fatás and Mihov (2009) point out, the disparity in the findings on fiscal procyclicality could be due to how it is measured. Therefore as a robustness check, the cyclical components of GDP and government consumption extracted using the Hodrick-Prescott filter are used in the panel VAR model to see if the results differ from that using log differences in Section 4.3.2.

Figure 4.B1 in Appendix 4.B displays the impulse responses of the cyclical component of government consumption to a 1% shock in the cyclical component of GDP. The effectiveness of oil funds in reducing fiscal procyclicality in high IQ countries is still evident. In fact, fiscal policy is countercyclical only in high IQ countries when oil funds are in place. Hence regardless of measurement issues, the finding that oil funds are effective particularly in high IQ countries remains robust.

4.4.2 Endogeneity of institutions

In Section 4.3.1 the classification of the county-year observations by oil funds and institutional quality implicitly assumes that institutions are exogenous to the macroeconomy and do not change over time. The growth literature recognizes the potential endogeneity of institutions and the usual approach is to instrument institutional quality using settler mortality rates and latitude in growth regressions (see Acemoglu et al., 2001). The issue on endogeneity of institutions is explored here using the panel VAR approach. The institutional quality data set in Kunčič (2014) is useful as it allows using IQ as a variable in a panel data setting. IQ is therefore added to the vector of endogenous variable in the panel VAR model in eq. (4.1), which now consists of seven variables, $Z_{i,t} = \left[\Delta o_{i,t}\ , \Delta y_{i,t}\ , \Delta g_{i,t}\ , \Delta p_{i,t}\ , \Delta m_{i,t}\ , \Delta q_{i,t}\ , \Delta iq_{i,t}\right]'$, where Δiq is the change in institutional quality and is ordered last. However, IQ data is only available from 1990 to 2010; hence the analysis is restricted to this sample period.

Figure 4.B2 in Appendix 4.B shows the impulse responses of government consumption to an increase in the institutional quality score by 0.1. An improvement in institutional quality in the group without oil funds still results in procyclical fiscal policy but countercyclical fiscal policy is observed in the oil funds group, suggesting the effectiveness of oil funds even after controlling for the endogeneity of institutions. [43]

[43] The estimation results based on the baseline model in Section 4.3.1 remain qualitatively unchanged even with a shorter time period. The finding here with endogenous IQ is therefore not driven by the time period.

4.4.3 Oil funds, institutional quality, and investment

The analysis thus far focuses on the cyclicality of government consumption and the effects oil funds and institutional quality have on the conduct of fiscal policy. A related question of interest is whether investment also displays procyclical behaviour, which could amplify the domestic financial cycle and exacerbate macroeconomic fluctuations.[44] A natural extension is to include investment into the panel VAR model. It would be ideal to be able to separate investment into government investment and private investment. Unfortunately, data is not available for many developing countries. Instead, gross capital formation is used as the investment variable.

Figures 4.B3 and 4.B4 in Appendix 4.B display the impulse responses of government consumption and gross capital formation to a 1% GDP shock respectively. Adding investment into the panel VAR model does not alter the response of government consumption by much. Government consumption is still procyclical in all the groups except during the periods with oil funds in high IQ countries, whereby government consumption is countercyclical. However, such countercyclical behaviour is not observed in gross capital formation—it is procyclical across all groups, i.e., investment increases during good times and falls during bad times. Nevertheless, this procyclical bias is least pronounced in high IQ countries with oil funds in place, again demonstrating the effectiveness of oil funds and the importance of good institutions in macroeconomic stabilization.

4.5 Robustness checks

In this section, nine robustness tests are performed. First, besides global oil prices, oil-exporting countries are vulnerable to other external shocks such as the global demand for oil and U.S. monetary policy (many oil-exporting countries operate on pegs to the U.S. dollar or have tightly managed exchange rates). Since these shocks are not explicitly identified in the panel VAR model, a robustness check is necessary to see if the inclusion of these variables affects the results. The vector of endogenous variable in eq. (4.1) now consists of eight variables,

[44] See Aghion et al. (2010) on the adverse effects of procyclical investment on long-term growth.

$Z_{i,t} = [\Delta o_{i,t}, \Delta ip_{i,t}, \Delta r_{i,t}, \Delta y_{i,t}, \Delta g_{i,t}, \Delta p_{i,t}, \Delta m_{i,t}, \Delta q_{i,t}]'$, where Δip is the first log difference of industrial production in the advanced economies (as a proxy of global demand) and Δr is the change in the U.S. interest rate. Second, the ordering of GDP and government consumption is reversed. Another specification is to change the ordering of CPI and money supply. Third, two lags are used instead of one to allow for different system dynamics. Fourth, advanced economies are excluded from the sample. Many studies have documented the success of Norway's oil fund in delivering macroeconomic stability and allowing the government to smooth expenditures (e.g., Ekeli and Sy, 2011). There is also empirical evidence that OECD countries tend to run countercyclical fiscal policy (e.g., Lane, 2003). A robustness check that excludes developed countries will ascertain whether the results are influenced by these countries. Fifth, the sample period from 1990 to 2014 is used. This avoids earlier periods in which data is sparse.

Sixth, hyperinflation periods are removed. Many hyperinflation episodes occurred in the 1980s and 1990s; periods in which most countries do not have oil funds in place. Therefore, including these periods will tend to bias the results such that macroeconomic volatility appears higher without oil funds when in fact these hyperinflationary episodes are purely exogenous, e.g., the breaking up of the Soviet Union, which led to hyperinflation in the transition countries. In the analysis here, a country is defined to experience hyperinflation in year t if $\Delta p_{i,t} \geq 1$, i.e., if annual inflation is at least 100%. The hyperinflation periods are Angola (1992–97, 1999–2000), Argentina (1975–78, 1983–85, 1988–90), Azerbaijan (1993–95), Indonesia (1965–66), Iraq (1991, 1993–95), Kazakhstan (1993–95), Russia (1993–95), Turkmenistan (1993–95), and Vietnam (1986–88). This definition picks up more inflationary periods (years) than in Hanke and Krus (2012) whereby the authors define hyperinflation periods as months with inflation exceeding 50%. Reinhart and Rogoff (2004) define extreme inflation in which the 12-month inflation is at least 40%. According to their definition, more observations will have to be excluded. The robustness test here takes the middle ground.

Seventh, the effectiveness of oil funds might not be observed immediately as there are usually kinks to iron out in the initial years of institutionalization and policy implementation. To take this into account, the first three years from the oil fund establishment year are excluded to avoid contamination due to the 'ineffective' period. The periods without oil funds remain unchanged (i.e., the three excluded years are not

piled into the non-oil funds period but are discarded). Eighth, instead of using a common real oil price series for all the countries, national real oil prices constructed by converting the crude oil price into national currency and deflating by national CPI is used. Finally, ninth, the effectiveness of oil funds might only be observed in the face of large oil price shocks. An oil price shock is defined to be large if the absolute value of the annual change is at least 20%. In the panel VAR model, $\Delta o_{i,t}$ is replaced by $\Delta o_{i,t}^{L}$ defined as:

$$\Delta o_{i,t}^{L} = \begin{cases} \Delta o_{i,t} & if\ |\Delta o_{i,t}| \geq 0.2 \\ 0 & otherwise \end{cases} \tag{4.5}$$

The findings that oil funds are effective in reducing fiscal procyclicality particularly in high IQ countries are robust to these nine specification variations.[45] Statistical test results of these robustness checks are in Appendix 4.C.

4.6 Conclusion

Oil-exporting countries face challenges in reducing fiscal policy procyclicality and macroeconomic volatility as a result of volatile oil prices that cause boom-bust cycles. This problem is exacerbated by rent-seeking behaviour especially in countries with low institutional quality that can undermine governance and make the process of building growth-enabling institutions more difficult. The standard policy advice is to set up oil funds to delink the economy from volatile oil revenues. Oil funds, which are usually established with the objectives of either saving for the future or stabilising the economy, gained increasing popularity starting from the late 1990s when oil prices were booming. However, the effectiveness of oil funds remains open to debate.

This paper examines the roles of oil funds and institutional quality in reducing fiscal procyclicality and macroeconomic volatility in 42 oil-exporting countries from 1960 to 2014 using panel vector autoregression techniques. By comparing periods with and without oil funds, the results show that fiscal procyclicality is significantly reduced in the presence of oil funds in countries with high institutional quality; in fact, fiscal policy is countercyclical in these countries after the establishment of oil funds, on

[45] For the fifth robustness test, i.e., time period restricted to 1990–2014, statistical significance suffers as the sample is reduced by half.

average. There is also a reduction in the procyclical bias in those with low institutional quality but the evidence is less compelling. Nevertheless, oil funds are associated with reduced volatility of government consumption and the real exchange rate in countries with low institutional quality. These findings therefore provide evidence that oil funds are a potentially useful policy instrument in the conduct of fiscal policy to stabilize the economy. More importantly, the results highlight the central role of institutional quality in effecting appropriate fiscal policies to manage volatile oil windfalls. Oil funds are therefore not a panacea and are not a substitute for prudent fiscal discipline, sound macroeconomic management, and political commitment. Their effectiveness could also depend on the design of the transparency and accountability rules in the operation of the fund as some scholars argue; further research in this area should provide more refined answers.

Appendix 4.A

Table 4.A1 List of oil-exporting countries

Country	Group[a]	Net oil exports[b]	Oil exports % Exports[c]	Oil exports % GDP[c]	Oil rents % GDP[c]
Algeria	DEV	954.3	92.5	37.9	17.4
Angola	DEV	1,359.9	93.0	69.2	53.5
Argentina	DEV	128.5	12.4	2.8	3.7
Azerbaijan	DEV	495.2	82.7	44.7	43.9
Bahrain	DEV	-225.4	59.7	54.1	18.0
Brunei Darussalam	DEV	171.1	85.5	62.3	30.5
Cameroon	DEV	36.1	35.9	9.8	8.6
Canada	ADV	1,039.0	15.4	5.3	2.3
Chad	DEV	96.5	78.3	37.5	34.3
Colombia	EME	337.9	28.1	4.8	6.2
Congo, Rep.	DEV	251.8	83.8	67.5	64.2
Denmark	ADV	151.9	6.0	3.0	1.9
Ecuador	DEV	324.6	46.2	13.5	18.5
Egypt, Arab Rep.	EME	75.0	18.4	4.5	8.7
Equatorial Guinea	DEV	295.6	97.4	100.8	74.8
Gabon	DEV	237.5	79.9	46.8	45.0
Indonesia	EME	80.8	9.7	3.0	4.2
Iran, Islamic Rep.	DEV	2,289.0	85.0	22.0	29.4
Iraq	DEV	1,740.6	N/A	42.6	53.7
Kazakhstan	DEV	911.0	52.4	26.1	30.1
Kuwait	DEV	1,520.9	81.5	49.6	50.3
Libya	DEV	1,184.2	100	59.4	49.5

Malaysia	EME	172.4	7.2	7.4	6.7
Mexico	EME	1,703.6	12.4	3.5	5.7
Nigeria	DEV	2,162.1	97.7	38.5	28.3
Norway	ADV	2,235.8	30.6	13.2	12.0
Oman	DEV	731.3	81.0	45.4	37.8
Papua New Guinea	DEV	30.3	22.4	12.5	15.5
Qatar	EME	875.8	87.4	53.6	22.2
Russian Federation	EME	4,571.6	41.0	13.5	15.5
Saudi Arabia	DEV	6,888.5	83.9	42.9	44.1
Sudan	DEV	294.0	79.8	13.8	16.9
Syrian Arab Rep.	DEV	168.5	34.4	12.5	22.8
Timor-Leste	DEV	59.4	N/A	N/A	N/A
Trinidad and Tobago	DEV	-23.4	32.7	21.6	12.1
Turkmenistan	DEV	44.5	75.0	37.0	28.8
Tunisia	DEV	47.8	9.6	4.5	3.6
United Arab Emirates	EME	2,113.9	40.6	27.8	19.4
United Kingdom	ADV	88.2	6.2	1.8	1.1
Venezuela, RB	DEV	1,767.2	82.7	25.0	28.0
Vietnam	DEV	294.0	15.3	10.3	8.4
Yemen, Rep.	DEV	252.4	79.0	27.5	28.4

Notes: [a] Advanced economies (ADV) are based on the classification in IMF World Economic Outlook (WEO), October 2016; Emerging economies (EME) are those included in the Morgan Stanley Capital International (MSCI) Emerging Markets Index; Developing countries (DEV) are the remaining unclassified countries.

Source: [b] Thousand barrels per day, U.S. Energy Information Administration (EIA); 2000–2012 average.

[c] Oil exports from IMF World Economic Outlook (WEO); Total exports, oil rents and GDP from World Bank World Development Indicators (WDI); 2000–2012 average. N/A denotes not available.

Table 4.A2 Variables and data sources

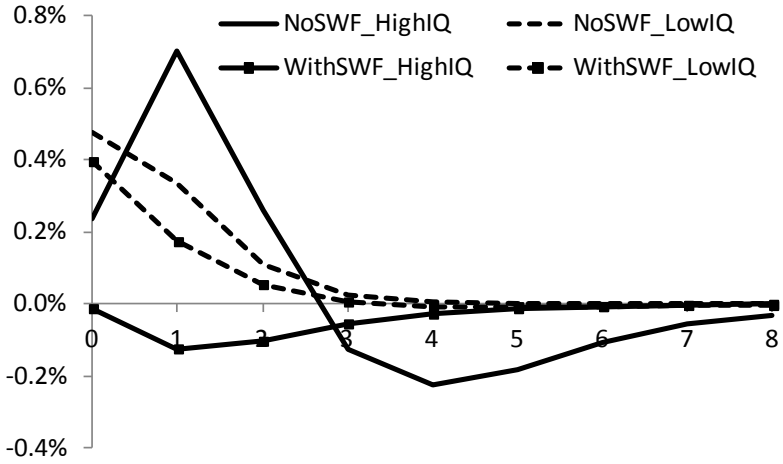
Variables[a]	**Definition**	**Symbol**	**Source**[b]
Real oil price	Crude oil price (U.S. dollars per barrel); deflated using U.S. CPI	o	IFS
Real GDP	Gross domestic product (constant local currency in billions)	y	WDI, WEO
Real government consumption	Government consumption expenditure, (current local currency in billions); deflated using national CPI	g	WDI, IFS
Price	Consumer price index (CPI) (2010=100)	p	WDI, IFS, WEO
Money supply	Money and quasi money, M2 (current local currency in billions)	m	WDI
Real exchange rate	Real effective exchange rate (2007=100)	q	Darvas (2012)

Notes: [a] All variables are expressed in natural logarithm.

[b] IFS – IMF International Financial Statistics, WDI – World Bank World Development Indicators, WEO – IMF World Economic Outlook. The primary source of the domestic variables is WDI, but if a longer time series is available in IFS or WEO, the alternative database is used. Data on government consumption and M2 for Turkmenistan are obtained from the Asian Development Bank (ADB). REER for Timor-Leste is calculated using weights of its top 20 trading partners, with CPI as the deflator. CPI for United Arab Emirates is obtained from the UAE National Bureau of Statistics.

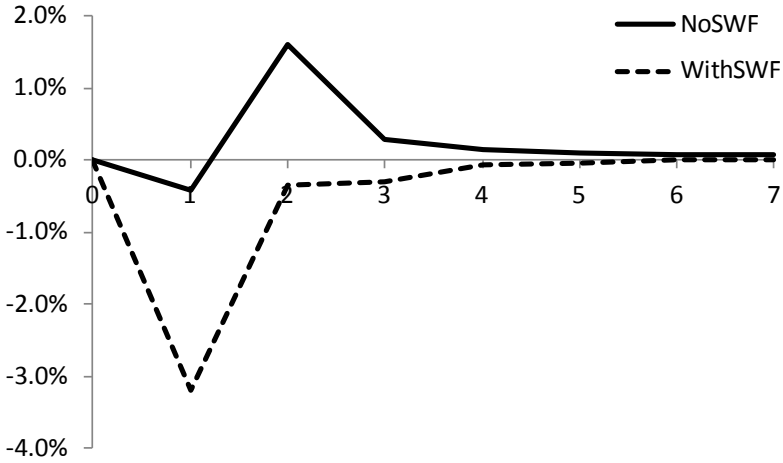
Appendix 4.B

Fig. 4.B1 Impulse responses of the cyclical component of government consumption to a 1% shock in the cyclical component of GDP



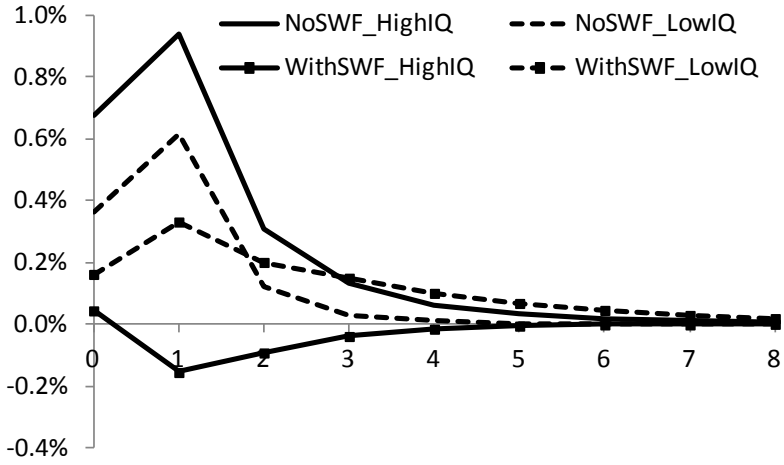
Notes: NoSWF_HighIQ – high institutional quality without oil funds; NoSWF_LowIQ – low institutional quality without oil funds; WithSWF_HighIQ – high institutional with oil funds; WithSWF_LowIQ – low institutional quality with oil funds.

