Federal Reserve Bank of Dallas

Appendix to Commodity Exports, Financial Frictions, and International Spillovers

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Globalization Institute Working Paper 419 Appendix
December 2022

Research Department

https://doi.org/10.24149/gwp419app

Appendix to: Commodity exports, financial frictions, and international spillovers

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November 24, 2022

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Appendix A: Motivation

A.1: Structure of merchandise exports in other SOE

Table 1: Shares of commodity and non-commodity merchandise exports (% GDP)

	Commodities	Non-Commodity
Argentia	6.15	2.93
Brazil	4.50	4.74
Chile	20.60	3.19
Colombia	8.60	2.67
Peru	13.10	1.79
South Africa	11.95	9.64
Average EMEs	10.82	4.16
Australia	11.45	3.21
Canada	11.50	17.22
New Zealand	14.90	5.79
Norway	19.65	7.81
Average Advanced	14.38	8.51

Note: Average over the period 1995-2017. Source: UNCTAD (2019)

A.2: SVAR analysis with the US: Other results and methodology

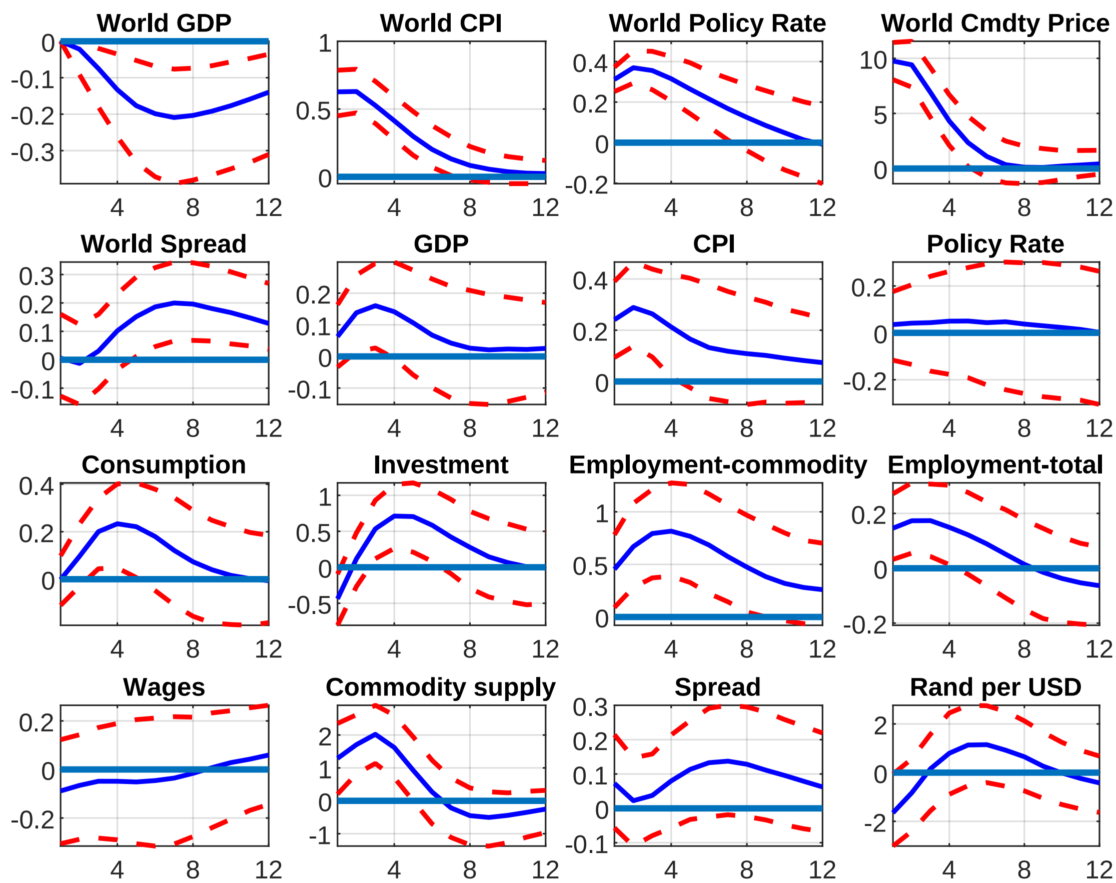
We employ SVAR models to present the dynamic effects of global shocks in Canada and South Africa. We use Bayesian methods to estimate VAR models with 16 variables (5 foreign variables and 11 domestic variables) with 2 lags using quarterly data over the 1994-2019 period. In the benchmark analysis, the US represents our foreign economy. The results are qualitatively similar with an alternative measure of the foreign economy defined by an aggregate OECD and BRIIC (Brazil, Russia, India, Indonesia, and China); see the appendix B.

