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Impact and Transmission Channels of Oil Price Shocks in the G20 Countries

Jean-Baptiste Gossé[*] Cyriac Guillaumin[**]

Abstract: The return of major oil price fluctuations in the 2000s provoked important macroeconomic effects such as current account imbalances, slowdowns in economic growth, inflation and exchange-rate movements. We develop a structural vector auto-regressive model in order to analyze the complete transmission channels of an oil price shock in the G20 countries. Our results show that such a shock has asymmetric effects. In the short term it generates a current account imbalance in most countries: a deficit in oil-importing countries and a surplus in oil-exporting countries. The nominal exchange rate does not contribute much to compensate the initial imbalance, and most of the adjustment is made through relative prices and growth differential. In the United States and Saudi Arabia oil price shocks provoke persistent imbalances, confirming that the increase in oil prices contributed to explaining the accumulation of global imbalances in the 2000s.

Keywords: Oil Price Shock, Current Account Imbalances, Structural VAR Models, Block Exogeneity, G20.

JEL Classification: F32, F41, G15.

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1. Introduction

Since the first oil shock in 1973, a large body of literature has developed on the impact of oil price shocks on the macroeconomic aggregates of oil-importing countries (Burbidge and Harrison, 1984; Jones and Leiby, 1996; Jones et al., 2004; Hamilton, 2005). Since then, and following the seminal paper of Hamilton (Hamilton, 1983), the oil price has been widely recognized as one of the major sources of economic fluctuations (Gisser and Goodwin, 1986; Mork, 1989; Brown and Yücel, 2002; Hamilton, 1983, 1996). These studies were mainly related to the United States (Hamilton, 2008), industrialized economies (Blanchard and Galí, 2007), European countries (Lardic and Mignon, 2006), or OECD countries (Jiménez-Rodriguez and Sánchez, 2005), but, to our knowledge, none of them focused on the G20 countries. Nevertheless, it seems that G20 countries are an interesting panel because: (i) they represent a broadly representative sample of both oil-importing and -exporting countries; and (ii) they represent 85 per cent of world trade, 90 per cent of the world GDP and more than 60 per cent of the world population.[2]

Previous studies aimed at studying the link between the oil price and economic activity (GDP, inflation, unemployment) using linear (Darby, 1982; Bruno and Sachs, 1985; Mork, 1994) or non-linear (Mory, 1993; Lardic and Mignon, 2006), econometrics techniques. All of these studies can broadly be classified into three categories (Tang et al., 2010). The first category includes the studies of the theoretical mechanisms and channels through which the oil price increase may retard economic activity (Hooker, 1996; Hamilton, 1996; Brown and Yücel, 2002), some of them using general equilibrium models (see, for example, Rotemberg and Woodford, 1996). The second category of studies focuses mainly on the empirical investigation of the relationship between oil price fluctuations and aggregate economic activity. Whether linear or non-linear, symmetric or asymmetric, the mathematical

[2] Authors' own calculations from CHELEM (CEPII) database.

relationship was verified for most of the developed countries between the 1970s and the 1990s (Mory, 1993; Lee and Ni, 2002; Lardic and Mignon, 2006). The third category analyzes the role of macroeconomic policies in dealing with the oil price shock. In particular, these studies examine the possibility of a weakening relationship between oil price fluctuations and aggregate economic activity (Huang et al., 2005; Cologni and Manera, 2008). It is worth noting that, despite the considerable number of articles on the subject, there is no consensus on the transmission mechanisms.

Few articles (see Kilian et al., 2009, for a summary) have studied the impact of an oil price shock on the external account, in particular on the current account. Yet the question of global imbalances has been very important for many years and the various oil shocks were put forward as one explanation for the worsening of global imbalances (see, for example, Bernanke, 2004, 2005; Rebucci and Spatafora, 2006). Moreover, global imbalances have recently become a major concern of international economics and since the G20 Seoul summit one of the G20's priorities has been to reduce them. The impact of oil price shocks on external accounts is transmitted through both the trade and the capital account, as shown by Backus and Crucini (2000), Bodenstein et al. (2001) and Kilian et al. (2009). For a net oil-exporting economy, the direct effect of rising world oil prices is expected to be positive, as it gets more export revenues. For a net oil-importing economy, an increase in oil price should provoke a deterioration of the trade balance, as the short-term elasticities of substitution are rigid. However, there is no consensus on the long-term effect of an oil price shock on external account for both oil-importing and oil-exporting countries (Kilian, 2009).

Given the existing literature, we can legitimately ask the following questions:

1. What are the effects of an oil price shock on the G20 countries in both the short and long terms?

2. Does an oil price shock have the same effect on the G20 countries?

3. What are the transmission channels to the G20 countries?

4. How do the G20 countries adjust these shocks?

The aim of our paper is to answer the previous questions using a structural VAR (SVAR) model with exogenous constraint. We study the transmission channels of an oil price shock using four domestic variables (relative GDP, nominal effective exchange rate, price differentials and current account) for each G20 country. We selected these variables because they represent the major channels of adjustment of external shocks. We refer to the Mundell-Fleming-Dornbusch model to analyze the theoretical effect of external shocks. This model considers that uncovered interest rate parity holds, but purchasing power parity does not, so that the exchange rate can vary to adjust the impact of external shocks. Price levels are supposed to be rigid in the short term and to adjust progressively over time. The current account balance depends upon growth differential, relative prices and nominal exchange rate. An increase in nominal effective exchange rate – as well as an increase in relative prices – increases imports and decreases exports, which deteriorates the current account balance. An increase in the domestic GDP higher than in the rest of the world leads to an increase in growth differential, which has a negative impact on the current account balance. Along with these different effects, the change in oil prices is a negative supply shock, which raises domestic prices and negatively affects the domestic GDP.

The remainder of the paper is organized as follows. Section 2 discusses the transmission channels through which oil price changes affect the macroeconomic variables. Section 3 presents the analytical framework used in this paper. Section 4 discusses our main empirical results. Section 5 examines the robustness of the results. Section 6 offers conclusions.

2. Impact of an Oil Price Shock

Since the first oil shock, the oil price has been widely recognized as one of the major sources of economic fluctuation (Hamilton, 2005; Jones et al., 2004; Lee and Ni, 2002). Despite the considerable number of articles on the subject, there is no consensus on the transmission mechanisms. From a theoretical perspective, we distinguish six mechanisms through which oil prices may affect the performances of macroeconomic variables. First, the price effect generates trade imbalances. As imports and exports are inelastic in the short term, an increase in the price of oil augments the value of imports (exports) in oil-importing (-exporting) countries.

Second, the initial trade deficit (surplus) can be adjusted through an exchange-rate depreciation (appreciation), as predicted by the Mundell-Fleming-Dornbusch model. Following the exchange-rate adjustment, foreigners purchase more domestic goods and nationals purchase fewer foreign goods. This results in a decrease in imports and an increase of exports, which improves the current account balance. Such an adjustment is only possible under floating exchange rates and does not apply to countries presenting pegged currencies.

Third, a long-lasting oil shock can give rise to a change in the production structure (Barsky and Kilian, 2004; Gisser and Goodwin, 1986) since it diminishes the rentability of oil-intensive sectors and can incite firms to adopt new production methods that are less intensive in oil inputs. In the long term this change could lead to a decrease in the demand for oil products and to an improvement of the current account balance. However, as shown by the IMF (2011),[3] oil demand is highly price-inelastic both in the short and the long terms. Thus, the initial trade imbalance may not be adjusted though a reduction in the demand for oil.

Fourth, a classic supply-side effect can result from rising oil prices (Bruno and Sachs, 1985). This reflects the reduced availability of a basic input to production, which reduces potential output (see, for example, Brown and Yücel, 1999; Abel and Bernanke, 2001). Consequently, there is an increase in cost production, and the growth of output and productivity are slowed.

[3] The IMF (2011) calculated oil demand price elasticities for a sample representing 83 per cent of the world oil demand between 1990 and 2009. For a sample including OECD, non-OECD and major oil-exporting economies, the short-term price elasticity is -0.017 and the long-term one is -0.067.