Fig. 4.B2 Impulse responses of government consumption to an increase in institutional quality score of 0.1



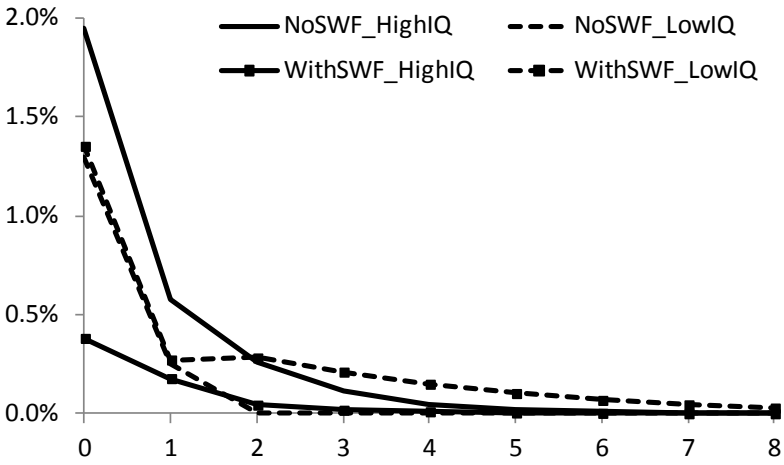
Notes: NoSWF – without oil funds; WithSWF – with oil funds.

Fig. 4.B3 Impulse responses of government consumption to a 1% shock in GDP



Notes: NoSWF_HighIQ – high institutional quality without oil funds; NoSWF_LowIQ – low institutional quality without oil funds; WithSWF_HighIQ – high institutional with oil funds; WithSWF_LowIQ – low institutional quality with oil funds.

Fig. 4.B4 Impulse responses of gross capital formation to a 1% shock in GDP



Notes: NoSWF_HighIQ – high institutional quality without oil funds; NoSWF_LowIQ – low institutional quality without oil funds; WithSWF_HighIQ – high institutional with oil funds; WithSWF_LowIQ – low institutional quality with oil funds.

Appendix 4.C

Table 4.C1a Hypothesis testing of the difference in the response of government consumption to a GDP shock with global demand and U.S. interest rate included in the model

Groups	**Coefficient of Δy**	**t statistic**
No oil funds and high IQ	0.486	0.100
No oil funds and low IQ	0.519	
No oil funds and high IQ	0.486	2.065**
With oil funds and high IQ	-0.183	
No oil funds and low IQ	0.519	1.346
With oil funds and low IQ	0.241	
With oil funds and high IQ	-0.183	2.183**
With oil funds and low IQ	0.241	

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal.

Table 4.C1b Impulse volatility (over 8 periods) in response to a 10% oil price shock with global demand and U.S. interest rate included in the model

	Δy	Δg	Δp	Δm	Δq
No oil funds and high IQ	0.05***	0.15***	0.06**	0.23***	0.11***
No oil funds and low IQ	0.18	0.46	0.14	0.54	0.30
No oil funds and high IQ	0.05	0.15	0.06	0.23	0.11
With oil funds and high IQ	0.07	0.24	0.04	0.36	0.16
No oil funds and low IQ	0.18	0.46	0.14	0.54	0.30
With oil funds and low IQ	0.12^	0.32^	0.04***	0.50	0.20^
With oil funds and high IQ	0.07*	0.24	0.04	0.36	0.16
With oil funds and low IQ	0.12	0.32	0.04	0.50	0.20

Notes: Hypothesis test of H_o: variance ratio = 1 vs. H_a: variance ratio < 1.

***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Table 4.C2a Hypothesis testing of the difference in the response of government consumption to a GDP shock with the order of GDP and government consumption reversed

Groups	**Coefficient of Δy**	**t statistic**
No oil funds and high IQ	0.435	0.330
No oil funds and low IQ	0.534	
No oil funds and high IQ	0.435	2.139**
With oil funds and high IQ	-0.183	
No oil funds and low IQ	0.534	1.368
With oil funds and low IQ	0.250	
With oil funds and high IQ	-0.183	2.240**
With oil funds and low IQ	0.250	

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal.

Table 4.C2b Impulse volatility (over 8 periods) in response to a 10% oil price shock with the order of GDP and government consumption reversed

	Δy	Δg	Δp	Δm	Δq
No oil funds and high IQ	0.05***	0.12***	0.09	0.21**	0.16**
No oil funds and low IQ	0.16	0.49	0.09	0.51	0.30
No oil funds and high IQ	0.05	0.12	0.09	0.21	0.16
With oil funds and high IQ	0.09	0.17	0.09	0.28	0.12
No oil funds and low IQ	0.16	0.49	0.09	0.51	0.30
With oil funds and low IQ	0.15	0.32^	0.09	0.48	0.20^
With oil funds and high IQ	0.09	0.17*	0.09	0.28*	0.12*
With oil funds and low IQ	0.15	0.32	0.09	0.48	0.20

Notes: Hypothesis test of H_o: variance ratio = 1 vs. H_a: variance ratio < 1.

***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Table 4.C3a Hypothesis testing of the difference in the response of government consumption to a GDP shock with two lags in the model

Groups	Coefficients of Δy		t statistic	
	1st lag	2nd lag	1st lag	2nd lag
No oil funds and high IQ	0.269	0.204	0.867	0.763
No oil funds and low IQ	0.477	-0.014		
No oil funds and high IQ	0.269	0.204	1.483^	1.208
With oil funds and high IQ	-0.086	-0.121		
No oil funds and low IQ	0.477	-0.014	0.933	0.716
With oil funds and low IQ	0.274	-0.157		
With oil funds and high IQ	-0.086	-0.121	1.661*	0.209
With oil funds and low IQ	0.274	-0.157		

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal.

Table 4.C3b Impulse volatility (over 8 periods) in response to a 10% oil price shock with two lags in the model

	Δy	Δg	Δp	Δm	Δq
No oil funds and high IQ	0.05***	0.14***	0.16	0.37^	0.17**
No oil funds and low IQ	0.19	0.51	0.15	0.56	0.35
No oil funds and high IQ	0.05	0.14	0.16	0.37	0.17
With oil funds and high IQ	0.08	0.24	0.07**	0.50	0.19
No oil funds and low IQ	0.19	0.51	0.15	0.56	0.35
With oil funds and low IQ	0.16	0.48	0.11	0.48	0.12***
With oil funds and high IQ	0.08**	0.24**	0.07	0.50	0.19
With oil funds and low IQ	0.16	0.48	0.11	0.48	0.12

Notes: Hypothesis test of H_o: variance ratio = 1 vs. H_a: variance ratio < 1.

***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Table 4.C4a Hypothesis testing of the difference in the response of government consumption to a GDP shock with advanced economies excluded

Groups	**Coefficient of Δy**	**t statistic**
No oil funds and high IQ	0.387	0.454
No oil funds and low IQ	0.534	
No oil funds and high IQ	0.387	1.894*
With oil funds and high IQ	-0.209	
No oil funds and low IQ	0.534	1.368
With oil funds and low IQ	0.250	
With oil funds and high IQ	-0.209	2.345**
With oil funds and low IQ	0.250	

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal.

Table 4.C4b Impulse volatility (over 8 periods) in response to a 10% oil price shock with advanced economies excluded

	Δy	Δg	Δp	Δm	Δq
No oil funds and high IQ	0.08**	0.16***	0.09	0.32^	0.25
No oil funds and low IQ	0.16	0.49	0.09	0.51	0.30
No oil funds and high IQ	0.08	0.16	0.09	0.32	0.25
With oil funds and high IQ	0.12	0.28	0.11	0.38	0.10***
No oil funds and low IQ	0.16	0.49	0.09	0.51	0.30
With oil funds and low IQ	0.15	0.32^	0.09	0.48	0.20^
With oil funds and high IQ	0.12	0.28	0.11	0.38	0.10**
With oil funds and low IQ	0.15	0.32	0.09	0.48	0.20

Notes: Hypothesis test of H_o: variance ratio = 1 vs. H_a: variance ratio < 1.

***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Table 4.C5a Hypothesis testing of the difference in the response of government consumption to a GDP shock with the sample period restricted to 1990–2014

Groups	**Coefficient of Δy**	**t statistic**
No oil funds and high IQ	0.281	0.500
No oil funds and low IQ	0.588	
No oil funds and high IQ	0.281	0.947
With oil funds and high IQ	-0.256	
No oil funds and low IQ	0.588	1.195
With oil funds and low IQ	0.153	
With oil funds and high IQ	-0.256	1.462^
With oil funds and low IQ	0.153	

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal.

Table 4.C5b Impulse volatility (over 8 periods) in response to a 10% oil price shock with the sample period restricted to 1990–2014

	Δy	Δg	Δp	Δm	Δq
No oil funds and high IQ	0.11	0.10***	0.07***	0.14***	0.28^
No oil funds and low IQ	0.12	0.49	0.22	0.41	0.44
No oil funds and high IQ	0.11	0.10	0.07	0.14	0.28
With oil funds and high IQ	0.17	0.15	0.13	0.23	0.09***
No oil funds and low IQ	0.12	0.49	0.22	0.41	0.44
With oil funds and low IQ	0.18	0.49	0.13*	0.47	0.22**
With oil funds and high IQ	0.17	0.15***	0.13	0.23**	0.09***
With oil funds and low IQ	0.18	0.49	0.13	0.47	0.22

Notes: Hypothesis test of H_o: variance ratio = 1 vs. H_a: variance ratio < 1.

***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Table 4.C6a Hypothesis testing of the difference in the response of government consumption to a GDP shock with hyperinflation periods removed

Groups	**Coefficient of Δy**	**t statistic**
No oil funds and high IQ	0.447	0.090
No oil funds and low IQ	0.475	
No oil funds and high IQ	0.447	2.130**
With oil funds and high IQ	-0.183	
No oil funds and low IQ	0.475	1.102
With oil funds and low IQ	0.250	
With oil funds and high IQ	-0.183	2.240**
With oil funds and low IQ	0.250	

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal.

Table 4.C6b Impulse volatility (over 8 periods) in response to a 10% oil price shock with hyperinflation periods removed

	Δy	Δg	Δp	Δm	Δq
No oil funds and high IQ	0.05***	0.13**	0.06	0.19***	0.19^
No oil funds and low IQ	0.16	0.49	0.06	0.54	0.31
No oil funds and high IQ	0.05	0.13	0.06	0.19	0.19
With oil funds and high IQ	0.09	0.17	0.09	0.28	0.12^
No oil funds and low IQ	0.16	0.49	0.06	0.54	0.31
With oil funds and low IQ	0.15	0.32^	0.09	0.48	0.20^
With oil funds and high IQ	0.09	0.17^	0.09	0.28*	0.12*
With oil funds and low IQ	0.15	0.32	0.09	0.48	0.20

Notes: Hypothesis test of H_o: variance ratio = 1 vs. H_a: variance ratio < 1.

***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Table 4.C7a Hypothesis testing of the difference in the response of government consumption to a GDP shock with the first three years of the oil fund period excluded

Groups	**Coefficient of Δy**	**t statistic**
No oil funds and high IQ	0.435	0.330
No oil funds and low IQ	0.534	
No oil funds and high IQ	0.435	1.911*
With oil funds and high IQ	-0.141	
No oil funds and low IQ	0.534	0.320
With oil funds and low IQ	0.466	
With oil funds and high IQ	-0.141	2.829***
With oil funds and low IQ	0.466	

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal.

Table 4.C7b Impulse volatility (over 8 periods) in response to a 10% oil price shock with the first three years of the oil fund period excluded

	Δy	Δg	Δp	Δm	Δq
No oil funds and high IQ	0.05***	0.12***	0.09	0.21**	0.16**
No oil funds and low IQ	0.16	0.49	0.09	0.51	0.30
No oil funds and high IQ	0.05	0.12	0.09	0.21	0.16
With oil funds and high IQ	0.10	0.16	0.05*	0.29	0.18
No oil funds and low IQ	0.16	0.49	0.09	0.51	0.30
With oil funds and low IQ	0.16	0.32^	0.08	0.40	0.11***
With oil funds and high IQ	0.10	0.16**	0.05	0.29	0.18
With oil funds and low IQ	0.16	0.32	0.08	0.40	0.11

Notes: Hypothesis test of H_o: variance ratio = 1 vs. H_a: variance ratio < 1.

***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Table 4.C8a Hypothesis testing of the difference in the response of government consumption to a GDP shock with national real oil price series

Groups	**Coefficient of Δy**	**t statistic**
No oil funds and high IQ	0.381	0.605
No oil funds and low IQ	0.560	
No oil funds and high IQ	0.381	1.979**
With oil funds and high IQ	-0.188	
No oil funds and low IQ	0.560	1.510^
With oil funds and low IQ	0.250	
With oil funds and high IQ	-0.188	2.273**
With oil funds and low IQ	0.250	

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal.

Table 4.C8b Impulse volatility (over 8 periods) in response to a 10% oil price shock with national real oil price series

	Δy	Δg	Δp	Δm	Δq
No oil funds and high IQ	0.05**	0.17	0.06	0.39	0.50^
No oil funds and low IQ	0.13	0.23	0.06	0.28	0.77
No oil funds and high IQ	0.05	0.17	0.06	0.39	0.50
With oil funds and high IQ	0.09	0.24	0.08	0.41	0.07***
No oil funds and low IQ	0.13	0.23	0.06	0.28	0.77
With oil funds and low IQ	0.14	0.29	0.03**	0.51	0.62
With oil funds and high IQ	0.09^	0.24	0.08	0.41	0.07***
With oil funds and low IQ	0.14	0.29	0.03	0.51	0.62

Notes: Hypothesis test of H_o: variance ratio = 1 vs. H_a: variance ratio < 1.

***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Table 4.C9a Hypothesis testing of the difference in the response of government consumption to a GDP shock under large oil price changes

Groups	**Coefficient of Δy**	**t statistic**
No oil funds and high IQ	0.433	0.361
No oil funds and low IQ	0.542	
No oil funds and high IQ	0.433	2.139**
With oil funds and high IQ	-0.188	
No oil funds and low IQ	0.542	1.275
With oil funds and low IQ	0.274	
With oil funds and high IQ	-0.188	2.370**
With oil funds and low IQ	0.274	

Notes: Hypothesis test of H_o: coefficients are equal vs. H_a: coefficients are not equal.

Table 4.C9b Impulse volatility (over 8 periods) in response to a 10% oil price shock under large oil price changes

	Δy	Δg	Δp	Δm	Δq
No oil funds and high IQ	0.06***	0.17***	0.03**	0.23***	0.25
No oil funds and low IQ	0.16	0.55	0.06	0.58	0.31
No oil funds and high IQ	0.06	0.17	0.03	0.23	0.25
With oil funds and high IQ	0.10	0.27	0.06	0.35	0.19
No oil funds and low IQ	0.16	0.55	0.06	0.58	0.31
With oil funds and low IQ	0.12	0.27**	0.11	0.44	0.14**
With oil funds and high IQ	0.10	0.27	0.06*	0.35	0.19
With oil funds and low IQ	0.12	0.27	0.11	0.44	0.14

Notes: Hypothesis test of H_o: variance ratio = 1 vs. H_a: variance ratio < 1.