For the home economy we focus on either Canada or South Africa. We employ a combination of two types of priors: (i) a normal-inverted Wishart prior; and (ii) a Minnesota type prior that assigns low weights on off-diagonal autoregressive coefficients and specifically zero weights on coefficients related to the home economy's indicators in the block defined by the foreign variables. The later follows from the assumption that Canada and South Africa are SOE.

We analyze three structural global shocks: aggregate demand, productivity, and commodity supply shocks. We identify the shocks with sign restrictions in addition to the zero restrictions derived from the SOE assumption. We discriminate between aggregate demand and productivity shocks using the standard co-moment prediction these shocks generate for prices and GDP. Aggregate demand shocks imply a positive co-movement between prices and GDP whereas productivity shocks imply a negative co-movement between prices and GDP. Commodity supply is also assumed to imply a negative co-movement between prices and GDP for a net commodity importer like the US. To discriminate between commodity supply and productivity shocks we impose a restriction on world commodity prices. We assume that commodity price increases for a contractionary commodity supply shock whereas it decreases for a contractionary productivity shock. Moreover, we assume that the central bank in the US increases the policy rate to respond to commodity price increase that follows a contractionary commodity price shock. The implementation of the sign restrictions follows the methodology proposed by Uhlig (2005).

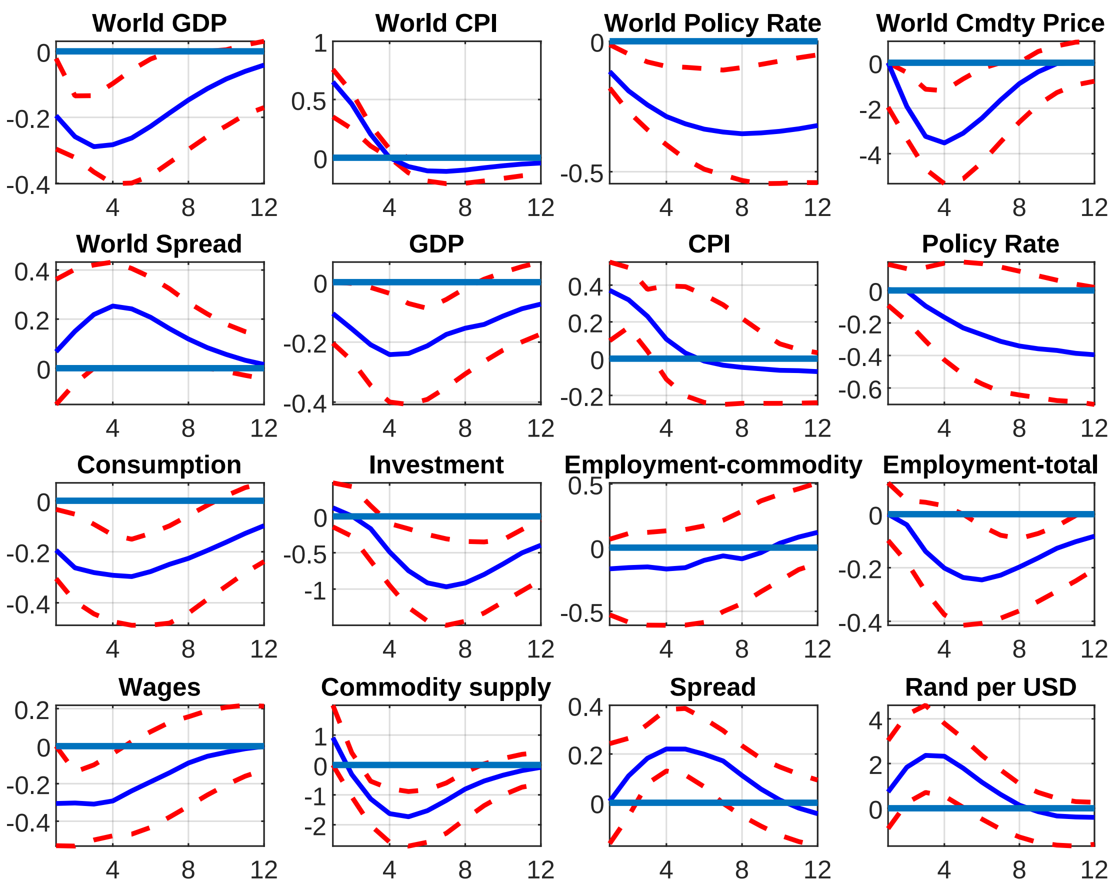
All the domestic variables are left unrestricted in the whole analysis. Moreover, the US spread is unrestricted in the whole analysis. Furthermore, note that identification of the world aggregate demand shocks only requires restrictions on GDP and prices in the foreign block. All the other foreign variables are left unrestricted. For this reason, we focus on the dynamic effects of world aggregate demand shocks in the paper. The results for the remaining two shocks are presented below.