Fifth, there is a wealth transfer from oil-importing to oil-exporting countries resulting from a deterioration in the terms of trade for oil-importing countries (see Dohner, 1981). This leads to a fall in the purchasing power of both firms and households in oil-importing countries and to a decrease in the growth differential. As oil exporters see their incomes grow faster than in oil-importing countries, their current account balance deteriorates while those of the latter improve. According to the IMF (2011), oil demand income elasticities are, respectively, 0.676 and 0.474 in the short and the long terms, which is much more flexible than the estimated price elasticities. This channel could thus play a determinant role in adjusting oil shocks.

Sixth, oil-exporting countries may be subject to the so-called Dutch disease effect. The inflation of oil price triggers a short-term current account surplus and an acceleration of domestic growth. For exogenously given prices of tradable goods, the higher aggregate demand leads to higher relative prices of non-tradable goods (Corden and Neary, 1982), and the augmentation of the price differential may eventually reverse the initial current account surplus if it exceeds the growth differential effect.

The expected responses of the variables to the oil price shock in both the oil-importing and oil-exporting countries are summarized in Table 1.

Table 1. Summary of the expected responses to external shocks

	y / y^{*}	n_{eer}	p / p^{*}	ca / y	Countries concerned
Price effect			↓ (↑)	↓ (↑)	Oil-importing (-exporting) countries
Demand effect		↓ (↑)		↑ (↓)	Oil-importing (-exporting) countries
Change in production structure				↑	Oil-importing countries
Supply-side effect	↓		↑	?	Oil-importing countries
Wealth transfer	↓ (↑)		↓ (↑)	↑ (↓)	Oil-importing (-exporting) countries
Dutch disease effect	↓		↑	?	Oil-exporting countries

Notes: y / y^{*}, n_{eer} p / p* and ca / y are, respectively, the growth differential, the nominal effective exchange rate, the price differential and the current account balance on GDP.
↑ and ↓ indicates, respectively, an increase and a decrease.

3. Analytical Framework

3.1. SVAR Model with Block Exogeneity

In the context of strong links of macroeconomic variables with complex feedback linkages, VAR models constitute useful tools to catch the interdependencies between multiple time series. In order to analyze the transmission channels of an oil price shock for G20 countries, consider the following structural VAR (SVAR) model with block exogeneity:

$$\underset{(n,n)}{\Lambda(L)}\underset{(n,1)}{Y_t} = \underset{(n,1)}{\varepsilon_t} \Leftrightarrow \begin{bmatrix} \Lambda_{11}(L) & \Lambda_{12}(L) \\ \Lambda_{21}(L) & \Lambda_{22}(L) \end{bmatrix} \begin{bmatrix} y_t^1 \\ y_t^2 \end{bmatrix} = \begin{bmatrix} \varepsilon_t^1 \\ \varepsilon_t^2 \end{bmatrix} \tag{1}$$

$$\Leftrightarrow \sum_{i=0}^{p} \begin{bmatrix} \Lambda_{11,i} & \Lambda_{12,i} \\ \Lambda_{21,i} & \Lambda_{22,i} \end{bmatrix} \begin{bmatrix} y_{t-i}^1 \\ y_{t-i}^2 \end{bmatrix} = \begin{bmatrix} \varepsilon_t^1 \\ \varepsilon_t^2 \end{bmatrix} \tag{2}$$

where L is the lag operator. ε_t is a Gaussian random vector satisfying $E[\varepsilon_t | y_{t-i}, i > 0] = 0$ and $E[\varepsilon_t \varepsilon_t^{'} | y_{t-i}, i > 0] = I$ with I the identity matrix.

The vector of external variables y_t^1 includes the external variables, while y_t^2 integrates the domestic variables and n is the number of variables. ε_t^1 is a vector of structural shocks of external origin – here the oil shock – and ε_t^2 is a vector of structural shocks of domestic origin. This model is estimated for each G20 country except for Russia.

y_t^1 includes the real oil price (*rBrent*). The vector of domestic variables y_t^2 includes the real growth differential (y / y^*), where y is the domestic GDP and y^* is the world GDP, the nominal effective exchange rate (n_{eer}), the price differential (p / p^*), where p is the domestic price index and p^* is the world price index, and the current account balance in per cent of GDP (ca / y).

The oil price is the first variable of our model. We define oil price in real terms, taking the ratio of the Brent oil price in US dollars to the US producer prix index, as in Jiménez-Rodriguez and Sánchez (2004). We make this choice because: (i) we cannot measure oil price in nominal terms given his undesirable property (Hamilton, 1996), according to which the increased inflation provoked by the nominal oil price would induce a decrease in real variables over time; (ii) the oil shock is an exogenous and common shock to all countries; and (iii) we want to compare some of our results with the existing literature. We include the growth differential (y/y^*) in our model in order to identify both the supply and demand side effects of an oil shock. Introducing the exchange rate is justified by the nature of this variable, which, whatever the source of the shock, constitutes an important transmission mechanism, as Cushman and Zha (1997) demonstrate. In order to properly distinguish the transmission mechanism between the price (i.e. the consumer price index, CPI) and the exchange rate, we propose to integrate in our model, on the one hand, the nominal effective exchange rate (n_{eer}) and, on the other hand, the consumer price index, as in Ito and Sato (2006) and Maćkowiak (2007). Unlike many studies that used a bilateral exchange rate vis-à-vis the US dollar, we think that the effective exchange rate is the most appropriate concept to capture the total effect of the exchange-rate channel, because effective exchange rate takes into account the trade composition of each country. The price differential (p/p^*) is included as a measure of relative domestic inflation. It can show the effect of the oil price shock on inflation and also the effect induced by the growth differential and the nominal effective exchange rate. The last variable of our model is the current account in per cent of GDP (ca/y). This variable reflects both trade and capital account channels and it gives us an indication of the importance of the impact of an oil price shock on global imbalances.

3.2. Estimation and Restrictions

Following Leeper et al. (1996), to obtain the representation of equation (1), we estimate a reduced-form VAR model:

$$A(L)Y_t = u_t \tag{3}$$

where u_t is a white noise, with zero mean and variance-covariance $\sigma^2 I$. Under the traditional hypothesis, equation (1) can be represented as a vector moving average (VMA) process:

$$Y_t = B(L)u_t \tag{4}$$

We can also re-write u_t as a linear combination of structural shocks:

$$u_t = S\varepsilon_t \tag{5}$$

where ε_t is a vector of structural shocks, independent from one another.

Then:

$$Y_t = C(L)\varepsilon_t \tag{6}$$

with:

$$C(L) = B(L)S \tag{7}$$

$C(L)$ describes the dynamic response of variables y_t^1 and y_t^2 to structural shocks.

In order to estimate the structural form (equation (1)), we need $n^2(p+1)$ structural parameters, which are in matrix $\Lambda(L)$. The estimation of the reduced-form VAR (equation (3)) provides $n^2 p + n(n+1)/2$ parameters. Given those assumptions, the identification of the structural form requires imposing $n(n-1)/2$ restrictions. We proceed to the estimation of matrix S in imposing restrictions in both the short and long terms. Short-term constraints are imposed directly on $C(0)$ (with $C(0) = B(0)S$), which describes the contemporaneous reactions of the variables to each structural shock. Long-term restrictions are imposed on $C(1)$ (with $C(1) = B(1)S$), which describes the long-term effects of the variables to each structural shock. As we have $n = 5$ we thus require ten restrictions of both short and long terms. Following Zha (1999), Cushman and Zha (1997), Elbourne and de Haan (2006), Maćkowiak (2007), and Sato et al. (2011), we impose the following constraints.