***, **, *, ^ denotes statistical significance at the 1%, 5%, 10%, 15% levels respectively.

Chapter 5

Fiscal cyclicality in Brunei Darussalam

ABSTRACT

This paper examines the conduct of fiscal policy in Brunei from 2003Q1 to 2014Q2, focusing on the cyclical patterns in government expenditure. The results from a structural vector autoregression model provide evidence that fiscal policy in Brunei is procyclical, which has an expansionary effect on output and thus exacerbates the business cycle. This behaviour is primarily driven by procyclical current expenditure while capital expenditure is largely acyclical. The government should exercise caution to avoid adding cyclical pressures to the economy already afflicted by volatile oil prices. A key policy recommendation would be to adopt clear fiscal rules to better integrate Brunei's oil funds into the budgetary framework to delink government spending from volatile oil revenue.

5.1 Introduction

The plunge in crude oil prices over the past two years, from US$110 per barrel in June 2014 to US$45 per barrel in September 2016, is putting heavy pressure on the fiscal balance of oil-exporting countries. Brunei is no exception. The oil and gas sector accounts for 90% of the government's revenue. Brunei's projected fiscal deficit for 2016 stands at B$3.85 billion, an astounding 26% of GDP (IMF, 2016a). The economy contracted by 0.6% in 2015, following a decline of 2.1% and 2.3% in 2013 and 2014 respectively.[46]

The large fall in oil prices necessitates short-run macroeconomic adjustments. According to economic theory dating back to Friedman (1953) and Poole (1970), oil-exporting countries with a flexible exchange rate regime can adjust through an exchange rate depreciation, which increases the domestic price of oil exports when its international price has fallen. This helps to soften the impact of adverse oil prices and hence stabilizes output. However, this is not a viable policy option for the country since the exchange rate regime is based on a currency board arrangement in which the Brunei dollar is pegged at par to the Singapore dollar. Both countries have openly committed to maintaining the Currency Interchangeability Arrangement (CIA) signed in 1967 (see Rajak, 2015).

Fiscal policy, therefore, has to bear the bulk of the macroeconomic adjustment costs. Brunei has accumulated surplus oil revenues in its General Reserve Fund (GRF) under the Brunei Investment Agency (BIA), which was set up in 1983. Besides the saving for future generations, the GRF can also be used to finance budgetary shortfalls (IMF, 1999). According to the Sovereign Wealth Fund Institute, BIA's assets are valued at US$40 billion (SWFI, 2016).[47] This fiscal buffer is large enough to absorb fiscal deficits of the projected magnitude for 2016 for about 20 years. In 2008, the country

[46] Besides the fall in oil prices, Brunei's oil production has also been declining due to protracted closure of wells and pipelines for maintenance.

[47] Before the global financial crisis of 2007–8, BIA's assets were estimated at US$100 billion (Demange, 2009). Estimates of the fund size are highly imprecise since asset holdings are not disclosed. The fund has a Linaburg-Maduell transparency rating of 1, indicating that is highly secretive. Foreign investment income from the BIA accruing to the General Reserve Fund is also not recorded in the government budget (IMF, 1999).

established the Sustainability Fund Act which comprises three trust sub-funds. One of the sub-funds is the Fiscal Stabilization Reserve Fund (FSRF) to make up for government revenue shortfalls. Despite not having explicit fiscal rules, it can be inferred from the objectives of the GRF and FSRF that the government aims to maintain a neutral fiscal stance (i.e., acyclical fiscal policy) so that government expenditure is not disrupted by volatile oil revenue. This is a prudent macroeconomic stabilization measure since procyclical fiscal policy exacerbates the business cycle and therefore cannot be optimal from either a Keynesian or neoclassical theoretical perspective (see e.g., Ilzetzki and Végh, 2008).

The purpose of this paper is to examine the conduct of fiscal policy in Brunei, in particular, to assess the extent of fiscal cyclicality and its impact on output. This has important policy implications. For instance, if fiscal policy is procyclical, it amplifies the business cycle by increasing output volatility. In this case the government should consider exercising fiscal restraint by adopting clear fiscal rules and strengthening the governance of the reserve funds to ensure government expenditure does not co-move with oil prices. This would allow smoother execution of the planned projects in the five-year national development plans.

The remainder of this paper is organized as follows. Section 5.2 presents a brief overview of the literature on fiscal procyclicality in resource-rich countries. Section 5.3 takes a preliminary look at fiscal cyclicality in Brunei. Section 5.4 describes the econometric methodology, Section 5.5 discusses the empirical results, and Section 5.6 concludes.

5.2 Procyclical fiscal policy in resource-rich countries

Fiscal policy is defined as procyclical if government spending increases in good times and falls in bad times. This is dubbed the ‘when it rains, it pours’ phenomenon by Kaminsky et al. (2004). The fact that fiscal policy is procyclical in developing countries has been documented in several studies (e.g., Gavin and Perotti, 1997; Kaminsky et al., 2004; Talvi and Végh, 2005; Ilzetzki and Végh, 2008; Carneiro and Garrido, 2015).[45]

[45] On the other hand, fiscal policy in advanced economies is countercyclical or acyclical (see Arreaza et al., 1998; Lane, 2003).

This phenomenon is also observed when the sample is restricted to resource-rich countries (e.g., Céspedes and Velasco, 2014). The two main explanations in the literature on why countries would pursue a procyclical fiscal policy are: (i) borrowing constraints during bad times and hence the need to cut back spending; and (ii) political economy arguments, for example, fiscal profligacy during good times in response to pressures to distribute windfalls.

Frankel et al. (2013) find that a third of the developing world has 'graduated' from fiscal procyclicality over the past decade. Almost half of this cohort consists of oil-exporting countries, and coincidentally, this period corresponds to the proliferation of oil funds. Several papers investigate whether oil funds, or resource funds more generally, are associated with reduced fiscal procyclicality, but the empirical evidence is mixed (e.g., Ossowski et al., 2008; Coutinho et al., 2014). A key conclusion from these studies emphasizes the role of good institutions in implementing sound macroeconomic policies to stabilize the economy. Thus the macroeconomic stabilization effect of resource funds, if any, is achieved not only through the operation of the funds but also via political incentives.

A case in point is Norway, often cited for the success of integrating its oil fund, known as the Government Pension Fund Global (GPFG), into the country's overall macroeconomic policy. Norway's GPFG, with assets of US$885 billion (SWFI, 2016), is independently managed by the Norges Bank Investment Management within the central bank with clear mandates on investment holdings, accumulation and withdrawal rules, and clear lines of reporting, accountability, and transparency.[46] The transparent governance structure and the integration mechanism with fiscal policy are key factors in achieving macroeconomic stability (Ekeli and Sy, 2011).

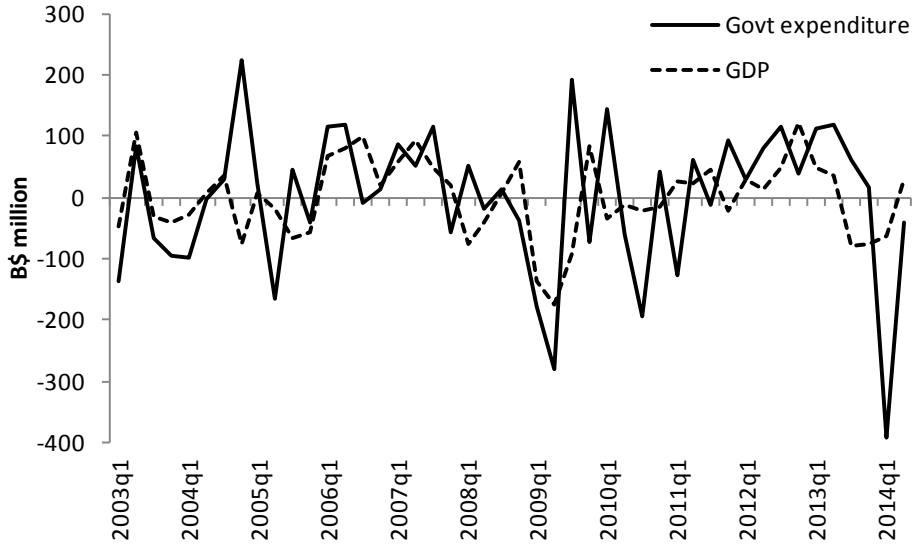
5.3 Stylized facts on fiscal cyclicality in Brunei

Figure 5.1 plots the cyclical component of real government expenditure and real GDP of Brunei using quarterly data from 2003Q1 to 2014Q2. The data series are seasonally adjusted using the X-12 census method and the cyclical components are extracted using the Hodrick-Prescott filter. The variables and data sources are summarized in Table

[46] Norway's oil fund has a maximum Linaburg-Maduell transparency rating of 10.

5.A1 in Appendix 5.A. As seen in Fig. 5.1, the co-movement of government expenditure and GDP is evident in some periods. The correlation between the two series is 0.34.[47] Another view of fiscal cyclicality is to look at the percentage changes (growth rates) of real government expenditure and GDP. This is shown in Fig. 5.2. Similarly, some co-movement is observed, with a correlation of 0.10.[48]

Fig. 5.1 Cyclical component of real government expenditure and GDP



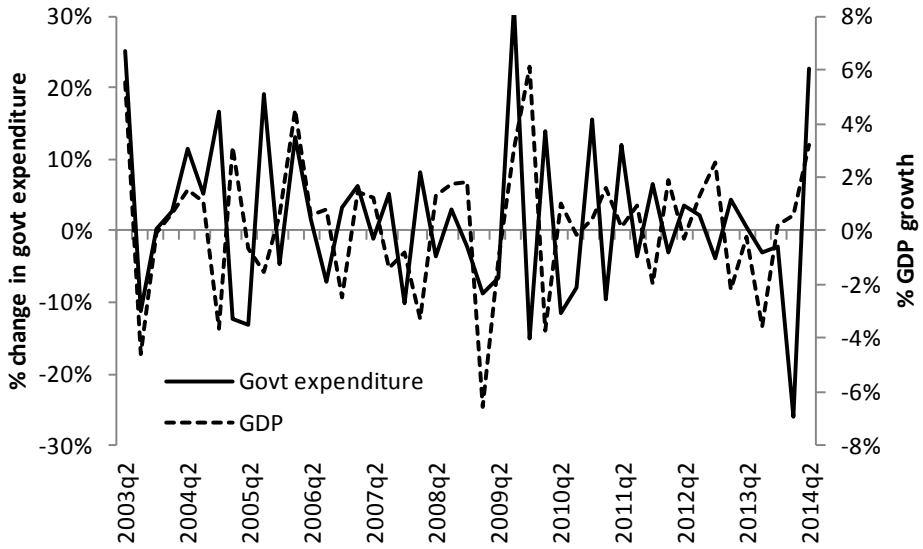
However, a positive correlation does not indicate causality from the business cycle to fiscal policy. The pattern could also be explained by reverse causality, in which fiscal policy drives output. Procyclical fiscal policy can only be inferred if the observed positive relationship remains after properly accounting for this endogeneity problem. There are generally two methodological approaches used in the empirical literature: (i) using instrumental variables for output in a regression of a fiscal policy measure on

[47] The Hodrick-Prescott filter is the standard method for removing trends in the business cycle literature (Ravn and Uhlig, 2002). The positive correlation between the cyclical components of real GDP and real government expenditure is also observed using alternative filters. They are 0.68, 0.66, and 0.31 using the Baxter-King, Christiano-Fitzgerald, and Butterworth filters respectively.

[48] 'Good' and 'bad' times in the literature are normally defined as an increase and decrease in GDP, respectively. For Brunei's case, GDP can also be replaced with government revenue such that an increase (a decrease) in government revenue from oil price booms (busts) is considered good (bad) times. The correlation of the cyclical component of real government expenditure and real government revenue is 0.24, while it is 0.23 using percentage changes instead. Regardless of the definition, this positive correlation is still observed.

output; and (ii) using vector autoregression (VAR) in which all the variables are endogenous. Both approaches are adopted in the analysis in the following section, but the primary focus is on the dynamic impulse responses of the VAR model.

Fig. 5.2 Percentage changes of real government expenditure and GDP



5.4 Econometric specifications

5.4.1 Ordinary least squares (OLS) and instrument variables (IV)

The following empirical model specification is first specified:

$$\Delta g_t = \alpha + \beta \Delta y_t + \theta \Delta o_t + \delta \Delta g_{t-1} + \varepsilon_t \tag{5.1}$$

where g_t is the log of real government expenditure, y_t is log of real GDP, o_t is log of the real oil price, and Δ is the difference operator. Taking the first difference of log variables approximates growth rates. The real oil price is obtained by converting the oil price in US$ per barrel into local currency and then deflated using Brunei's CPI (see Table 5.A1 in Appendix 5.A for details on variables and data sources). Equation (5.1) can be viewed as a fiscal reaction function in which fiscal policy responds to contemporaneous GDP growth, oil price changes, and lagged government expenditure. Oil price change is included to control for exogenous oil price shocks and the lagged dependent variable allows mean reversion of fiscal behaviour.

Fiscal cyclicality is determined by the sign and magnitude of the β coefficient, which measures the elasticity of government expenditure with respect to GDP growth. A positive value indicates that fiscal policy is procyclical, a value of zero represents acyclical fiscal policy, while a negative value corresponds to countercyclical fiscal policy. In the case of Brunei being highly dependent on oil, the θ coefficient also provides some indication of cyclicality. During oil price booms, which should benefit Brunei's economy, an increase in government spending is also symptomatic of procyclical fiscal policy.

As mentioned in Section 5.3, there is potential reverse causality between output and government expenditure. The usual approach is to estimate eq. (5.1) using two stage least squares (2SLS). Following Ilzetzki and Végh (2008), the trade-weighted GDP growth of Brunei's main trading partners is used to instrument for output.[49] As argued in Jaimovich and Panizza (2007), this is a valid instrument since trading partners' growth rate should be correlated with Brunei's output (e.g., Korea's demand for Brunei's oil and gas increase as its economy grows) while Brunei's government spending has no effect on the growth rates of its trading partners.

A variation to eq. (5.1) is to specify a lagged fiscal rule instead. This is perhaps more appropriate with the use of quarterly data since GDP data is usually released after a quarter. In this case, Δy_t is replaced by Δy_{t-1} in eq. (5.1), i.e., government expenditure responds to lagged output. The coefficients can be estimated consistently using ordinary least squares (OLS).

5.4.2 Vector autoregression (VAR)

The next empirical framework used is based on the structural VAR approach. A three-variable VAR consisting of oil price, government expenditure, and GDP is used, and the focus is on the dynamic impulse responses of government expenditure to an

[49] Brunei's main trading partners are Japan, Korea, Singapore, Malaysia, Thailand, Australia, China, United States, the Euro Area, Indonesia, India, and the United Kingdom.

unanticipated output shock.[50] The reduced-form VAR model of order p (i.e., p number of lags) has the following specification:

$$Z_t = A_0 + \sum_{j=1}^{p} A_j Z_{t-j} + e_t \tag{5.2}$$

where $Z_t = (\Delta o_t, \Delta g_t, \Delta y_t)'$ is the vector of stationary endogenous variables, A_0 is the intercept vector, A_j is the j^{th} matrix of autoregressive coefficients for $j = 1, \dots, p$, and e_t is a vector of reduced-form residuals.

Since the reduced-form residuals are correlated and cannot be interpreted as structural shocks, a block-recursive structure is imposed on the contemporaneous relationship between the reduced-form residuals and the structural innovations to orthogonalize the shocks:

$$e_t = \begin{pmatrix} e_t^o \\ e_t^g \\ e_t^y \end{pmatrix} = \begin{pmatrix} a_{11} & 0 & 0 \\ a_{21} & a_{22} & 0 \\ a_{31} & a_{32} & a_{33} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{oil\ price\ shock} \\ \varepsilon_t^{fiscal\ shock} \\ \varepsilon_t^{GDP\ shock} \end{pmatrix} \tag{5.3}$$

The zeros in the top row correspond to the small open economy assumption, in which domestic variables have no effect on the global oil price (block exogeneity restriction). The zero in the second row reflects the assumption that GDP does not have a contemporaneous effect on government expenditure, but GDP can affect government expenditure after one period (quarter). This is the usual identification approach following Blanchard and Perotti (2002) in which policymakers take more than a quarter to learn about a GDP shock. The impulse response of government expenditure to a GDP shock after one quarter captures the β coefficient in the fiscal reaction function in eq. (5.1).

[50] These three variables are most relevant in the context of examining fiscal procyclicality in oil-exporting countries. Husain et al. (2008) also use a three-variable specification.

5.5 Empirical results

5.5.1 Is fiscal policy in Brunei procyclical?

The estimation results of eq. (5.1) using both OLS and 2SLS are shown in Table 5.1. The point estimate of the β and θ coefficients are positive in all the specifications; however, the standard errors are large. From a statistical standpoint, the results are inconclusive because of the relatively small sample size (46 observations).[51] Nevertheless, the consistency of the positive coefficient estimates is suggestive of procyclical fiscal policy.