Figure A1: SVAR - World commodity supply shocks in South Africa



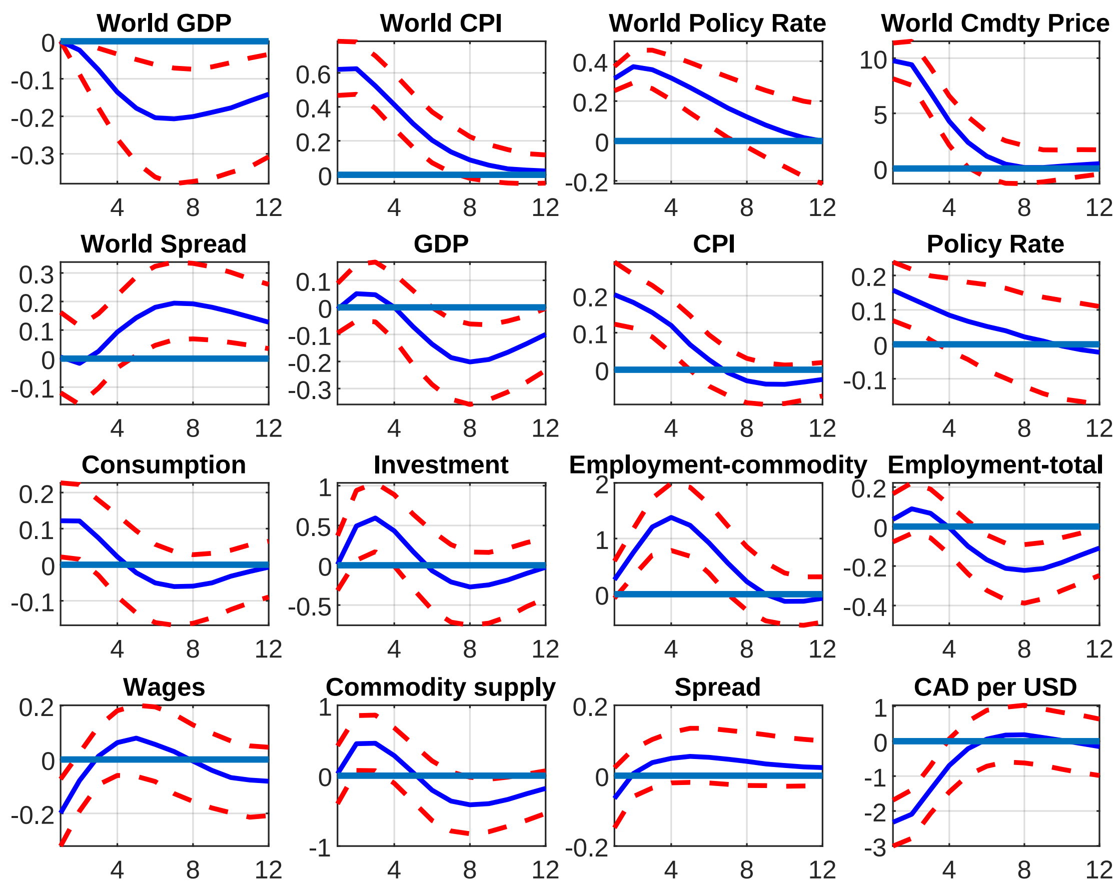
Note: The plain line indicates the median IRF. The areas defined by the red dashed lines report the 68% credible intervals.