The block exogeneity restriction implies that domestic structural shocks ε_t^2 do not affect the vector of external variables y_t^1 at time t, $\forall t$. We thus impose four constraints on $C(0)$.[4] Regarding the domestic block, we impose restrictions following Jiménez-Rodriguez and Sánchez (2004), Ito and Sato (2006) and Blanchard and Galí (2007). The growth differential is not affected by the three other domestic shocks in the long term. We obtain three additional constraints. The nominal effective exchange rate responds to oil price and growth differential shocks but in the long term is not affected by price and current account shocks. We get two additional constraints. Finally, the last restriction is that inflation differentials are not affected by the current account shocks. The short- and long-term restrictions are summed up, respectively, in the matrices $C(0)$ and $C(1)$:

$$C(0)=\begin{bmatrix} . & 0 & 0 & 0 & 0 \\ . & . & . & . & . \\ . & . & . & . & . \\ . & . & . & . & . \\ . & . & . & . & . \end{bmatrix} \tag{8}$$

and

$$C(1)=\begin{bmatrix} . & . & . & . & . \\ . & . & 0 & 0 & 0 \\ . & . & . & 0 & 0 \\ . & . & . & . & 0 \\ . & . & . & . & . \end{bmatrix} \tag{9}$$

3.3. Data and BVAR Methodology

We consider the following countries belonging to the Group of the Twenty (G20):[5] Argentina (ARG), Australia (AUS), Brazil (BRA), Canada (CAN), China (CHN), France (FRA), Germany (GER), Italia (ITA), India (IND), Indonesia (INDN), Japan (JAP), Mexico (MEX),

[4] In an alternative version of the VAR model without exogeneity hypothesis, these four restrictions are obtained by imposing short-term constraints on oil price reactions to domestic shock (see Maćkowiak, 2007).

[5] Our sample covers all of the G20 countries except for Russia and the European Union because of data availability.

Saudi Arabia (SA), South Africa (ZAF), South Korea (KOR), Turkey (TUR), the United Kingdom (UK) and the United States (USA).

The oil price matches the Brent oil price taken from the database of EIA (Energy Information Administration) and the database of the Federal Reserve Bank of St Louis. Real oil price is obtained by deflating oil price using the US producer price index taken from the Federal Reserve Bank of St Louis. Real GDP, price index and current account (in per cent of GDP) come from the database of the OECD and from the IMF's *International Financial Statistics*. Nominal effective exchange rates come from the IMF's *International Financial Statistics* and the Bank of International Settlements. Finally, OECD data from 30 member countries were used to obtain world GDP and world price.

We use quarterly data from 1981:1 to 2011:3. Every variable except for current account has been turned into logarithms. GDP, price and current account have been deseasonalized.[6]

We can choose to estimate a VAR model in level following Sims et al. (1990) and Sims (1992). These works show that the common practice of attempting to transform models to stationary form by difference or cointegration operators, whenever it appears likely that the data are integrated, is in many cases unnecessary. Moreover, there are several problems with the traditional approach to VAR estimation, using Least Square or Maximum Likelihood (Ni and Sun, 2005). The difficulties encountered in the frequentist approach of VAR inference can be circumvented by the Bayesian approach, which combines information from data with the researcher's prior. According to Sims et al. (1990), a Bayesian approach finds no reason ever to use a transformed model, except possibly for computational simplicity. That is why we decide to estimate a Bayesian VAR (BVAR) model for each country. As in Kim and Roubini (2008), our statistical inference is not affected by the presence of unit roots and cointegrating relations, since we follow a Bayesian inference to construct standard errors of

[6] Census X-12 method. Current account data have been deseasonalized using the Census X-11 method because multiplicative and log-additive adjustments do not allow negative data.

impulse response functions and to forecast error variance decomposition.[7] We use one year plus two periods of lags (Doan, 2010).[8]

Table 2. List of dummy variables applied for each country

	Argen-tina	Austra-lia	Brazil	Canada	China	France	Germany	India	Indo-nesia
Lehman Brothers crisis	√	√	√	√	√	√	√	√	√
Local/regional crisis	√		√		√			√	√
Hyperinflation	√		√						√
Introduction of the euro						√	√		
German reunification							√		

	Italy	Japan	Korea	Mexico	Saudi Arabia	South Africa	Turkey	United Kingdom	United States
Lehman Brothers crisis	√	√	√	√	√	√	√	√	√
Local/regional crisis		√	√				√		
Hyperinflation				√			√		
Introduction of the euro	√								
German reunification									

Note: "√" indicates that a dummy is applied for the country.

Several dummy variables capture the effect of major shocks that have hit the G20 countries. As in Berthaud and Colliac (2010), we introduce a dummy variable, which equals one from 2008:3 to 2009:2 and 0 otherwise, in order to take into account the effects of the world crisis (started with the *subprime* crisis). We also introduce a dummy variable for local or regional crises observed during the period. Following Rüffer et al. (2007), dummy variables indicate the occurrence of the Asian crisis from 1997:2 to 1998:3,[9] the Brazilian crisis in 1999:1, the Turkish crisis from 1993:4 to 2000:1, and the Argentine crisis from 2001:4 to 2002:1. During

[7] We still have conducted unit root and cointegration tests with structural breaks, following Bai and Perron's (2003) methodology, in order to detect breaks. This information (the number and date of breaks) is then used in our VAR estimations. Results are available upon request from the authors.
[8] The standard errors are constructed by Monte Carlo integration with the Jeffrey's prior, as in Doan (2010) and Kim and Roubini (2008).
[9] We introduced alternatively a dummy for the post-Asian crisis period but this variable was not significant.

the periods of hyperinflation[10] observed in Argentina, Brazil, Indonesia, Mexico and Turkey, we introduce a dummy variable. Finally, we use dummy variables to take into account the introduction of the euro (1999:1) and the reunification of Germany (1989:4–1990:4). Table 2 presents the dummies used for each country.

The root mean square error (*RMSE*) enables us to compare the forecasting performances eight quarters ahead of the three models in the period 2001Q1–2011Q3. The VAR model is first estimated for the period 1981Q1–2000Q4 and we then use the Kalman filter to update the coefficients. A relative *RMSE* smaller than one indicates that the mean-adjusted BVAR forecasts better than the naive model at a given forecasting horizon. Results are presented in Table 3. We can see that the BVAR model with block exogeneity outperforms the other models for 10 countries and the simple BVAR for 7 countries (*). The only case in which the OLS model does better than the BVAR models is India.

Table 3. Forecasting performance of alternative models
(Relative Root Mean Square Errors)

	OLS	Simple BVAR	BVAR with block exogeneity
Argentina	1	0.8867	0.8841*
Australia	1	0.8814*	0.8938
Brazil	1	0.8615	0.8453*
Canada	1	0.9023	0.8913*
China	1	0.9264*	0.9484
France	1	0.8904	0.8289*
Germany	1	0.8698	0.8696*
India	1*	1.0120	1.0696
Indonesia	1	0.8225*	0.8889
Italy	1	0.8799	0.8328*
Japan	1	0.6871*	0.7191
Korea	1	0.7579*	0.7736
Mexico	1	0.9343*	0.9365
Saudi Arabia	1	0.9175	0.9076*
South Africa	1	0.9545*	0.9690
Turkey	1	0.9048	0.8874*
United Kingdom	1	0.8015	0.7980*
United States	1	0.8751	0.8661*

[10] We follow the definition proposed by Reinhart and Rogoff (2009) according to which hyperinflation is characterized by an annual inflation rate higher than 40 per cent.

4. Results and Discussion

4.1. Analysis of the Contribution of Oil Shocks

We perform a variance decomposition analysis in order to determine the importance of the contribution of oil shocks to the fluctuations of each domestic variable (y/y^*; n_{eer}; p/p^*; ca/y). The results of the variance decomposition analysis for the G20 countries are presented in Table A.1 for the short and long terms.

In the short term, oil shocks mostly impact the current account balance. In Japan, Korea, Mexico and the United States, the contribution of the oil shock ranges from 10 to 14 per cent. Saudi Arabia presents a particularly high value of 52 per cent, which means that in the short term half of the fluctuations of its current account balance are explained by oil shocks. The impact on the other domestic variables is limited in the short term. The growth differential is only significantly impacted in the United Kingdom. The nominal effective exchange rate (NEER) does not substantially adjust the oil shock, except for Canada. The price differential is almost unaffected by the shock.