Table 5.1 Estimation results using OLS and 2SLS

	Dependent variable: Δg_t		
Variables	**OLS**	**OLS**	**IV**
Δy_t	0.564		0.317
	(0.624)		(1.58)
Δy_{t-1}		0.571	
		(0.592)	
Δo_t	0.080	0.100	0.084
	(0.105)	(0.106)	(0.109)
Δg_{t-1}	-0.533***	-0.511***	-0.547*
	(0.136)	(0.133)	(0.334)
constant	0.012	0.011	0.013
	(0.015)	(0.015)	(0.016)
Adjusted R^2	0.229	0.231	0.215

Notes: o, g, y are log of real oil price, real government expenditure, and real GDP, respectively. IV – output instrumented using contemporaneous and three lags of trade-weighted GDP growth of Brunei's main trading partners. Standard errors are in parentheses. ***, **, * denote statistical significance at the 1%, 5%, 10% level.

Turning next to the VAR model in eq. (5.2), the lag length selected based on the Schwartz-Bayesian Information Criterion (SBIC) is two. Unit root tests using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests (see Dickey and Fuller,

[51] Quarterly GDP data for Brunei is only available from 2003Q1, thus the small sample size of 46.

1979; Phillips and Perron, 1988) suggest that the variables in first log differences are stationary. The results are summarized in Table 5.2.

Table 5.2 Unit root tests

	ADF test		PP test	
Variables	**C**	**C&T**	**C**	**C&T**
Δo_t	-4.20***	-4.36***	-5.26***	-5.29***
Δg_t	-4.66***	-5.14***	-12.05***	-12.43***
Δy_t	-6.95***	-6.87***	-8.55***	-8.41***

Notes: o, g, y are log of real oil price, real government expenditure, and real GDP, respectively. ADF – Augmented Dickey-Fuller; PP – Phillips-Perron. C denotes the unit root test with a constant term and without a trend. C&T denotes the unit root test with both a constant term and trend. ***, **, * denote statistical significance at the 1%, 5%, 10% level respectively.

Figure 5.3 plots the cumulative impulse responses of the variables to the structural shocks. Oil price and fiscal shocks are normalized to 10% while GDP shock is normalized to 1%. This is roughly the size of one standard deviation of the respective shocks and allows easier interpretation of the results. The solid lines are the mean responses while the dotted lines correspond to the 90% error bands.

In response to a 10% oil price shock, government expenditure increases and reaches a peak of 2.7% after a quarter. GDP also increases with a peak of 0.7% after two quarters. These positive effects are statistically significant. The increase in government expenditure also has an expansionary effect on GDP. This can be seen in the response of GDP to a 10% fiscal shock, in which the peak increase in GDP is 0.9% after a quarter.[52] In response to a 1% GDP shock, government expenditure increases by 1.2% after a lag and the positive response is statistically significant. Taken together, the results here provide evidence of procyclical fiscal policy in Brunei, which reinforces the business cycle.

[52] Note that the oil price is not affected by fiscal and GDP shocks, reflecting the imposed block exogeneity assumption (i.e., domestic shocks have no impact on global oil price).

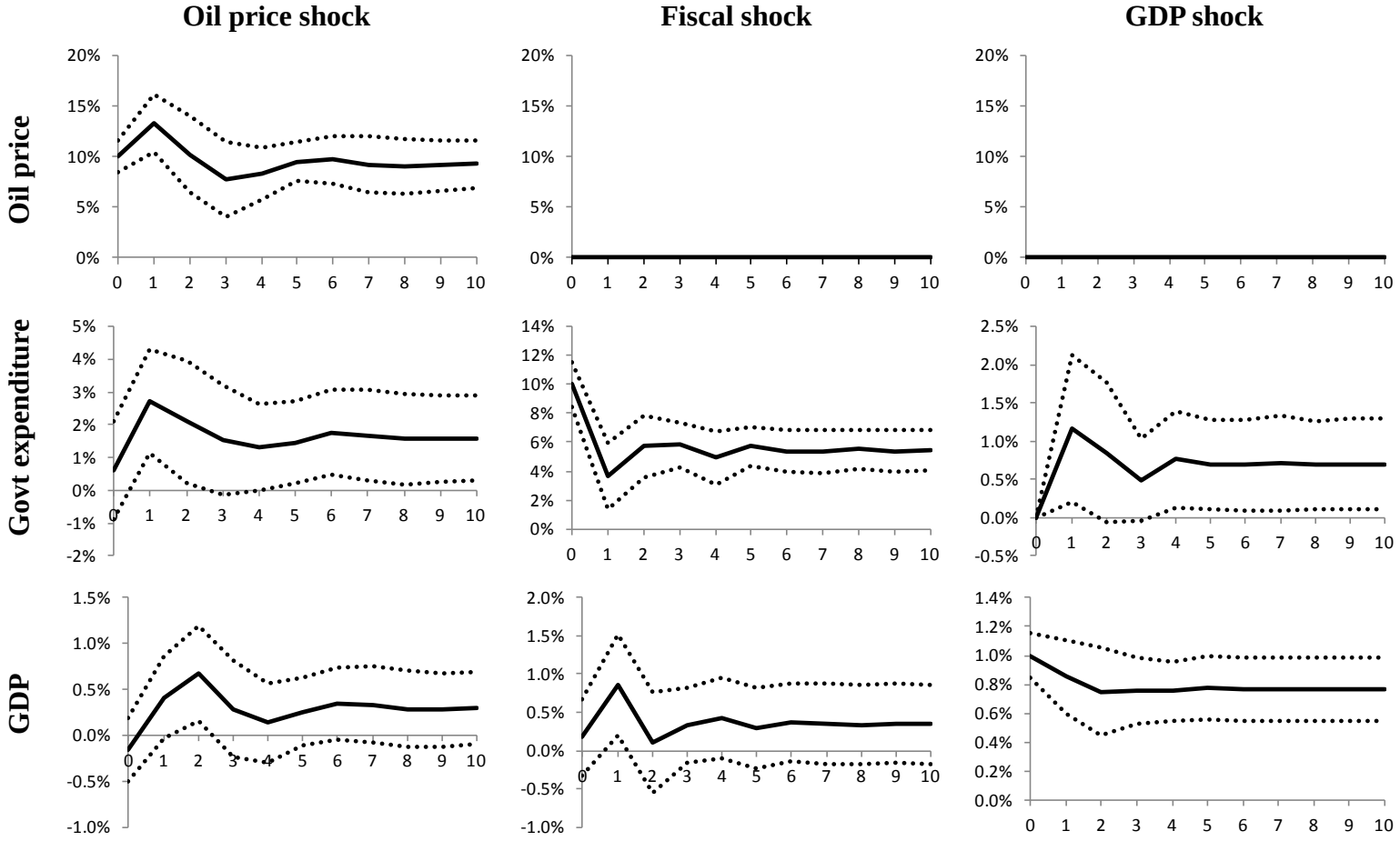
5.5.2 Does the composition of government spending matter?

Although procyclical fiscal policy is undesirable from both neoclassical and Keynesian perspectives, the situation is aggravated if spending on capital investment is also procyclical, especially if it is scaled down during cycle downturns. In this section, the analysis is extended to examine the composition of government spending. Government expenditure can be broadly classified into current and capital expenditure. Current expenditure consists of items such as wages and salaries, royalties, and pensions (i.e., government consumption). Capital expenditure is mainly spending on infrastructure and development projects (i.e., government investment). The correlation between the cyclical component of real government current expenditure and GDP is 0.32, while the correlation is 0.15 between real government capital expenditure and GDP. Using percentage changes instead, the correlations are 0.19 and -0.02. The correlations suggest current expenditure is more procyclical compared to capital expenditure.

The VAR model in eq. (5.2) is now estimated separately with the government expenditure components. Figure 5.4 shows the cumulative impulse responses with government current expenditure in the VAR model. The results appear similar to Fig. 5.3. In response to an oil price shock, government current expenditure increases significantly. Likewise, it increases in response to a GDP shock though the error bands suggest that the effect is not statistically significant. Figure 5.5 plots the cumulative impulse responses with government capital expenditure. A striking observation is that the responses are now different from Figs 5.3 and 5.4. Oil price shocks do not have any statistically significant impact on government capital expenditure. Similarly, an increase in GDP does not lead to an increase in government capital expenditure. These findings clearly show that while current spending is procyclical, capital spending is largely acyclical.

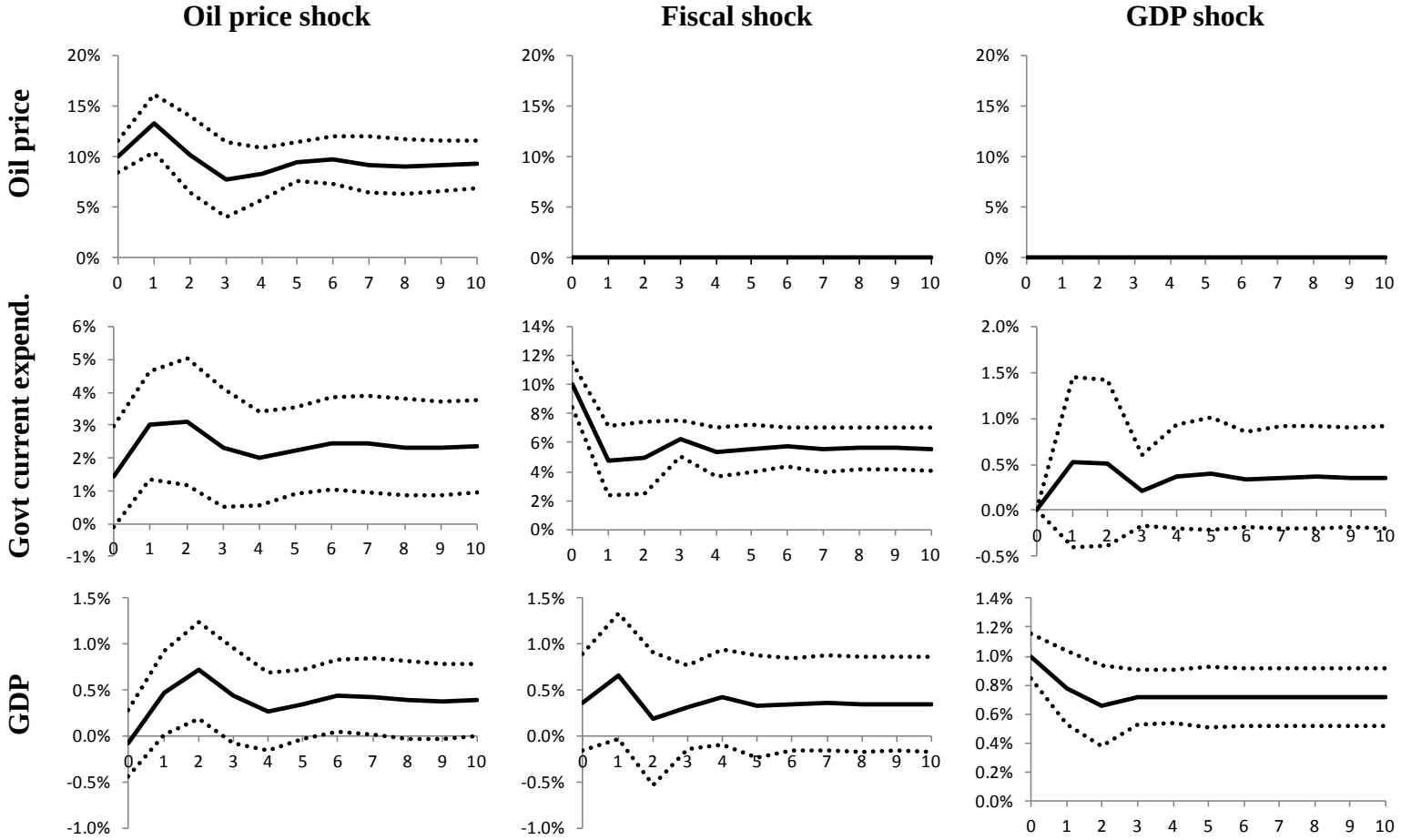
The results here tell an important story. Public capital investment in development projects such as building roads, schools, hospitals, and other infrastructure is vital to enhancing productivity and economic growth as documented in several studies (e.g., Aschauer, 1989; Romp and de Haan, 2007). Procyclical public capital spending in which development projects are pushed ahead during good times but are being cut back during bad times would have had a damaging impact on the economy. Although

Fig. 5.3 Cumulative impulse responses to structural shocks



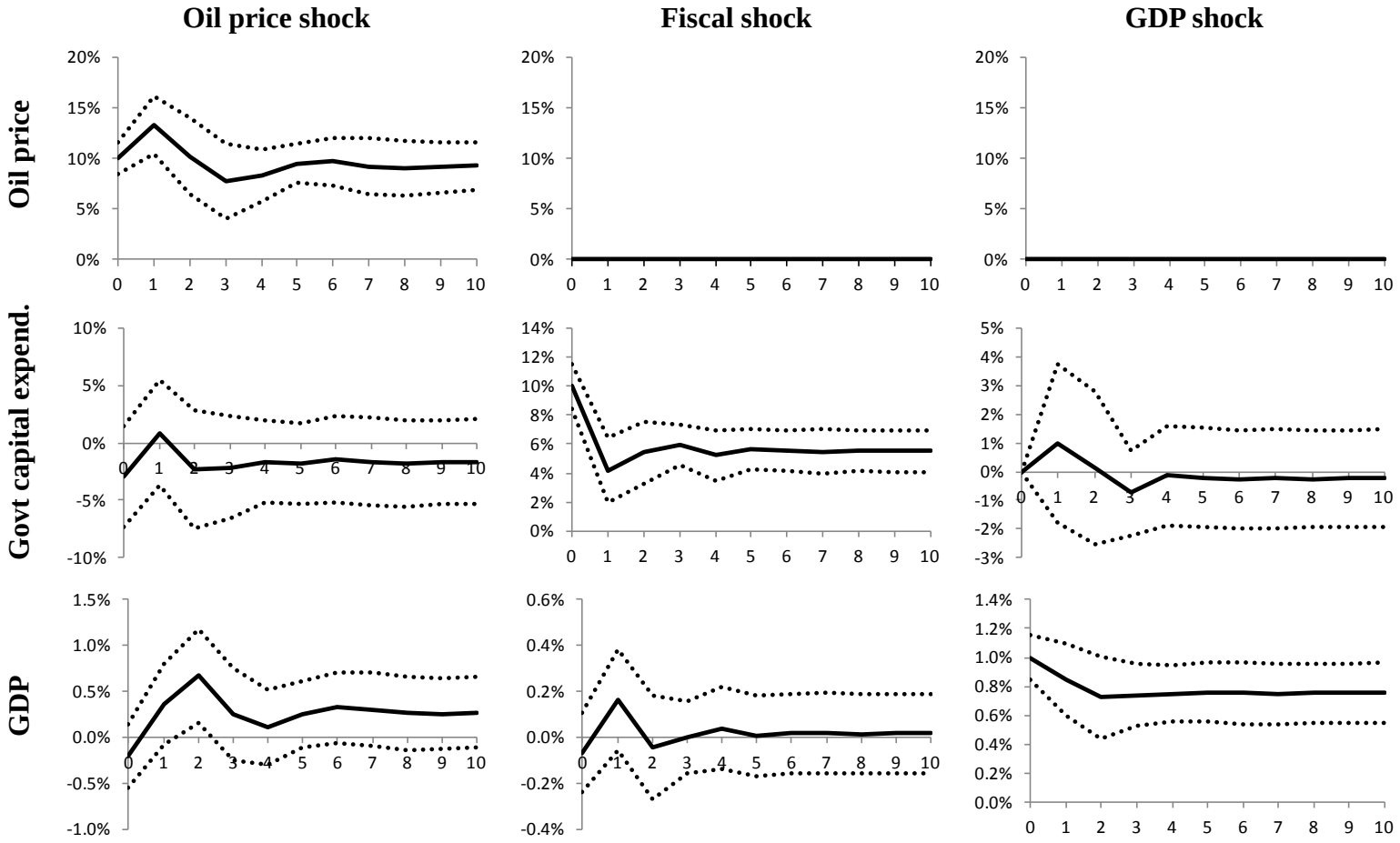
Notes: Solid lines are the mean impulse responses; dotted lines are the 90% error bands.

Fig. 5.4 Cumulative impulse responses to structural shocks, with real government current expenditure



Notes: Solid lines are the mean impulse responses; dotted lines are the 90% error bands.