In the long term, the oil shock mostly affects price variables (NEER and price differential). Only four countries – Argentina, China, Germany and Indonesia – are not affected by any of these two channels. The long-run adjustment of the NEER is in line with the Mundell-Fleming-Dornbush model, according to which current account imbalances are adjusted through exchange-rate variations. The contribution to the variance of the exchange rate is particularly large in Canada and Turkey and in the countries presenting a floating exchange-rate regime, while it tends to be very small in countries presenting rigid exchange-rate regimes (Table A.1). Adjustments through the price differential result from the supply-side effects in oil-importing countries and from the Dutch disease effect in oil-exporting countries. Oil shocks durably affect the level of the current account balance both in oil-exporting (Saudi Arabia and Mexico) and oil-importing countries (the United States and France). The initial impact on the trade balance is not adjusted through the other channels and the increase in the price of oil leads to persistent external imbalances. In the long term, the growth differential contributes to the adjustment of the oil shock in some advanced economies (the United States, the United Kingdom, Italy and France) through the supply-side channel. The shock also substantially contributes to the fluctuations of the growth differential of some oil-producing countries such as Argentina and China.

More generally, we notice that all the G20 countries are substantially influenced by the oil shock, except for Germany and Indonesia. Despite Germany being an industrialized country that is highly dependent on oil imports, and Indonesia being a massive oil exporter, these two countries remains strangely unaffected by the oil shock. China is only significantly affected through the growth differential and Australia and India seem to adjust most of the shock through an exchange-rate variation. In the other countries a variation in oil price provokes important adjustments through at least two domestic variables. The adjustments are particularly spectacular in the United States, the United Kingdom, Italy and France.

4.2. The Effects of Oil Shock on G20 Countries

The study of impulse response functions enables us to examine the reactions of current account balance following an oil price shock and to determine the adjustment channels at the domestic level. Dynamic responses of each domestic variable to the oil price shocks are depicted in Figures B.1 to B.4.[11]

Most countries are directly affected by the price effect. In the short term, as importations (exportations) become more expensive in oil-importing (-exporting) countries, the oil shock provokes a current account deficit (surplus). The initial current account imbalance is adjusted through three different channels. Argentine and Chinese current account surpluses adjust through faster growth than in the rest of the world. In Canada we observe a Dutch disease

[11] The solid line is the median of the posterior distribution and the dashed lines represent the sixteenth and eighty-fourth quantiles, which correspond to one standard deviation band.

effect. The oil shock provokes an appreciation of domestic prices in the non-trading sector, leading to a reduction in domestic demand. In Japan and Korea, the high flexibility of the exchange rate allows for adjustment of the current account deficit through depreciation. This result confirms that the exchange-rate fluctuations can efficiently adjust current account imbalances under a floating exchange-rate regime.

Surprisingly, Germany and Indonesia remain mostly unaffected by the oil shock, which corroborates the results of variance decompositions. The remaining countries are not affected directly through a current account imbalance but the oil price has other consequences. It provokes a slowing down of domestic growth and an appreciation of domestic prices relative to the rest of the world. The United Kingdom, despite the fact it is a net-oil exporter in the period, presents all the characteristics of an oil-importing country, except for the initial current account deficit.

In some countries, the initial imbalance cannot be adjusted in the long term. Despite an increase in domestic prices in Saudi Arabia and an appreciation of the nominal exchange rate in Mexico, the surplus persists. The persistent deficits of the United States and France result from the contradictory combination of the growth differential effect and of the exchange rate and price effects. Our results confirm that the oil price shocks contribute to explaining the accumulation of global imbalances in the United States and in oil-exporting countries such as Saudi Arabia and Mexico. All our results are summed up in Table D.1.

5. Robustness

To check the stability of the results, we estimate a VAR model using OLS (Model 1), a simple BVAR (Model 2), a BVAR without dummies (Model 3) and a BVAR with block exogeneity (Model 4). The comparison of the results obtained with each model allows us to determine whether the choices we made modify our conclusions. The impulse response functions of the four models are presented in Figures C.1 to C.4. Generally speaking, the reactions to the oil shock are very similar whichever model we use. In almost all cases the shape of response function is the same.

In a few cases the magnitude of the reactions differs quite significantly from one model to another. For Argentina and Brazil the responses are slightly stronger without the dummy variables but the magnitude is still of the same order. In contrast, the results for the three countries of the eurozone are affected to a much greater degree. The introduction of dummy variables tends to reduce the importance of the responses. This is particularly true for Germany in which the model without dummies reveals a supply-side effect characterized by an increase in relative prices and a decrease in growth differential. In the long term, the German current account balance improves quite substantially, pushed by the combined effect of the growth differential reduction and the exchange-rate depreciation.

For India, Model 1[12] produces responses that are perfectly in line with those of the other models. Model 2 tends to undervalue the effect of oil shocks for the Indonesian domestic variables and the introduction of dummies strongly reduces the effect on the exchange rate. This can explain why the reactions of Indonesia to the shock were relatively small and insignificant. Finally, we note that the responses of the four models are remarkably similar for the United States, Saudi Arabia and Mexico – which are important actors in the global imbalances observed in the 2000s – as well as for Canada, Korea and the United Kingdom.

6. Conclusion

This paper attempted to determine how, and to what extent, oil price shocks impact the G20 economies. To that end, we developed a structural vector auto-regressive model with block exogeneity in order to analyze the transmission channels of an oil price shock in the G20 countries. We especially study the adjustments through the output, the exchange rate, the price and the current account. Our results confirm the short-term impact of oil shocks on

[12] The study of the *RMSE* reveals that the OLS model is the best suited to predicting the evolution of Indian domestic variables in the 2000s (see Section 3.3).

current account balances, generating surpluses in oil-exporting countries and deficits in oil-importing ones.

In most countries, the initial imbalance is adjusted. The depreciation of the nominal exchange rate efficiently adjusts the initial Japanese and Korean imbalances in the long term. This variable contributes to adjusting the Canadian and Mexican surplus but, as a general rule, it does not significantly compensate current imbalances. The GDP differential contributes to correcting the current account imbalance in half of the countries, in particular the United States, the United Kingdom, Argentina and Italy, where the oil shock explains more than one-third of the long-run fluctuations. In oil-importing countries, the deterioration of the growth differential results from the increase in domestic prices triggered by the oil shock. In oil-exporting countries, the improvement of GDP performances results from larger oil exports.

Beyond the heterogeneity of the channels of adjustment, our results shed light on some contemporary major issues. First, Germany is not significantly affected by oil shocks. It puts in evidence the particular feature of this economy among the G20 countries and, more particularly, among the euro area. Second, Canada’s economy seems to carry the burden of the Dutch disease. The increase of its domestic prices contributes to a growth slowdown. We also observe such inflation in Saudi Arabia but without any negative impact on domestic growth. Third, oil shocks generate persistent imbalances in some critically important countries, such as the United States and Saudi Arabia. This confirms that oil shocks have contributed to the accumulation of global imbalances in the 2000s as they explain respectively 25 and 66 per cent of the current account variances of the major debtor country and of one of the main creditors.

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Appendix A

Table A.1. Oil balances and exchange rate regimes of the G20 countries

	Argentina	**Australia**	**Brazil**	**Canada**	**China**	**France***	**Germany***	**India**	**Indonesia**
Exchange rate flexibility	40%	89%	83%	100%	30%	22%	22%	75%	72%
Oil balance (% GDP)	1%	0%	-1%	1%	0%	-2%	-2%	-2%	4%

	Italy*	**Japan**	**Korea**	**Mexico**	**Saudi Arabia**	**South Africa**	**Turkey**	**United Kingdom**	**United States**
Exchange rate flexibility	32%	100%	80%	84%	21%	98%	77%	100%	100%
Oil balance (% GDP)	-2%	-2%	-4%	4%	40%	-3%	-2%	1%	-1%

Notes: authors' own calculations from IEA (2011) for oil balance (average for 1981–2010); Reinhart and Rogoff (2009) for exchange-rate flexibility (average for 1981–2008).
* Eurozone countries.

Appendix B

Variance decomposition & Impulse response functions

Table B.1. Variance decomposition

Variables	Steps	ARG	AUS	BRA	CAN	CHN	FRA	GER	IND	INDN
y/y^*	4 quarters	2	0	1	1	3	3	3	2	0
	20 quarters	32	1	1	13	24	30	2	7	1
n_{eer}	4 quarters	2	8	2	19	1	4	0	2	2
	20 quarters	2	26	21	55	6	11	2	21	8
p/p^*	4 quarters	1	0	0	5	0	0	1	1	0
	20 quarters	2	1	16	32	0	10	3	6	1
ca/y	4 quarters	6	2	0	4	5	7	1	6	1
	20 quarters	10	5	2	5	6	18	1	6	4

Variables	Steps	ITA	JAP	KOR	MEX	SA	ZAF	TUR	UK	USA
y/y^*	4 quarters	7	0	1	1	1	4	2	10	6
	20 quarters	31	6	6	1	5	21	5	40	40
n_{eer}	4 quarters	0	7	2	5	1	0	6	3	3
	20 quarters	14	13	14	15	4	4	35	10	3
p/p^*	4 quarters	1	1	1	1	1	0	1	3	9
	20 quarters	29	0	19	15	46	12	14	29	29
ca/y	4 quarters	1	10	10	14	52	3	1	2	12
	20 quarters	3	10	10	17	66	13	7	7	25

Notes: y / y^*, n_{eer}, p / p^* and ca / y are, respectively, the growth differential, the nominal effective exchange rate, the price differential and the current account balance in per cent of GDP. Four quarters corresponds to the cumulative response after four quarters. Twenty quarters corresponds to the cumulative response after twenty quarters.