Fig. 5.5 Cumulative impulse responses to structural shocks, with real government capital expenditure



Notes: Solid lines are the mean impulse responses; dotted lines are the 90% error bands.

policymakers in Brunei can take comfort that government capital spending does not experience boom and bust cycles that can be harmful to economic health, they should be wary about the procyclical current spending behaviour. Current expenditure makes up about 80% of total government expenditure, and its procyclical nature exacerbates the business cycle. Fiscal consolidation, especially in reducing current spending, is already a recurrent theme in the IMF Article IV consultations with Brunei. The finding that government current expenditure amplifies the business cycle should further push fiscal spending reform higher up in the national agenda. There is also a need to develop explicit fiscal rules and better integrate the reserve funds into the government budgetary framework.

5.6 Conclusion

The current episode of falling oil prices is straining Brunei's public finances. Brunei's fiscal deficit is projected to be B$3.85 billion in 2016, an alarming 26% of GDP. Oil prices are expected to remain low through 2017 and there is a need for short-run macroeconomic adjustments. While oil exporters with flexible exchange rates can adjust through currency depreciations, fiscal policy is Brunei's main policy tool. The budgetary shortfall can be financed by transfers from Brunei's oil fund, which is large enough to sustain such deficits for about 20 years. This would help to prevent drastic cuts in government spending which can amplify output volatility.

This paper examines the conduct of fiscal policy in Brunei, in particular, in assessing the cyclical patterns in government expenditure. Using quarterly data from 2003Q1 to 2014Q2, the primary focus is on the dynamic impulse responses of government expenditure to oil price and GDP shocks based on the structural vector autoregression approach. The empirical results provide evidence of procyclical fiscal policy having an expansionary effect on output, thus amplifying output volatility. The results also show that government capital spending is acyclical, and the procyclical nature of fiscal policy is largely driven by government current spending. With current expenditure making up about 80% of total fiscal spending, the procyclical behaviour which exacerbates the business cycle is of policy concern.

The government should weigh the costs of procyclical current expenditure on the economy against the benefits. While balancing such considerations is beyond the scope of this paper, a compelling reason as to why the costs could outweigh the benefits centres on the structure of Brunei's economy. Being a small, open economy highly dependent on oil and gas, Brunei is already subjected to volatile international prices. Adding cyclical pressures through a procyclical fiscal stance is clearly undesirable. In this respect, the passing of the Sustainability Fund Act to set up a reserve fund for fiscal stabilization is certainly an encouraging move. However, policymakers need to devise explicit fiscal rules and better integrate the oil reserve fund into the budgetary framework to decouple government spending from volatile oil revenue to prevent boom and bust cycles. A neutral fiscal stance would then allow smoother execution of Brunei's five-year national development plans.

Appendix 5.A

Table 5.A1 Variables and data sources

Variables	Definition	Symbol	Source[a]
Real oil price	World crude oil price (U.S. dollars per barrel) converted to Brunei dollars and deflated by Brunei CPI	o	IFS
Real GDP	Gross domestic product (constant local currency in billions)	y	IMF country report
Real government expenditure	Government expenditure, (current local currency in billions); deflated using national CPI	g	IMF country report

Notes: [a] IFS – IMF International Financial Statistics, IMF country report – Brunei Darussalam Statistical Appendix, where the primary data source is from Brunei's Department of Economic Planning and Development and the Ministry of Finance.

Chapter 6

Sources of macroeconomic fluctuations in Brunei Darussalam

ABSTRACT

This paper investigates the sources of macroeconomic fluctuations in Brunei Darussalam from 2003Q1 to 2014Q3 using a structural vector autoregression model. Shocks are identified by imposing block exogeneity and long-run restrictions motivated by an open economy model that includes oil prices. The results show that oil price shocks account for only a small proportion of output fluctuations while productivity shocks have the largest share. Real exchange rate movements are largely driven by demand shocks while monetary shocks explain most of the variability in prices. Economic policies should focus on productivity improvement and capital investment to increase output in the long run, and the conduct of fiscal policy should take into account the impact on real exchange rate volatility.

6.1 Introduction

Brunei Darussalam, like many other oil-exporting countries, is facing immense pressures on public finances with oil prices plummeting from US$110 per barrel in June 2014 to US$45 per barrel as of September 2016, and is projected to see a budget deficit of B$3.85 billion in 2016, an astounding 26% of GDP (IMF, 2016a). In addition to declining oil prices, oil production in Brunei has also dwindled to 122 thousand barrels per day (tbpd) in 2015Q3 from a recent peak of 228 tbpd in 2006Q3 due to supply constraints as oil wells are depleted. Adding to these woes is the decline in labour productivity and a low rate of capital investment (Koh, 2014). It is therefore not surprising that Brunei has only achieved GDP growth of 0.7% averaged over the past decade, a far cry from the nation's target of 6%. To design effective macroeconomic policies, it is important to first understand the underlying forces of macroeconomic fluctuations and their impact on the economy.

Identifying the sources of macroeconomic fluctuations and assessing the relative importance of shocks in the propagation of business cycles is an important strand of applied macroeconomic research. In particular, the role of oil price shocks has attracted considerable attention since the seminal work of Hamilton (1983). Structural vector autoregression (SVAR) models are a popular approach used in studying business cycles. Early SVAR work that includes oil prices focus on the U.S. economy (e.g., Shapiro and Watson, 1988; Rotemberg and Woodford, 1996), and it is only in the past decade or so that other advanced economies (e.g., Jiménez-Rodríguez and Sanchez, 2005; Kilian, 2008), emerging economies (e.g., Hoffmaister and Roldos, 2001; Huang and Guo, 2007), and oil-exporting countries (e.g., Bjørnland, 2004; Mehrara and Oskoui, 2007) gain much coverage in the literature.

The findings from these studies show that in oil-importing countries, oil price shocks lead to a fall in output and an increase in prices, supply shocks increase output but decrease prices, and demand shocks increase both output and prices.[56] The effects on the real exchange rate are somewhat mixed. However, oil price shocks account for only a small proportion of macroeconomic fluctuations. Supply shocks account for most

[56] Blanchard and Galí (2009) find that the macroeconomic effects of oil price shocks have in fact declined over time in advanced economies.

of output variability, while demand and/or monetary shocks explain most of real exchange rate and price fluctuations. These findings are generally echoed in studies of oil-exporting countries, except for the fact that oil price shocks increase output as expected.[57]

The objective of this paper is to provide answers to the following questions: (i) What are the sources of fluctuations in Brunei's GDP, real exchange rate, and prices?; and (ii) To what extent do oil price shocks influence the Brunei economy, and how important are they compared to domestic shocks? The results from a SVAR model with shocks identified using block exogeneity and long-run restrictions show that oil price shocks account for only a small proportion of output fluctuations; the bulk of output movements are explained by productivity (supply) shocks. Real exchange rate movements are largely explained by demand shocks while price fluctuations are due to monetary shocks. These findings are consistent with those of existing studies, and highlight the fact that oil price shocks are not as important compared to other sources of shocks. Focusing on structural reforms such as improving productivity, increasing capital investment in oil and gas exploration and production to boost supply capacity, as well as devising clear fiscal rules to avoid incurring excessive real exchange rate volatility should therefore be accorded high priority in the government's policy agenda.

An implicit assumption in many SVAR studies is that exogenous changes in the oil price result from oil supply shocks ('traditional' view). More recently, Kilian (2009) argues that oil price fluctuations, like all other commodity prices, are driven by both global demand and supply shocks and therefore determining the underlying cause of oil price increases is important ('modern' view). As such, recent studies focus on the impact of different types of oil shocks (e.g., Peersman and van Robays, 2012; Cashin et al., 2014). For instance, Cashin et al. (2014) find that the economic consequences of a supply-driven oil price shock are different from those of a demand-driven shock, and

[57] There are a few exceptions; e.g., Mehrara and Oskoui (2007) find that oil price shocks are the main cause of output fluctuations in Saudi Arabia and Iran, but Dibooğlu and Aleisa (2004) and Korhonen and Mehrotra (2009) find that supply shocks explain most of output fluctuations in these countries, in accordance with the findings in most studies. A possible reason is the sample period considered in Mehrara and Oskoui (2007) which covers the two oil crisis in the 1970s (Arab embargo in the Yom Kippur War in 1973–74 and the Iranian revolution in 1979).

the effects also vary for oil importers compared to oil exporters. While oil-importing countries experience a fall in economic activity in response to a supply-driven oil price increase, the impact is positive for oil-exporting countries with large proven oil reserves. However, such cross-country differences are absent when faced with a demand-driven oil price increase.

As this paper is the first attempt in understanding the sources of macroeconomic fluctuations in Brunei, which has received scant attention in the empirical macroeconomics literature, the methodology used follows the more traditional SVAR approach, allowing results to be compared to existing SVAR studies of oil-exporting countries (see Table 6.A1 in Appendix 6.A).

The rest of this paper is structured as follows. Section 6.2 provides a brief overview of the Brunei economy. Section 6.3 develops a simple open economy model that includes oil prices. Section 6.4 discusses the identification and estimation of the SVAR model. Section 6.5 presents the empirical results and Section 6.6 concludes with policy recommendations.

6.2 The economy of Brunei Darussalam

Brunei is heavily dependent on oil and gas, which account for more than half of its GDP and over 90% of exports and government revenue. Despite considerable efforts to diversify the economy from hydrocarbons since the 1960s, success has remained elusive. GDP growth averaged 1.2% over the past three decades, the lowest among ASEAN peers and high income oil-exporting countries. Brunei's hydrocarbon-centred economy is still vulnerable to volatile international oil prices and fluctuations in oil production, which can have significant effects on government finances and hence GDP, particularly if fiscal policy is procyclical such that government spending increases during oil price booms and decreases during busts.[58]

Brunei has a sovereign wealth fund, set up in 1983, which invests accumulated fiscal surpluses. The fund is estimated at US$40 billion as of 2016 and has a Linaburg-

[58] Brunei's non-oil sector is largely dependent on government spending. The correlation between non-oil GDP and government expenditure from 2003Q1 to 2014Q3 is 0.80.

Maduell transparency rating of 1, indicating that it highly non-transparent (SWFI, 2016). As such, there is little public information on the fund's strategies and asset holdings. A fiscal stabilization fund was also established in 2008. These fiscal buffers can potentially be used to smooth government expenditure and therefore help to stabilize output. However, the effectiveness of the oil funds remains an open question as there are no clear and transparent rules on how they are utilized. Brunei also has long-term supply contracts, most notably with Japan and Korea, to cushion fluctuations in crude oil prices.

Brunei operates on a currency board agreement in which the Brunei dollar is pegged at par to the Singapore dollar, which has been in effect since 1967, and therefore its monetary policy commits to maintaining the exchange rate parity. This means Brunei does not have monetary sovereignty and Singapore's monetary policy can have an influence on Brunei's economy, particularly in exchange rate movements and hence inflation, depending on the degree of pass-through. Being a welfare state, Brunei has a wide array of universal subsidies and administered price controls. As such, domestic prices are somewhat sheltered from external shocks. This has helped to keep inflation low at an average of 1.3% over the past three decades.

6.3 A stochastic rational expectations open economy model

This section develops a stochastic rational expectations open economy Keynesian model that includes oil prices, drawing primarily from Clarida and Galí (1994), Weber (1997), Bjørnland (2004), and Huang and Guo (2007). More specifically, the theoretical model extends the four-equation model in Clarida and Galí (1994), which consists of an aggregate demand function, a price setting equation, a money demand function, and uncovered interest parity, to include a supply side production function and labour demand and supply schedules as in Weber (1997), an exogenous evolution of oil prices following Bjørnland (2004) and Huang and Guo (2007), augmenting the aggregate demand and production equations with oil prices, and adding a foreign monetary policy rule which reacts to oil prices. The system is summarized below:

$$o_t = o_{t-1} + \varepsilon_t^o \tag{6.1}$$

$$y_t^d = d_t + \eta(e_t + p_t^* - p_t) - \sigma\big(i_t - E_t(p_{t+1} - p_t)\big) + \phi o_t \tag{6.2}$$

$$d_t = d_{t-1} + \varepsilon_t^d \tag{6.3}$$

$$p_t = (1-\theta)E_{t-1}p_t^e + \theta p_t^e \tag{6.4}$$

$$y_t^s = A_t + \alpha l_t + \beta k_t + (1-\alpha-\beta)o_t \tag{6.5}$$

$$A_t = A_{t-1} + \varepsilon_t^A \tag{6.6}$$

$$l_t^d = -\rho(w_t - p_t) \tag{6.7}$$

$$l_t^s = \varphi\big(i_t - E_t(p_{t+1} - p_t)\big) + \gamma(w_t - p_t) \tag{6.8}$$

$$m_t^d = p_t + y_t - \lambda i_t - d_t \tag{6.9}$$

$$m_t^s = m_{t-1}^s + \varepsilon_t^m \tag{6.10}$$

$$i_t - i_t^* = E_t(e_{t+1} - e_t) \tag{6.11}$$

$$r_t^* = \mu o_t + \chi_t \tag{6.12}$$

$$\chi_t = \chi_{t-1} + \varepsilon_t^\chi \tag{6.13}$$

$$y_t^d = y_t^s = y_t \tag{6.14}$$

$$l_t^d = l_t^s = l_t \tag{6.15}$$

$$m_t^d = m_t^s = m_t \tag{6.16}$$

where o is log of the real oil price, y is log of real output, d is an aggregate demand shock, e is log of the nominal exchange rate, $p^*$is log of the foreign price level (trade-weighted), p is log of the domestic price level, E is the expectations operator, i is the nominal domestic interest rate, A is log of technology, l is log of labour input, k is log of capital stock, w is log of the wage rate, m is log of the money supply, i^* is the nominal foreign interest rate (trade-weighted), r^* is real foreign interest rate (trade-weighted), χ is a stochastic component reflecting foreign monetary policy rules (trade-weighted), and the ε's are serially uncorrelated orthogonal shocks, normally and independently distributed with zero mean and finite variance, with ε^o, ε^d, ε^A, ε^m, and

ε^{χ} representing oil price shock, demand shock, technology (or productivity) shock, monetary (or velocity) shock, and foreign monetary policy shock respectively.

Equation (6.1) shows the evolution of the real oil price as a random walk, assumed to be exogenous. Equation (6.2) is a standard output demand function (IS curve) with the real exchange rate ($q_t = e_t + p_t^* - p_t$) and real interest rate $\left(r_t = i_t - \right.$ $Etpt{+}1{-}pt$ as its main arguments, augmented by the real oil price. It is expected that $\eta < 0$ such that a depreciation of the real exchange rate leads to an improvement in the trade balance. Due to the dominance of the oil sector in Brunei which benefits from oil price increases, it is expected that $\phi > 0$. The aggregate demand shock evolves as a random walk as in eq. (6.3). Equation (6.4) is a price setting equation such that the current price level is an average of the price expected in the previous period to prevail in the current period, $E_{t-1}p_t^e$, and the price that would actually prevail in the current period, p_t^e. When θ = 0, prices are fixed and when θ = 1, prices are fully flexible. In the long run, it is assumed that prices are flexible. The supply side in eq. (6.5) assumes that in the long run, firms have a Cobb-Douglas production function with labour, capital, and oil price as factor inputs, augmented by the level of technology that is modelled as a random walk process in eq. (6.6).

Labour demand is a negative function of real wages as shown in eq. (6.7), while labour supply in eq. (6.8) depends positively on the real interest rate and real wages. Equation (6.9) is a standard money demand function (LM curve) whereby real money demand has income and nominal interest rate as its main arguments, with a demand shock component. Money supply follows a random walk process in eq. (6.10).

Uncovered interest rate parity is assumed to hold in eq. (6.11), where the risk premium term is excluded.[59] Equation (6.12) is a (trade-weighted) foreign monetary policy rule whereby foreign monetary authorities react to the real oil price and includes a stochastic component that follows a random walk in eq. (6.13) reflecting different

[59] For simplicity, the risk premium is excluded following Clarida and Galí (1994) and Weber (1997). However, the risk premium can be incorporated by modeling it as a non-stationary stochastic process and the identifications in this section follow through.

rules in the trade partner countries.[60] If foreign central banks tighten monetary policy to stem inflation from rising due to oil price increases, $\mu > 0$ and output is expected to fall. If an expansionary policy is pursed to offset the impact of oil prices on output, $\mu < 0$ with nominal GDP and inflation growing. It can also be the case where nothing is done such that $\mu = 0$, accepting some inflation. Equations (6.14), (6.15), and (6.16) show the goods, labour, and money market equilibrium respectively.

Equations (6.1) to (6.16) can be solved under the flexible price equilibrium to yield:

$$\Delta o_t = \varepsilon_t^o \tag{6.17}$$

$$\Delta r_t^* = \mu\varepsilon_t^o + \varepsilon_t^\chi \tag{6.18}$$

$$\Delta y_t = \left(\frac{\alpha\rho\varphi\mu}{(1-\beta)(\rho+\gamma)} + \frac{1-\alpha-\beta}{1-\beta}\right)\varepsilon_t^o + \frac{\alpha\rho\varphi}{(1-\beta)(\rho+\gamma)}\varepsilon_t^\chi + \frac{1}{1-\beta}\varepsilon_t^A \tag{6.19}$$

$$\begin{aligned}\Delta q_t = &\left(\frac{\alpha\rho\varphi\mu}{\eta(1-\beta)(\rho+\gamma)} + \frac{1-\alpha-\beta}{\eta(1-\beta)} + \frac{\sigma\mu-\phi}{\eta}\right)\varepsilon_t^o \\ &+ \left(\frac{\alpha\rho\varphi}{\eta(1-\beta)(\rho+\gamma)} + \frac{\sigma}{\eta}\right)\varepsilon_t^\chi + \frac{1}{\eta(1-\beta)}\varepsilon_t^A - \frac{1}{\eta}\varepsilon_t^d\end{aligned} \tag{6.20}$$

$$\begin{aligned}\Delta p_t = &\left(\lambda\mu - \frac{\alpha\rho\varphi\mu}{(1-\beta)(\rho+\gamma)} + \frac{1-\alpha-\beta}{1-\beta}\right)\varepsilon_t^o \\ &+ \left(\lambda - \frac{\alpha\rho\varphi}{(1-\beta)(\rho+\gamma)}\right)\varepsilon_t^\chi - \frac{1}{1-\beta}\varepsilon_t^A + \varepsilon_t^d + \varepsilon_t^m\end{aligned} \tag{6.21}$$

Details on the derivation can be found in Appendix 6.B. Notice that the long-run solution of the model exhibits a triangular structure, which provides motivation for the identifying restrictions in the next section.

[60] Brunei's major trading partners have different monetary policy rules; for instance, Australia has an inflation target, China has a crawl-like arrangement and Singapore operates a managed float. The random walk specification is a naïve and simplified exposition to model the (trade-weighted) rules.

6.4 The SVAR approach and identification of structural shocks

The reduced form of the structural model in Section 6.3 can be expressed as:

$$Z_t = \Theta(L)\varepsilon_t \tag{6.22}$$

where $Z_t = (\Delta o_t\ , \Delta r_t^*, \Delta y_t, \Delta q_t, \Delta p_t)'$ is the vector of stationary variables, $\Theta(L)$ denotes a lag polynomial matrix, and ε_t = (ε^o, ε^χ, ε^A, ε^d, ε^m)′ denotes the structural shocks with $E(\varepsilon_t\varepsilon_t') = \mathrm{I}_5$.

Consider the long-run effects by setting L = 1 in eq. (6.22), and by virtue of the orthogonality of the structural shocks, the model can be summarized as:

$$\begin{pmatrix} \Delta o \\ \Delta r^* \\ \Delta y \\ \Delta q \\ \Delta p \end{pmatrix} = \begin{pmatrix} \theta_{11}(1) & 0 & \vdots & 0 & 0 & 0 \\ \theta_{21}(1) & \theta_{22}(1) & \vdots & 0 & 0 & 0 \\ \cdots & \cdots & \vdots & \cdots & \cdots & \cdots \\ \theta_{31}(1) & \theta_{32}(1) & \vdots & \theta_{33}(1) & 0 & 0 \\ \theta_{41}(1) & \theta_{42}(1) & \vdots & \theta_{43}(1) & \theta_{44}(1) & 0 \\ \theta_{51}(1) & \theta_{52}(1) & \vdots & \theta_{53}(1) & \theta_{45}(1) & \theta_{55}(1) \end{pmatrix} \begin{pmatrix} \varepsilon^o \\ \varepsilon^\chi \\ \varepsilon^A \\ \varepsilon^d \\ \varepsilon^m \end{pmatrix} \tag{6.23}$$

The long-run matrix containing θ's, the long-run multipliers, has a lower triangular structure and is partitioned into external and domestic components.[61] Since the model consists of five variables, $5(5-1)/2 = 10$ restrictions need to be imposed for exact identification. The identification strategy consists of the small open economy assumption by imposing block exogeneity restrictions such as that suggested by Cushman and Zha (1997) and long-run restrictions as in Blanchard and Quah (1989).

The small open economy assumption prevents domestic variables from affecting external variables in both the short and long run, which is appropriate given the size of the Brunei economy, i.e., domestic shocks (productivity, demand and monetary) have no effect on external variables (real oil price and foreign real interest rate) in all periods. The block exogeneity of ε^o and ε^χ is specified such that $\theta(k)_{ij} = 0$ for $i = 1,2$ and

[61] Note that a labour supply shock could have been added in eq. (6.8) and identified in the SVAR model with Δl ordered before Δy, but data constraints prohibit this from being done. What this implies is that the role of labour supply shocks will be attributed to productivity shocks. However, this does not change the major thrust of the findings that supply shocks account for most of output fluctuations (see Section 6.5.2).

j= 3,4,5 for $k = 1,2, \ldots, \infty$. This is represented by the zeros in the northeast quadrant, which provide six restrictions.

The long-run restrictions are informed by the theoretical model developed in Section 6.3. The zeros in the southeast quadrant are the restrictions imposed such that demand and monetary shocks do not affect output in the long run, and monetary shocks do not affect the real exchange rate in the long run. No restrictions are placed on the price level. In the northwest quadrant, the zero is the restriction imposed such that foreign monetary policy shocks have no effect on the real oil price in the long run. This restriction is reasonable since long-run oil prices should be influenced by demand and supply factors, e.g., the availability of alternative energy sources or exploration and production capacities. These assumptions therefore provide four additional restrictions for exact identification.

6.5 Empirical results

Quarterly data from 2003Q1 to 2014Q3 (47 observations) are used in the estimation.[62] The variables and data sources are summarized in Table 6.A2 in Appendix 6.A. Preliminary data analyses are performed to ensure that the variables are specified in accordance with their time series properties (i.e., the variables are stationary and their levels are not cointegrated). Figure 6.1 plots the log real oil price, trade-weighted foreign real interest rate, log oil production, log real effective exchange rate (REER), and log consumer price index (CPI) in levels and first differences. Results of unit root tests using the Zivot-Andrews single structural break (see Zivot and Andrews, 1992) and the augmented Dickey-Fuller (ADF) (see Dickey and Fuller, 1979) tests are shown in Tables 6.1 and 6.2. Based on the Zivot-Andrews test, we cannot reject the null hypothesis of a unit root in all the variables. The ADF tests suggest that the variables in levels are non-stationary but their first differences are stationary.

[62] Brunei has adopted a new series of national accounts with base year 2010, but revisions of past data series are only available from 2010. This paper uses data with base year 2000 to allow a sufficiently long time series for econometric analysis. As such, GDP data is available only from 2003Q1 to 2014Q3.

Fig.6.1 Data series plots of the variables in levels and first differences

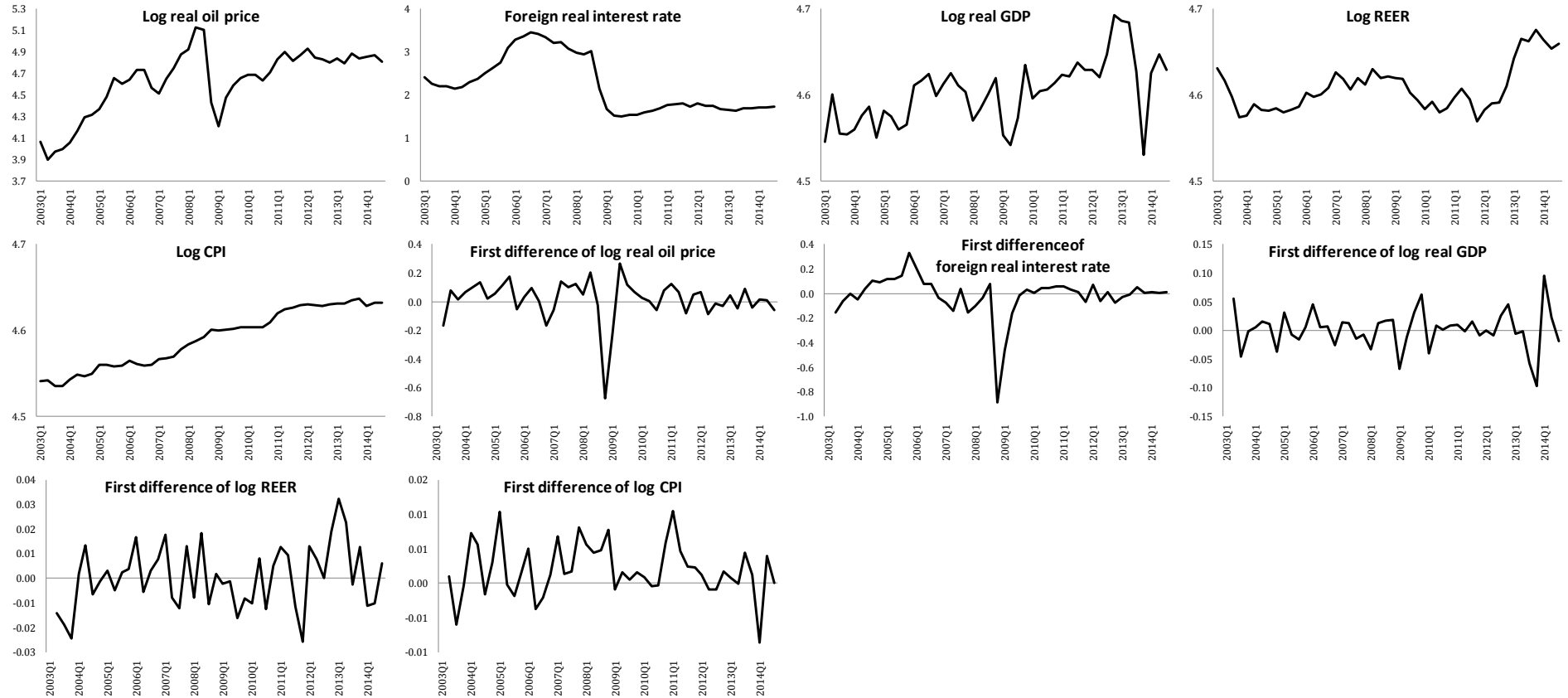


Table 6.1 Zivot-Andrews unit root test with a single structural break

Variable	Period[a]	Minimum t-statistics	Variable	Period[b]	Minimum t-statistics
o	2008Q4	-3.96	o	2005Q4	-3.73
r^*	2008Q4	-5.19*	r^*	2005Q4	-2.50
y	2008Q1	-4.39	y	2012Q4	-4.07
q	2012Q4	-3.92	q	2012Q1	-3.04
p	2007Q4	-2.95	p	2012Q2	-3.20

Notes: [a] Break in intercept; 5% critical level is -4.80.

[b] Break in trend; 5% critical level is -4.42.

* denotes rejection at the 5% significance level.

Table 6.2 Augmented Dickey-Fuller unit root tests

Variable[a]	ADF (lags)	test-statistic	Variable[b]	ADF (lags)	test-statistic
o	ADF (2)	-2.42	Δo	ADF (1)	-6.25*
r^*	ADF (1)	-2.15	Δr^*	ADF (2)	-3.29*
y	ADF (4)	-2.18	Δy	ADF (1)	-6.86*
q	ADF (3)	-1.75	Δq	ADF (1)	-4.43*
p	ADF (2)	-0.99	Δp	ADF (1)	-5.74*

Notes: [a] A constant and time trend included in the regression.

[b] A constant included in the regression.

* denotes rejection at 5% significance level.

Since the theoretical model does not provide any guide on dynamics, the lag order is determined using the Akaike information criteria (AIC) test, which suggests using two lags.[63] Johansen's (1988, 1991) trace statistic and maximum eigenvalue likelihood tests indicate there is no evidence of cointegration. Results are displayed in Table 6.3.

[63] The SVAR model is also estimated using alternative lag lengths; the main results are invariant to the use of up to four lags.

Table 6.3 Johansen's cointegration tests

H_0	H_1	Critical value 5% λ_{trace}	Critical value 5% λ_{max}	λ_{trace}	λ_{max}
$r = 0$	$r \geq 1$	68.52	33.46	65.43	29.98
$r \leq 1$	$r \geq 2$	47.21	27.07	35.46	17.87
$r \leq 2$	$r \geq 3$	29.68	20.97	17.58	8.36
$r \leq 3$	$r \geq 4$	15.41	14.07	9.22	8.10
$r \leq 4$	$r \geq 5$	3.76	3.76	1.12	1.12

Notes: r denotes the number of significant cointegrating vectors under the null and alternative hypotheses.

6.5.1 Impulse responses

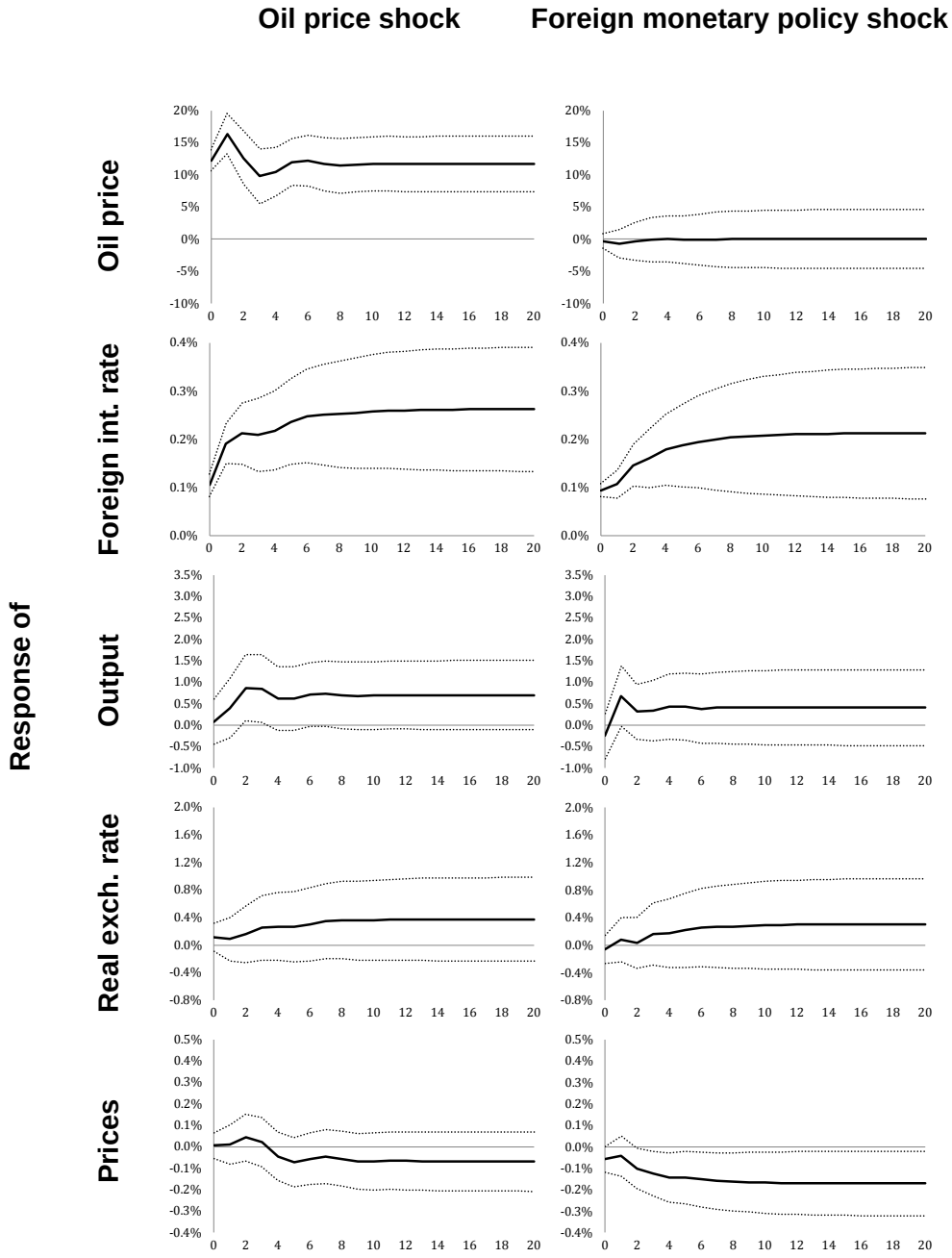
The cumulative effects of the domestic macroeconomic variables to the structural shocks are shown in Fig. 6.2, with the dotted lines representing 90% error bands.