Figure B.1. Impulse response functions

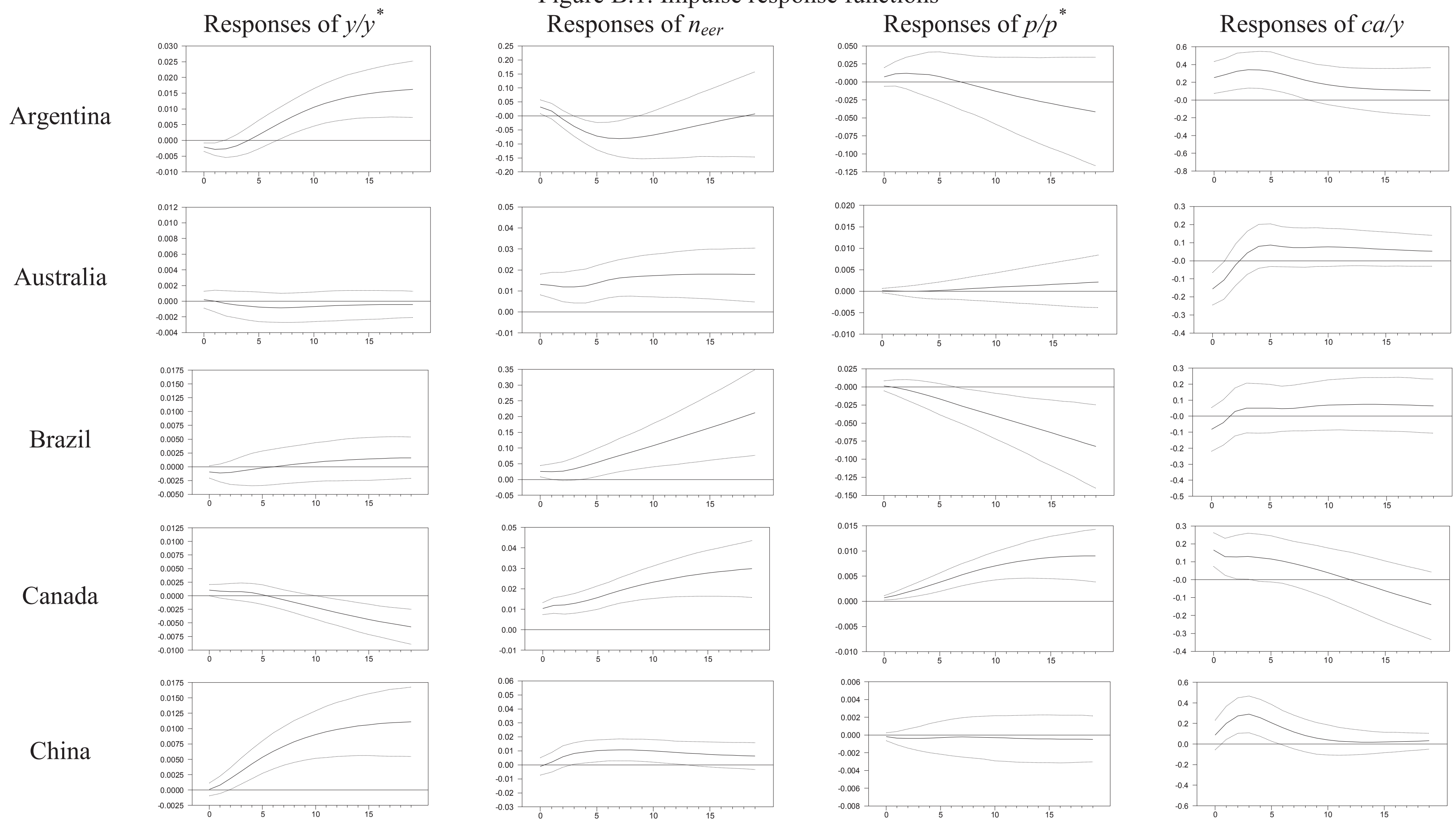


Figure B.2. Impulse response functions

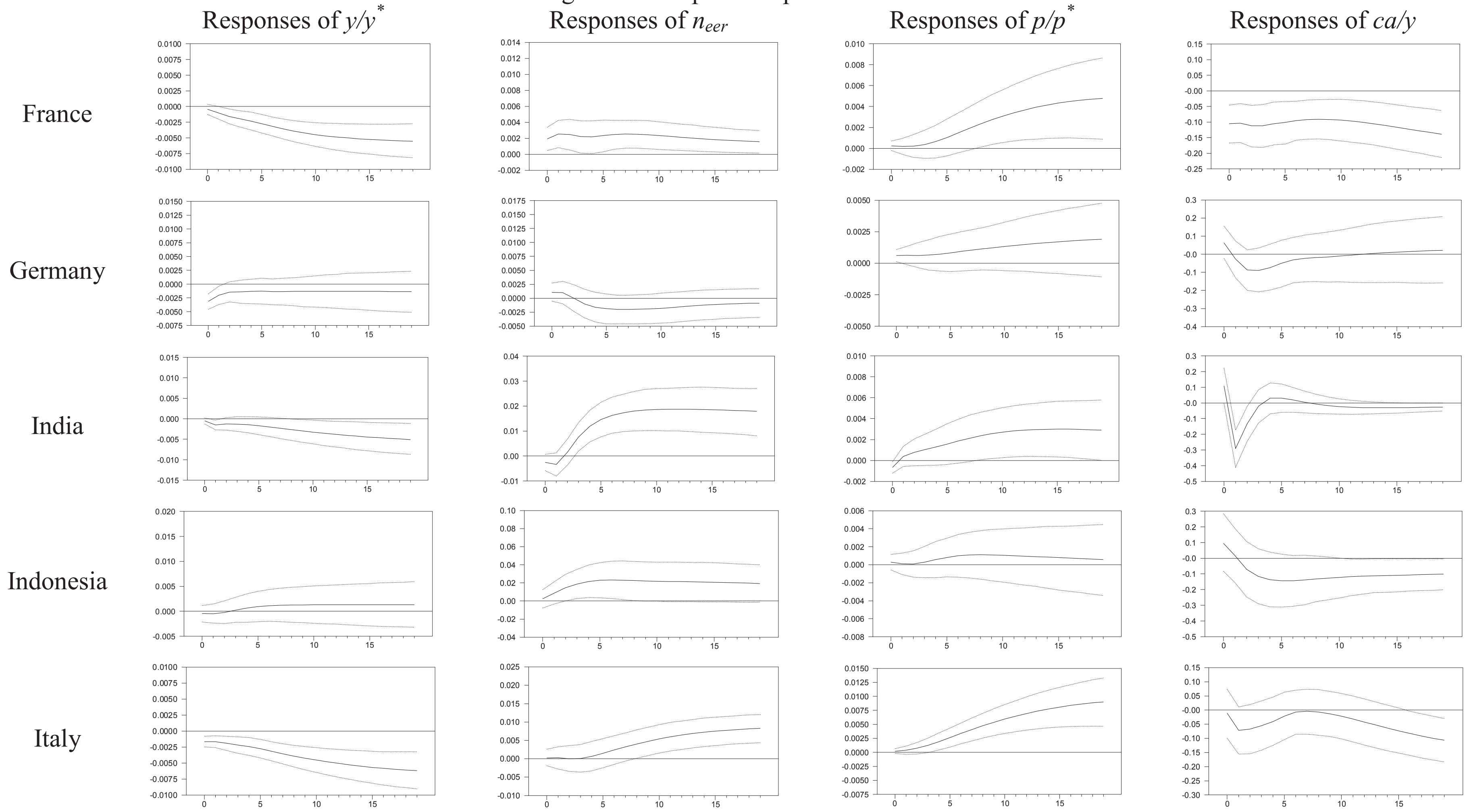


Figure B.3. Impulse response functions

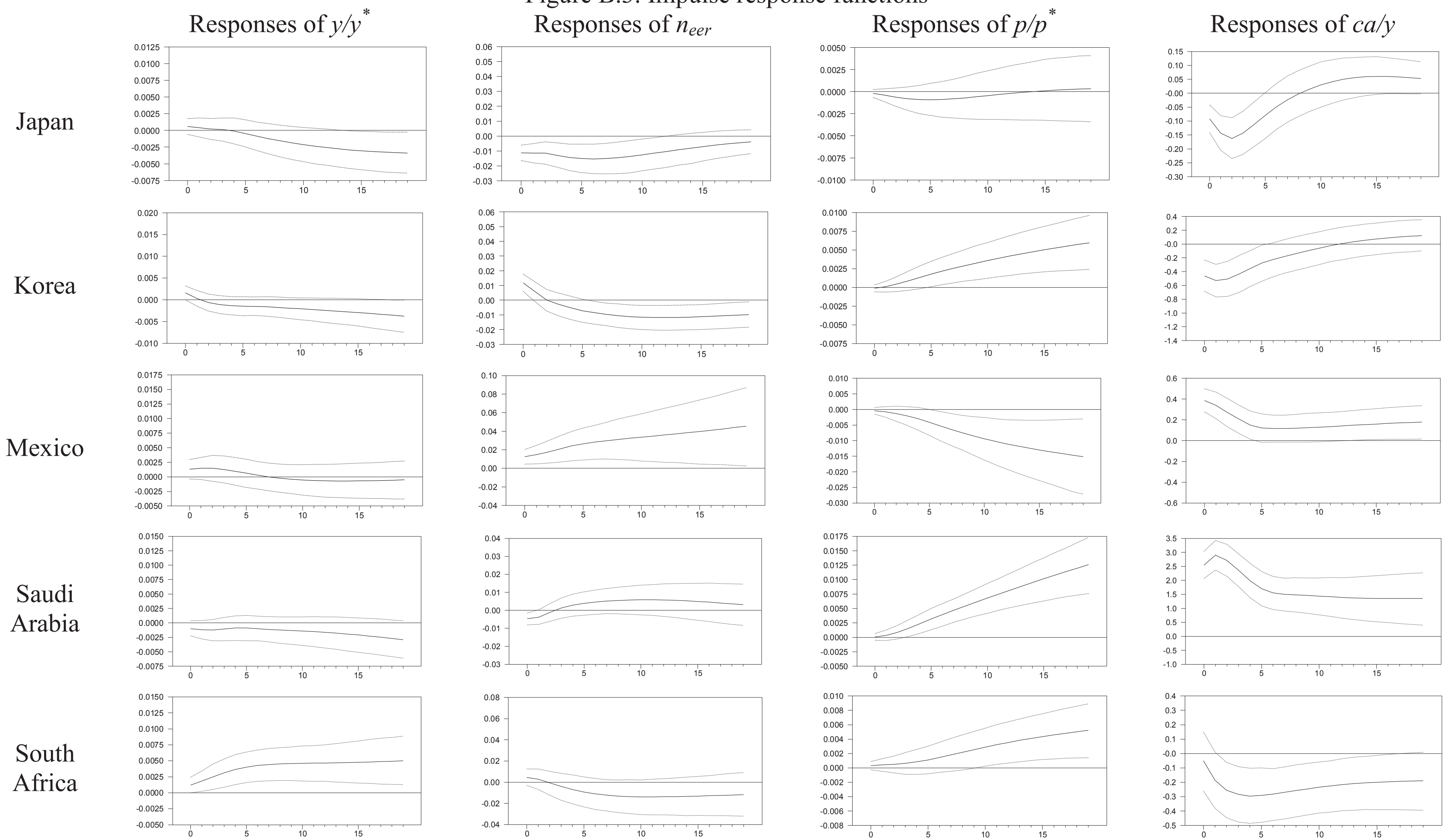
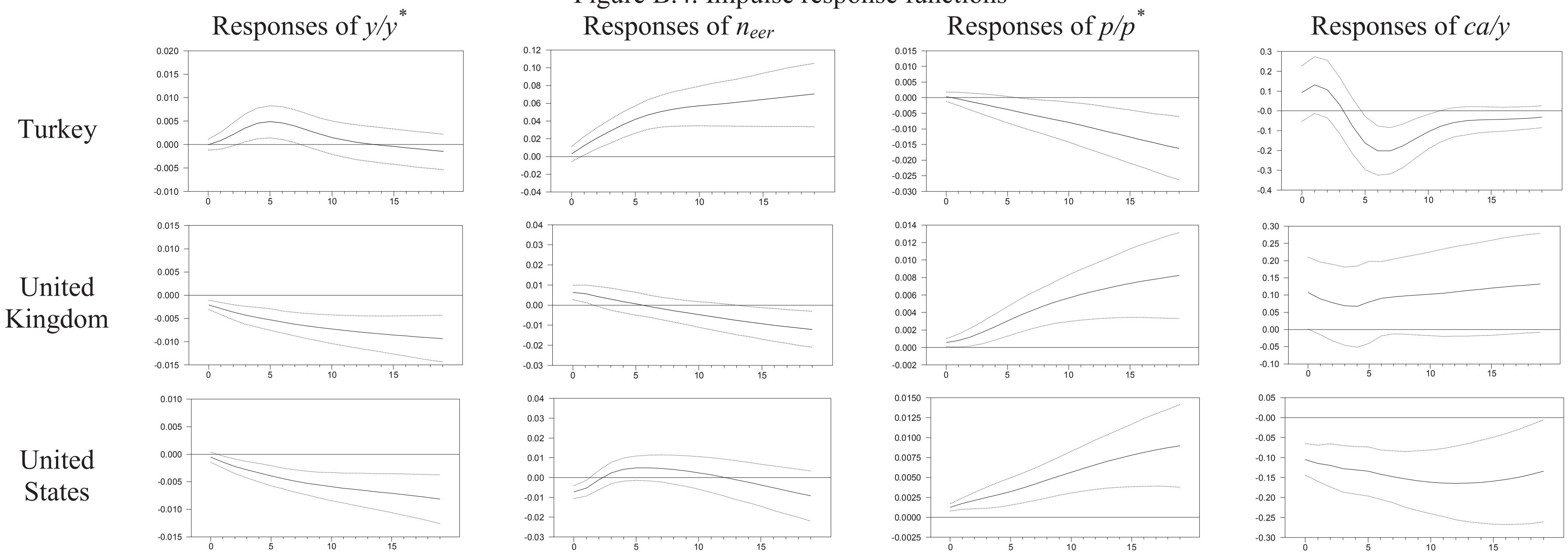