An oil price shock leads to a permanent output expansion in Brunei.[64] This positive effect is expected for oil-exporting countries and is reported in several studies (e.g., Dibooğlu and Aleisa, 2004; Mehrara and Oskoui, 2007), though the error bands indicate that the long-run effect is only marginally statistically significant. The real exchange rate also appreciates as expected due to terms of trade gains, but the effect is not statistically significant. There is minimal impact on the CPI level, largely due to government-administered price controls and subsidies. The real exchange rate appreciation also helps to keep imports cheaper in local currency terms. Though the focus is on domestic variables, it is worthwhile to mention that in response to an oil price shock, the foreign real interest rate increases, suggesting that foreign central banks attempt to offset the inflationary impact of oil price increases through contractionary monetary policy.[65]

[64] Global crude oil price is used in the analysis with the implicit assumption that the law of one price holds for Brunei. This is reasonable as the crude oil market is an integrated one, with low transportation costs and largely interchangeable crude oil products of different geographic origins (Nordhaus, 2009).

[65] A related strand of research is on the endogenous response of monetary policy to oil shocks. Bernanke et al. (1997) argue that the Fed's interest rate responses to inflationary pressures induced by oil shocks are an important source of fluctuations in the U.S. economy, but opposing views can be found in Hamilton

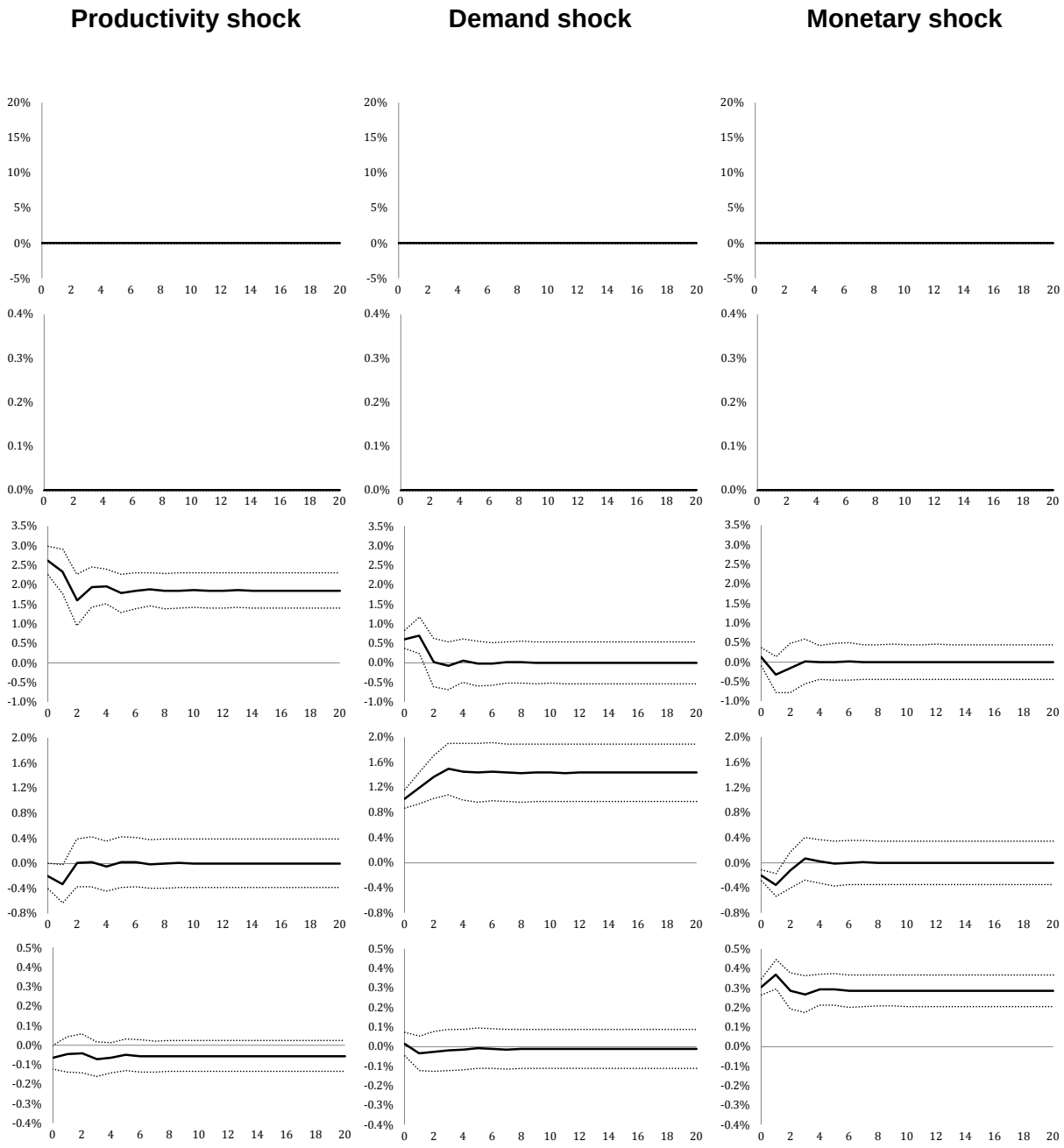
Fig.6.2 Cumulative impulse responses to structural shocks



Notes: Solid lines are the mean impulse responses; dotted lines are the 90% error bands.

and Herrera (2004) and Kilian and Lewis (2011). Since Brunei does not have monetary independence and the domestic interest rate is not an active monetary policy instrument, this research area is excluded from the study.

Fig.6.2 Cumulative impulse responses to structural shocks (continued)



Notes: Solid lines are the mean impulse responses; dotted lines are the 90% error bands.

Following a foreign monetary policy shock, the real exchange rate appreciates but the effect is not statistically significant. Prices fall as a result of an increase in the interest rate, which is expected of how conventional monetary policy works. The real appreciation partially reflects Brunei's fixed exchange rate regime (currency board arrangement with Singapore) whereby Singapore has a relatively large weight in Brunei's REER.[66] An increase in Singapore's interest rate and an appreciation of the Singapore dollar would simultaneously lead to an increase in Brunei's interest rate and hence an appreciation of the Brunei dollar for the parity rate to be maintained. While there is a one-to-one correspondence of the nominal exchange rate, the response of the real exchange rate can differ depending on how prices react. In the case here, prices fall and hence the real exchange rate appreciation is muted.

A productivity shock has a large permanent positive impact on output, while the real exchange rate depreciates, conforming to theoretical predictions, since domestic prices fall. This can be explained by the standard textbook AD-AS model, in which a productivity shock shifts the AS curve to the right, resulting in an increase in output and a fall in prices. The real depreciation comes via a price adjustment rather than a nominal exchange rate adjustment due to the peg to the Singapore dollar.

The response of output to a demand shock is positive but the effect is transitory and not statistically significant after the initial quarter. The real exchange rate appreciates but there is no significant impact on prices. The responses can be explained by the Mundell-Fleming-Dornbusch model. For instance, an expansionary fiscal policy which shifts the IS curve to the right leads to an increase in the interest rate and hence an exchange rate appreciation. The transitory output effect suggests that expansionary fiscal policy to stimulate the economy is only effective in the short run. A possible reason is the deterioration of the trade balance due to the real exchange rate appreciation which leaves output unchanged in the long run. A similar temporary effect is also observed for Saudi Arabia (Dibooğlu and Aleisa, 2004) and Iran (Korhonen and Mehrotra, 2009). However, the findings for other oil exporters show that demand shocks do not increase output (see Table 6.A1 in Appendix 6.A).

[66] There is a high correlation (0.904) between Singapore's real interest rate and the constructed trade-weighted foreign real interest rate. The results are roughly the same with either series in the SVAR model.

A monetary shock does not have any statistically significant impact on output while prices increase due to the money supply increase. The real exchange rate depreciates immediately but then appreciates and overshoots back to the long-run equilibrium, showing evidence of Dornbusch's (1976) overshooting model. These responses are consistent with the theoretical predictions of the Mundell-Fleming-Dornbusch model. An increase in money supply shifts the LM curve to the right, resulting in a fall in the interest rate and an exchange rate depreciation. To maintain the exchange rate peg, the monetary authority would have to sell foreign reserves, bringing the LM curve back to its equilibrium position. As a consequence, output remains unchanged.

6.5.2 Variance decompositions

The forecast error variance decomposition (FEVD) of the domestic variables are displayed in Table 6.4. FEVD gives the proportion of the variance of the forecast error attributed to each of the structural shocks at various horizons, i.e., the relative importance of each shock in the fluctuations of output, real exchange rate, and prices.

Oil price shocks account for about 11% of output fluctuations in the long run while productivity shocks account for three-quarters of output variability. The low FEVD of output due to oil price shocks might appear puzzling given Brunei's high dependence on oil, but this is a typical finding in other oil-exporting countries, e.g., Saudi Arabia (see Dibooğlu and Aleisa, 2004), Norway (see Bjørnland, 2004), Iran, Kazakhstan, Russia, and Venezuela (see Korhonen and Mehrotra, 2009).[67] The importance of supply shocks in explaining Brunei's output fluctuations is in fact not surprising since supply side constraints in oil production has been inhibiting growth.[68] In addition, the relationship between oil prices and Brunei's oil production (and also real GDP) has also changed over the years: there is a positive correlation from 1994 to 2005 but this relationship is

[67] Mehrara and Oskoui (2007) argue that oil price shocks explain only a small proportion of output fluctuations in Kuwait due to the success of its oil fund. It is conceivable that Brunei's oil fund has helped to stabilize output; however, there is no evidence to suggest so. Besides, there are no explicit fiscal rules on the use of these funds.

[68] Oil production in 2014 is half of the quantity produced in 2006. It is also worth noting that the emphasis of Brunei's current national development plan (2012–2017) to accelerate economic growth is on enhancing productivity and innovation.

non-existent from 2006 onwards. This helps to explain the low contribution of oil price shocks in explaining output fluctuations. Another likely explanation is Brunei's long-term supply contracts, which help to mitigate aggressive oil price movements. However, it is worth mentioning that the present analysis, which does not distinguish between oil demand and supply shocks, may be causing a somewhat relatively smaller contribution of oil price shocks in explaining Brunei's output fluctuations.

Table 6.4 Variance decomposition of domestic variables (%)

Quarters	FEVD of output due to shocks to				
	OP	**MP***	**PR**	**AD**	**MO**
1	0.9	0.1	94.0	4.8	0.2
2	11.0	1.3	80.9	4.2	2.6
4	10.7	3.2	75.0	8.3	2.8
8	10.7	3.8	74.3	8.5	2.7
20	10.7	3.8	74.3	8.5	2.7

Quarters	FEVD of REER due to shocks to				
	OP	**MP***	**PR**	**AD**	**MO**
1	1.1	0.3	3.8	91.2	3.6
2	1.1	1.9	4.8	87.2	5.1
4	1.8	2.7	11.5	74.1	10.0
8	2.0	2.9	12.0	73.1	10.0
20	2.0	2.9	12.0	73.1	10.0

Quarters	FEVD of CPI due to shocks to				
	OP	**MP***	**PR**	**AD**	**MO**
1	0.0	3.4	3.9	0.1	92.5
2	0.0	3.4	4.0	2.2	90.4
4	1.4	6.1	4.3	2.1	86.0
8	5.5	6.2	4.4	2.0	81.8
20	5.7	6.2	4.4	2.0	81.6

Notes: OP – oil price; MP* – foreign monetary policy; PR – productivity; AD – demand; MO – monetary.

Fluctuations in the real exchange rate are mainly attributed to demand shocks—over 90% in the short run and about three-quarters in the long run. Productivity and

monetary shocks explain only a small proportion in the short run, but in the long run they account for a significant one-fifth of real exchange rate movements. The negligible contribution of external shocks (oil price and foreign monetary policy) is not surprising since these shocks do not have statistically significant effects on the real exchange rate as the impulse responses in Section 6.5.1 illustrate. The importance of demand shocks in explaining real exchange rate movements in oil-exporting countries is similarly documented in various studies (see Table 6.A1 in Appendix 6.A).

Oil price shocks explain less than 6% of the variability in prices, since domestic prices of petroleum products are highly subsidized and therefore changes in the international oil price have limited effect on Brunei's CPI. Most of the fluctuations in prices are due to monetary shocks, accounting for more than 90% in the short run and 80% in the long run.

6.6 Conclusion

This paper investigates the sources of macroeconomic fluctuations in Brunei from 2003Q1 to 2014Q3 using a structural vector autoregression model. A stochastic rational expectations open economy model that includes oil prices is developed, which motivates the use of long-run identifying assumptions and block exogeneity restrictions based on the small country assumption. The results show that oil price shocks account for only a small proportion of output fluctuations, while productivity shocks account for the largest share. Fluctuations in the real exchange rate are driven mainly by demand shocks while variability in prices is due to monetary shocks.

These results are in line with empirical findings in other oil-exporting countries. They have important policy implications as policymakers must decide how closely to track external and domestic developments. Some economists advocate that oil-exporting countries adopt more flexible exchange rate regimes to stabilize output fluctuations caused by terms of trade shocks (e.g., Frankel, 2005; Setser 2008). The relatively small role of oil prices in influencing the Brunei economy suggests that the government need not be too concerned about a change in exchange rate policy to reduce macroeconomic volatility. Furthermore, Brunei's accumulated reserves in oil funds can be used to smooth oil price shocks. On the other hand, the importance of supply shocks in driving

output calls for more attention into structural reforms such as improving productivity, as well as increasing infrastructural and technological investments in offshore oil fields to increase oil production capacity. In addition, the conduct of fiscal policy should take into consideration the impact on real exchange rate volatility.

Appendix 6.A

Table 6.A1 Selected SVAR studies on oil-exporting countries

Author	Country	Sample period	Shocks[a]	Impulse response[b]						Forecast error variance decomposition (%)					
				Output		Real exch rate		Price		Output		Real exch rate		Price	
				SR	LR	SR	LR	SR	LR	SR	LR	SR	LR	SR	LR
This paper	Brunei	2003Q1 – 2014Q3	OP	0	+	0	0	0	0	1	11	1	2	0	6
			MP*	0	0	0	0	−	−	0	4	0	3	3	6
			AS	+	+	−	0	−	−	94	74	4	12	4	4
			AD	+	0	+	+	0	0	5	9	91	73	0	2
			MO	0	0	−	0	+	+	0	3	4	10	93	82
Bjørnland (2004)	Norway	1972Q1 – 1994Q4	OP	+	0	−	0	0	+	4	14	4	1	4	3
			PR	+	+	+	+	+	+	17	16	12	21	1	1
			LS	+	+	+	0	−	−	40	60	12	9	67	40
			AD	0	0	+	+	+	+	1	1	67	69	1	21
			MO	+	0	−	0	+	+	38	10	5	1	27	35
Dibooğlu and Aleisa (2004)	Saudi Arabia	1980Q1 – 2000Q1	OP	+	+	+	+	+	+	1	35	14	79	0	64
			AS	+	+	−	0	−	+	85	65	11	4	2	18
			BP	+	0	−	0	+	0	11	0	12	2	2	1
			AD	+	0	+	+	+	0	2	0	62	15	8	0
			MO	0	0	−	0	+	+	0	0	1	0	88	17
Mehrara and Oskoui (2007)	Iran	1970–2002	OP	+	+	−	0	0	+						
			AS	+	+	−	−	−	−						
			AD	+	0	+	+	+	+						
			MO	−	0	−	0	+	+						
	Indonesia	1970–2002	OP	+	0	+	+	0	0						
			AS	+	+	−	−	−	−						

			AD	0	0	+	+	−	−					
			MO	+	0	0	0	+	+					
	Kuwait	1972–2002	OP	+	+	−	−	−	−					
			AS	+	+	−	−	−	−					
			AD	0	0	+	+	−	−					
			MO	+	0	0	0	+	+					
	Saudi Arabia	1971–2002	OP	+	+	+	+	+	+					
			AS	+	+	−	−	−	−					
			AD	0	0	+	+	0	+					
			MO	−	0	0	0	+	+					
Korhonen and Mehrotra (2009)	Iran	2000Q4 – 2005Q1	OP	0	0	+	+			4	5	12	19	
			AS	+	+	−	−			80	73	14	12	
			AD	+	0	+	+			15	19	73	68	
			MO	0	0	0	0			2	3	1	1	
	Kazakhstan	2000Q4 – 2006Q3	OP	0	+	0	0			2	9	4	5	
			AS	+	+	+	+			58	6	10	17	
			AD	−	0	+	+			21	17	78	65	
			MO	+	0	+	0			20	15	7	14	
	Russia	2001Q1 – 2006Q4	OP	0	+	0	0			1	15	0	3	
			AS	+	+	−	0			90	77	6	8	
			AD	0	0	+	+			0	1	93	87	
			MO	+	0	+	0			8	7	2	2	
	Venezuela	2002Q3 – 2007Q4	OP	0	+	0	+			8	21	0	11	
			AS	+	+	+	+			89	46	7	11	
			AD	0	0	+	+			3	17	67	50	
			MO	0	0	+	0			0	16	26	29	
Berument et al. (2010)	Algeria	1952–2005	OP	+	0									
	Bahrain			0	0									
	Iran			+	0									

	Iraq	+	0
	Kuwait	+	0
	Libya	+	0
	Oman	0	+
	Qatar	+	0
	Syria	+	0
	UAE	+	0

Notes: [a] SR and LR refer to short run and long run respectively. OP – oil price shock; MP* – foreign monetary policy shock; AS – supply shock; AD – demand shock; MS – monetary shock; PR – productivity shock; LS – labour supply shock; BP – balance of payment shock.

[b] Impulse responses to a positive unit shock. + denotes an increase (appreciation for real exchange rate); − denotes a decrease (depreciation for exchange rate); 0 denotes at equilibrium or unchanged.

Table 6.A2 Variables and data sources

Variables		Definition	Symbol	Source[a]
External	Real oil price	World crude oil price (U.S. dollars per barrel) converted to Brunei dollars and deflated by Brunei CPI	o	IFS
	Foreign real interest rate	Trade-weighted foreign real interest rate[b]	r^*	IFS, Author's calculations
Domestic	Output	Real GDP	y	IFS
	Prices	Consumer price index (CPI)	p	IFS
	Real exchange rate	Real effective exchange rate (REER)[b]	q	IFS, Author's calculations

Notes: [a] IFS – IMF International Financial Statistics.

[b] Brunei's top 12 trading partners are, in descending order: Japan, Singapore, Korea, Indonesia, Australia, Malaysia, China, US, Thailand, UK, India, and New Zealand; making up more than 95% of total trade over the period 2003–2014.The REER is calculated as the trade-weighted exchange rate with the top 12 trading partners. The trade-weighted foreign real interest rate is calculated analogously.

Appendix 6.B

Details on the derivation of the long-run solution of the model in Section 6.3 are provided here.

From the price setting equation in eq. (6.4), set θ = 1 such that in the long run, prices are fully flexible and output is supply determined.

From eqs (6.1), (6.12), and (6.13), we have

$$\Delta o_t = \varepsilon_t^o \tag{6.B1}$$

$$\Delta r_t^* = \mu \varepsilon_t^o + \varepsilon_t^\chi \tag{6.B2}$$

Defining the real exchange rate as $q_t = e_t + p_t^* - p_t$ and r as the domestic real interest rate, the interest rate parity in eq. (6.11) can be written as

$$r_t - r_t^* = E_t(q_{t+1} - q_t) \tag{6.B3}$$

Next, from the labour demand, supply, and market equilibrium equations in eqs (6.7), (6.8), and (6.15) and using eq. (6.B3) we can obtain

$$l_t = \frac{\rho\varphi\mu}{\rho+\gamma} o_t + \frac{\rho\varphi}{\rho+\gamma} \chi_t + \frac{\rho\varphi}{\rho+\gamma} E_t(q_{t+1} - q_t) \tag{6.B4}$$

By making the assumption that the long-run steady state capital-output ratio is constant

$$k_t = y_t + \kappa \tag{6.B5}$$

and substituting eq. (6.B5) into eq. (6.5) yields

$$y_t^s = \frac{\beta\kappa}{1-\beta} + \frac{1}{1-\beta} A_t + \frac{\alpha}{1-\beta} l_t + \frac{1-\alpha-\beta}{1-\beta} o_t \tag{6.B6}$$

Next, substitute eq. (6.B4) into eq. (6.B6) to obtain the supply side equation

$$y_t^s = \frac{\beta\kappa}{1-\beta} + \left(\frac{\alpha\rho\varphi\mu}{(1-\beta)(\rho+\gamma)} + \frac{1-\alpha-\beta}{1-\beta}\right) o_t + \frac{\alpha\rho\varphi}{(1-\beta)(\rho+\gamma)}\chi_t + \frac{1}{1-\beta}A_t + \frac{\alpha\rho\varphi}{(1-\beta)(\rho+\gamma)}E_t(q_{t+1} - q_t) \tag{6.B7}$$

From eqs (6.2), (6.12), and (6.B3), we can obtain the output demand function

$$y_t^d = d_t + (\phi - \sigma\mu)o_t - \sigma\chi_t + (\eta+\sigma)q_t - \sigma E_t q_{t+1} \tag{6.B8}$$

Combining eqs (6.B7) and (6.B8) with the goods market equilibrium condition in eq. (6.14) yields

$$\begin{aligned} q_t &= \frac{\alpha\rho\varphi + \sigma(1-\beta)(\rho+\gamma)}{(\eta+\sigma)(1-\beta)(\rho+\gamma) + \alpha\rho\varphi} E_t q_{t+1} \\ &+ \frac{\beta\kappa(\rho+\gamma)}{(\eta+\sigma)(1-\beta)(\rho+\gamma) + \alpha\rho\varphi} \\ &+ \frac{\alpha\rho\varphi\mu + (1-\alpha-\beta)(\rho+\gamma) + (\sigma\mu-\phi)(1-\beta)(\rho+\gamma)}{(\eta+\sigma)(1-\beta)(\rho+\gamma) + \alpha\rho\varphi} o_t \\ &+ \frac{\alpha\rho\varphi + \sigma(1-\beta)(\rho+\gamma)}{(\eta+\sigma)(1-\beta)(\rho+\gamma) + \alpha\rho\varphi}\chi_t + \frac{\rho+\gamma}{(\eta+\sigma)(1-\beta)(\rho+\gamma) + \alpha\rho\varphi} A_t \\ &- \frac{(1-\beta)(\rho+\gamma)}{(\eta+\sigma)(1-\beta)(\rho+\gamma) + \alpha\rho\varphi} d_t \end{aligned} \tag{6.B9}$$

This is a stochastic difference equation in q_t. Using the method of undetermined coefficients, conjecture a guess linear solution

$$q_t = G_1 o_t + G_2\chi_t + G_3 A_t + G_4 d_t \tag{6.B10}$$

Take the time t conditional expectations on both sides and use eqs (6.1), (6.3), (6.6), and (6.13) to get

$$E_t q_{t+1} = G_1 o_t + G_2\chi_t + G_3 A_t + G_4 d_t \tag{6.B11}$$

Substitute eqs (6.B10) and (6.B11) into eq. (6.B9) and equating coefficients of the variables to get

$$G_1 = \frac{\alpha\rho\varphi\mu}{\eta(1-\beta)(\rho+\gamma)} + \frac{1-\alpha-\beta}{\eta(1-\beta)} + \frac{\sigma\mu-\phi}{\eta}$$

$$G_2 = \frac{\alpha\rho\varphi}{\eta(1-\beta)(\rho+\gamma)} + \frac{\sigma}{\eta}$$

$$G_3 = \frac{1}{\eta(1-\beta)}$$

$$G_4 = -\frac{1}{\eta}$$

Therefore we obtain

$$\begin{aligned}\Delta q_t = &\left(\frac{\alpha\rho\varphi\mu}{\eta(1-\beta)(\rho+\gamma)} + \frac{1-\alpha-\beta}{\eta(1-\beta)} + \frac{\sigma\mu-\phi}{\eta}\right)\varepsilon_t^o \\ &+ \left(\frac{\alpha\rho\varphi}{\eta(1-\beta)(\rho+\gamma)} + \frac{\sigma}{\eta}\right)\varepsilon_t^\chi + \frac{1}{\eta(1-\beta)}\varepsilon_t^A - \frac{1}{\eta}\varepsilon_t^d\end{aligned} \tag{6.B12}$$

Substituting eqs (6.B10) and (6.B11) into eq. (6.B5) yields

$$\begin{aligned}\Delta y_t = &\left(\frac{\alpha\rho\varphi\mu}{(1-\beta)(\rho+\gamma)} + \frac{1-\alpha-\beta}{1-\beta}\right)\varepsilon_t^o + \frac{\alpha\rho\varphi}{(1-\beta)(\rho+\gamma)}\varepsilon_t^\chi \\ &+ \frac{1}{1-\beta}\varepsilon_t^A\end{aligned} \tag{6.B13}$$

Next, to solve for price, substitute eqs (6.B7), (6.11), (6.B3), and (6.12) into eq. (6.9) to get

$$\begin{aligned}p_t = &\frac{\lambda}{1+\lambda}E_t p_{t+1} - \frac{\beta\kappa}{(1+\lambda)(1-\beta)} \\ &+ \frac{\lambda\mu(1-\beta)(\rho+\gamma) - \alpha\rho\varphi\mu - (1-\alpha-\beta)(\rho+\gamma)}{(1+\lambda)(1-\beta)(\rho+\gamma)}o_t \\ &+ \frac{\lambda(1-\beta)(\rho+\gamma) - \alpha\rho\varphi}{(1+\lambda)(1-\beta)(\rho+\gamma)}\chi_t - \frac{1}{(1+\lambda)(1-\beta)}A_t \\ &+ \frac{1}{(1+\lambda)}d_t + \frac{1}{(1+\lambda)}m_t\end{aligned} \tag{6.B14}$$

In a similar fashion, conjecture a linear solution

$$p_t = H_1 o_t + H_2\chi_t + H_3 A_t + H_4 d_t + H_5 m_t \tag{6.B15}$$

and taking conditional expectations at time t on both sides to get

$$E_t p_{t+1} = H_1 o_t + H_2 \chi_t + H_3 A_t + H_4 d_t + H_5 m_t \tag{6.B16}$$

Equating coefficients yield

$$\Delta p_t = \left(\lambda\mu - \frac{\alpha\rho\varphi\mu}{(1-\beta)(\rho+\gamma)} + \frac{1-\alpha-\beta}{1-\beta}\right)\varepsilon_t^o + \left(\lambda - \frac{\alpha\rho\varphi}{(1-\beta)(\rho+\gamma)}\right)\varepsilon_t^\chi - \frac{1}{1-\beta}\varepsilon_t^A + \varepsilon_t^d + \varepsilon_t^m \tag{6.B17}$$

The complete solution is given by eqs (6.B1), (6.B2), (6.B12), (6.B13), and (6.B17).

Chapter 7

Conclusion

This thesis consists of five essays in empirical macroeconomics. Each essay contributes new empirical results to the literature. In this concluding chapter, I summarize the key findings and discuss the policy implications as well as suggest avenues for further research.

In Chapter 2, I find that, contrary to conventional wisdom, fiscal multipliers are not necessarily smaller in countries that are relatively open to trade and financial flows and operating under flexible exchange rate regimes. The relationship between the size of fiscal multipliers and the three dimensions of openness—trade openness, capital mobility, and exchange rate flexibility—hinges on the response of the real exchange rate and the degree of monetary policy accommodation. It should therefore not be taken for granted that, with increasing global integration and countries transitioning to flexible exchange rates, fiscal stimulus would become less effective as a policy tool. This ought to be comforting for policymakers, especially in developing countries, to continue pushing reforms to integrate with the world economy. The interaction of fiscal and monetary policy is important in understanding the transmission of fiscal shocks to the economy. In the prevailing environment with nominal interest rates close to the zero lower bound, an expansionary fiscal policy could have a large leverage in stimulating the economy as monetary policy is fully accommodated. However, the lack of fiscal space and debt build-up after the GFC might limit the size of fiscal stimulus packages.

An extension to the analysis on the effectiveness of fiscal stimuli in Chapter 2 is to use an interacted panel VAR model (see Towbin and Weber, 2013), where the coefficients are time-varying, to allow the model parameters to interact with an important variable, such as fiscal space. An application of this technique can be found in Huidrom et al. (2016). An alternative approach is to identify government spending shocks as a first step, and then use the estimated shocks in a second step in a fixed-effects panel regression with conditioning variables. This is the approach in Corsetti et al. (2012a), which has similarities to the local projections method (see Jorda, 2005;

Teulings and Zubanov, 2014) used in Riera-Crichton et al. (2015). A potential research avenue is to examine the effects of different fiscal instruments. Several studies on advanced economies find that tax cuts have a larger effect on GDP than spending increases (see e.g., Mountford and Uhlig, 2009; Alesina and Ardagna, 2010). Another aspect pertains to the composition of government expenditure (i.e., consumption vs. investment). Ilzetzki et al. (2011) find that the multiplier on government investment is larger than government consumption in a small subset of developing countries. As data on tax rates and government investment become more readily available in developing countries, such analyses would be very much welcome.

In Chapter 3, I provide evidence that flexible exchange rates and oil funds help oil-exporting countries to better adjust to a decline in oil prices. This finding supports the views of the IMF and the World Bank, and related studies (see Baffes et al., 2015; Husain et al., 2015; IMF, 2015; World Bank Group, 2015). Indeed, several oil exporters have recently transitioned to more flexible exchange rates after the plunge in oil prices, e.g., Russia, Kazakhstan, Azerbaijan, and Nigeria. Oil funds have also been set up in many countries during the oil price boom since the beginning of the new millennium.

In Chapter 4, I find that oil funds are effective in reducing fiscal procyclicality in countries with high institutional quality. There is also a reduction in the procyclical bias in countries with low institutional quality but the evidence is less compelling. This is an important finding as several studies highlight that good institutions, and not oil funds per se, are associated with lower fiscal procyclicality (e.g., Ossowski et al., 2008; Bova et al., 2016). My results show that, controlling for institutional quality, oil funds do in fact contribute to reducing the extent of the procyclical fiscal stance. As oil funds are now utilized to weather adverse oil prices, it would be interesting to see if stronger evidence emerges.

A potentially fruitful line of enquiry on oil price declines is to examine the differential effects of the nature of the shocks, as the unfolding of supply-driven and demand-driven shocks are inherently different. Several papers examine the effects of oil price increases (see e.g., Peersman and Van Robays, 2012; Cashin et al., 2014) but oil price changes could have asymmetric effects. In my preliminary analysis on a country-by-country basis, I find that, generally, a decline in oil prices due to an unanticipated

increase in global oil production has a relatively mild effect on output contraction in oil-exporting countries compared to a decrease in global demand. This would suggest that policymakers should pay attention to the driving forces of oil price changes and tailor policy responses accordingly. Another important consideration is whether the shocks are perceived to be temporary or permanent. A temporary oil price decline would induce policymakers to turn to fiscal buffers for adjustments, whereas a permanent scenario would necessitate structural reforms such as strengthening medium-term expenditure frameworks and phasing out energy subsidies.

In Chapter 5, I provide evidence of procyclical fiscal policy in Brunei, in spite of the availability of relatively large fiscal buffers in its oil reserve funds. The procyclical stance has an expansionary effect on output and thus exacerbates the business cycle. This behaviour is primarily driven by procyclical current expenditure while capital expenditure is largely acyclical. Adopting clear and transparent fiscal rules to better integrate the oil funds in the country's macroeconomic policy framework to delink government spending from volatile oil revenue would help to stabilize the economy.

In Chapter 6, I find that oil price shocks account for only a small proportion of output fluctuations while productivity shocks have the largest share. Real exchange rate movements are largely driven by demand shocks while monetary shocks explain most of the variability in prices. While several oil-exporting countries have recently moved towards more flexible exchange rate regimes, the relatively small contribution of oil price shocks in explaining macroeconomic fluctuations in Brunei suggests that there is no urgent need to abandon the existing currency peg to the Singapore dollar. Instead, economic policies should focus on productivity improvement and capital investment to increase output in the long run, and the conduct of fiscal policy should take into account the impact on real exchange rate volatility.

A future research project is to examine the effects of macroeconomic shocks on the Brunei economy under alternative fiscal and monetary policy arrangements in a dynamic stochastic general equilibrium (DSGE) framework. This would allow an assessment of how different fiscal rules (e.g., budget balance rule, expenditure rule) and monetary frameworks (e.g., exchange rate target, inflation target, nominal income target) contribute to macroeconomic stability. Important features of the calibrated

DSGE model would include a natural resource sector, accumulation of fiscal surpluses in a sovereign wealth fund, provision of oil subsidies by the government, a central bank operating on a currency board arrangement, and other real and nominal rigidities such as price stickiness, non-Ricardian households, and inefficiency of public investment.

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