Figure B.4. Impulse response functions



Appendix C

Robustness check

Figure C.1. Impulse response functions

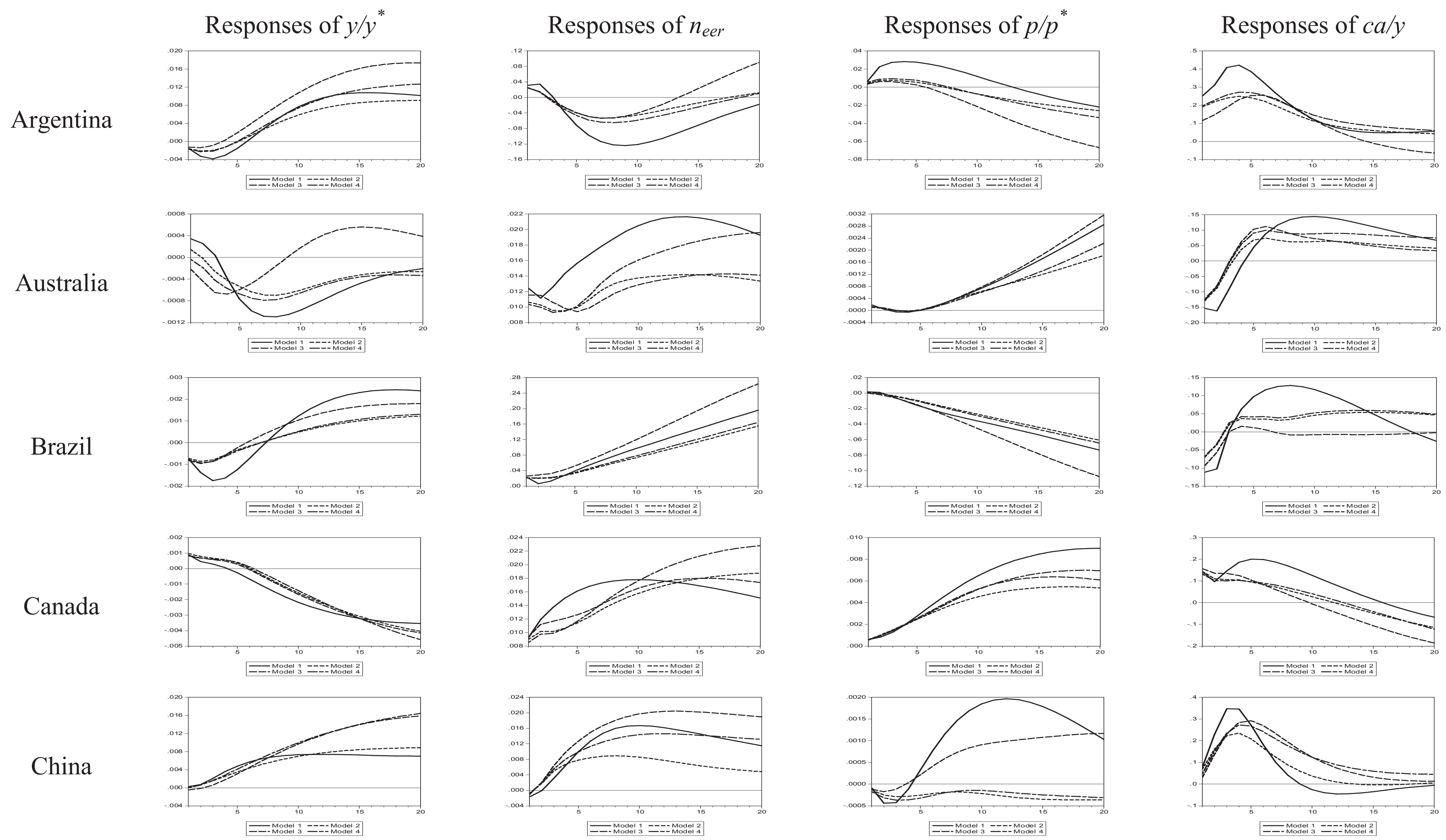


Figure C.2. Impulse response functions

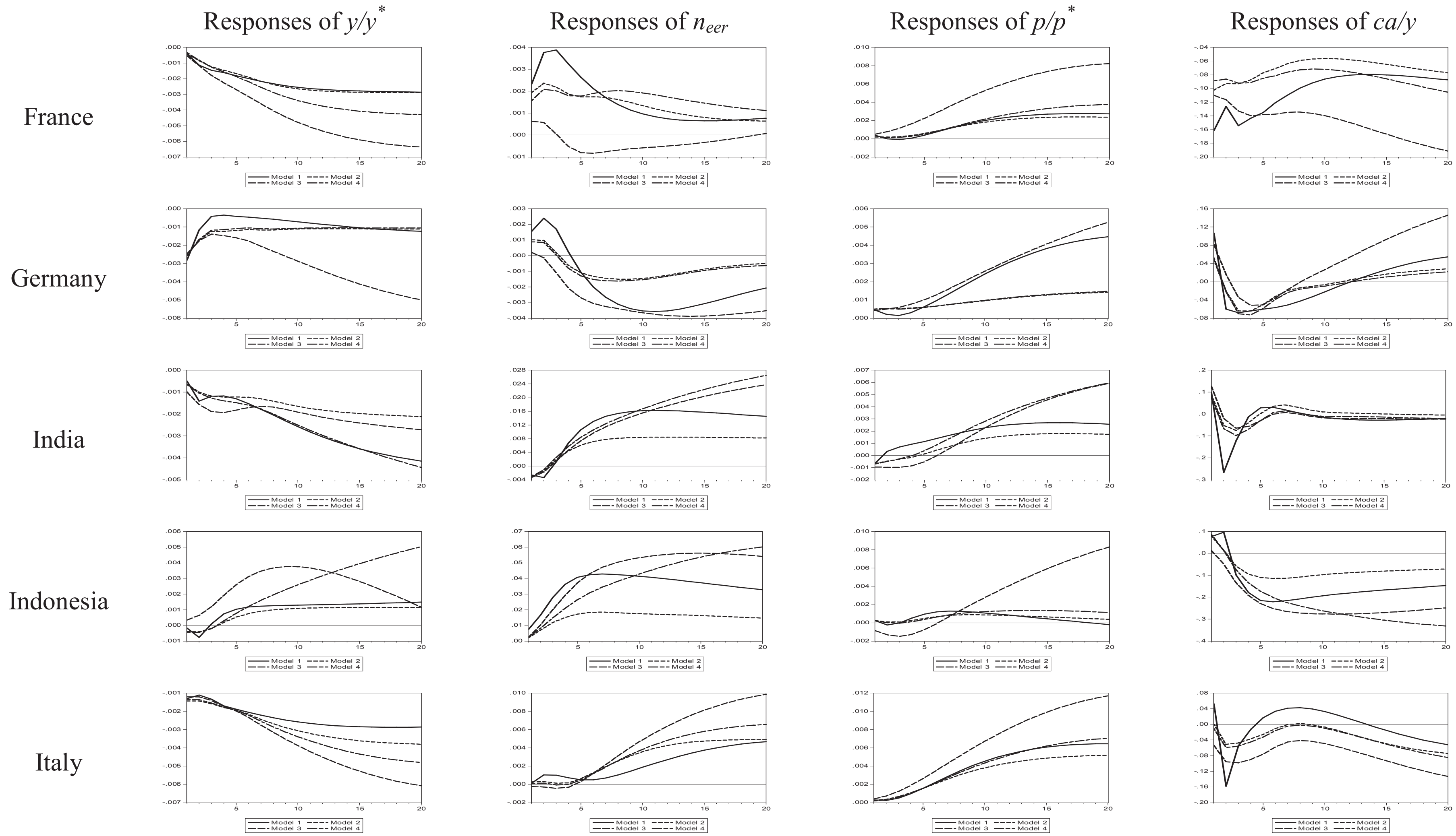


Figure C.3. Impulse response functions

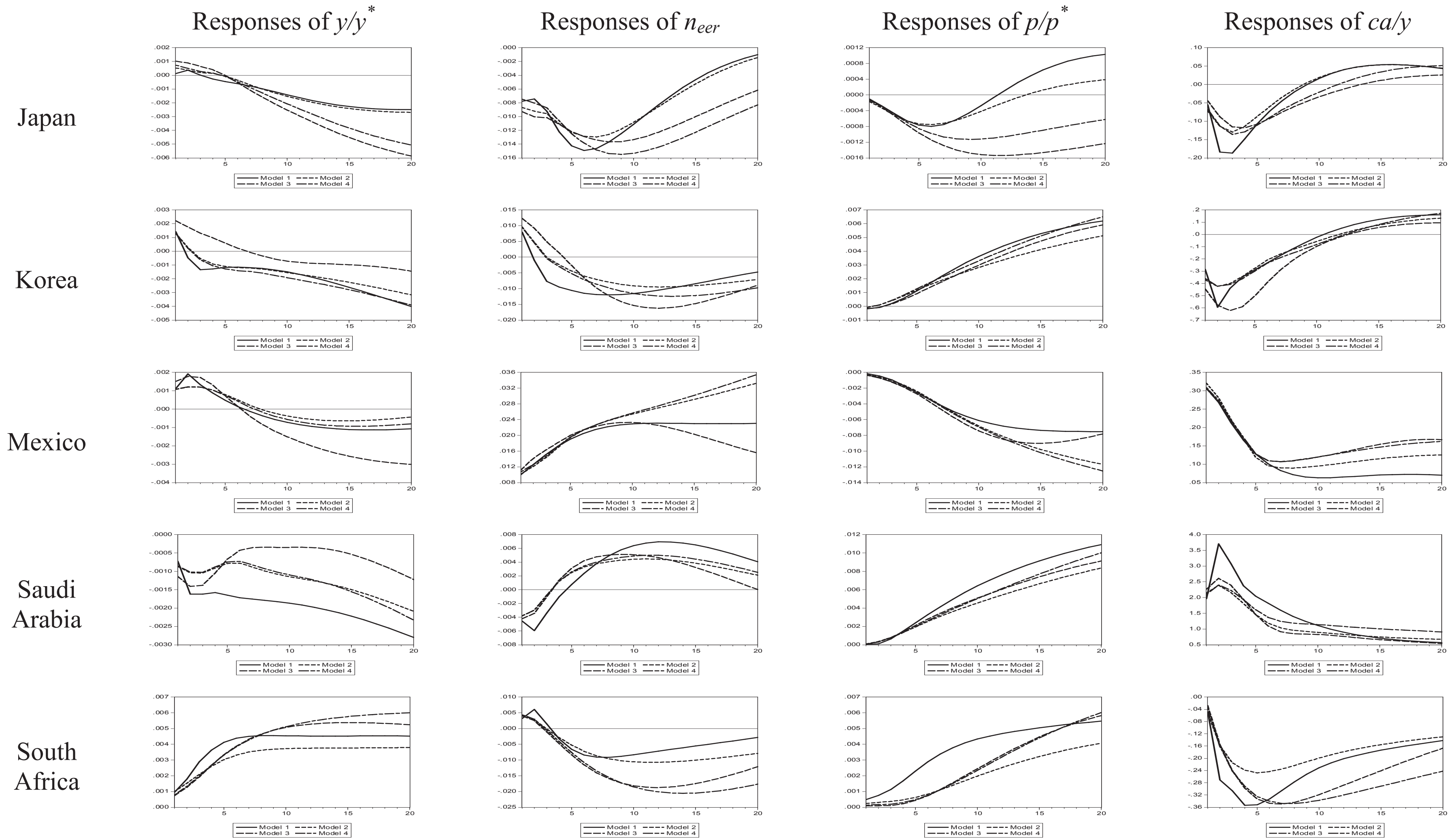
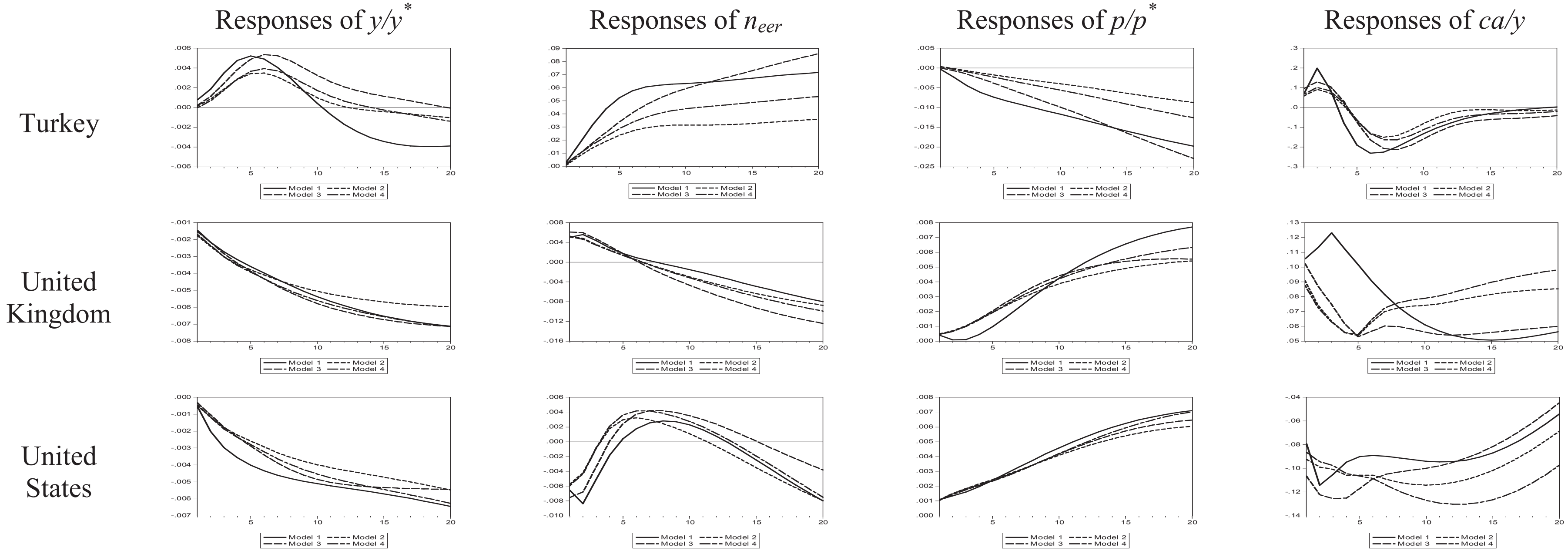


Figure C.4. Impulse response functions



Appendix D

Table D.1. Summary of the results

Variables	Steps	ARG	AUS	BRA	CAN	CHN	FRA	GER	IND	INDN
y/y^*	4 quarters									
	20 quarters	+ (32)			- (13)	+ (24)	- (18)			
n_{eer}	4 quarters		+ (8)	+ (2)	+ (19)					
	20 quarters		+ (26)	+ (21)	+ (55)	+ (6)	+ (9)		+ (21)	+ (8)
p/p^*	4 quarters				+ (5)					
	20 quarters			- (16)	+ (32)		+ (5)			
ca/y	4 quarters	+ (6)	- (3)		+ (4)	+ (5)	- (6)		- (6)	
	20 quarters						- (13)			

Variables	Steps	ITA	JAP	KOR	MEX	SA	ZAF	TUR	UK	USA
y/y^*	4 quarters	- (7)					+ (4)		- (10)	- (6)
	20 quarters	- (31)					+ (21)		- (40)	- (40)
n_{eer}	4 quarters		- (7)	+ (2)				+ (6)		
	20 quarters	+ (14)	- (13)	- (14)	+ (15)			+ (35)		
p/p^*	4 quarters	+ (1)							+ (3)	+ (9)
	20 quarters	+ (29)		+ (19)	- (15)	+ (46)	+ (12)	- (14)	+ (29)	+ (29)
ca/y	4 quarters		- (10)	- (10)	+ (14)	+ (52)	- (3)			
	20 quarters				+ (17)	+ (66)	- (13)			- (25)

Notes: y / y^*, n_{eer}, p / p^* and ca / y are, respectively, the growth differential, the nominal effective exchange rate, the price differential and the current account balance in per cent of GDP. Four quarters corresponds to the cumulative response after four quarters. Twenty quarters corresponds to the cumulative response after twenty quarters.
Positive (negative) signs indicate that the shock significantly improves (deteriorates) the variable. Contributions to the variance of the variable are in parentheses..