Figure A2: SVAR - World productivity shocks in South Africa



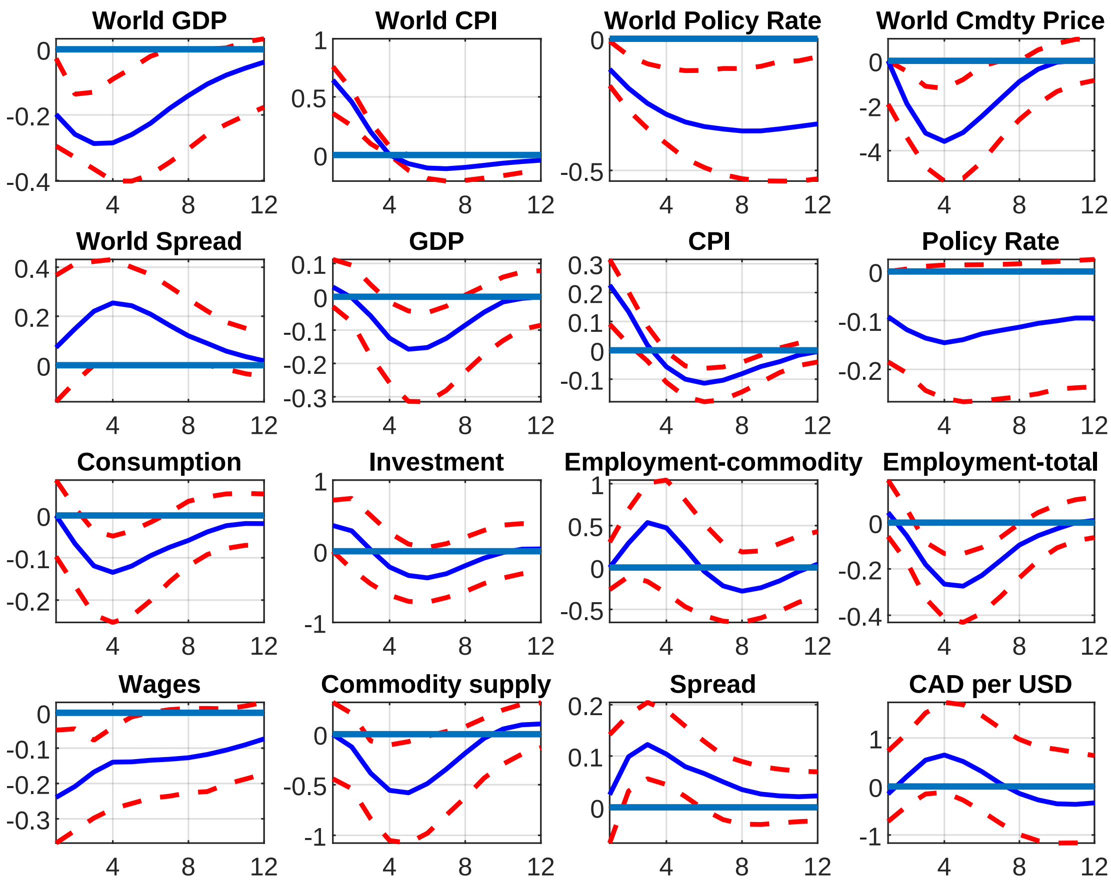
Note: The plain line indicates the median IRF. The areas defined by the red dashed lines report the 68% credible intervals.

Figure A3: SVAR - World commodity supply shocks in Canada



Note: The plain line indicates the median IRF. The areas defined by the red dashed lines report the 68% credible intervals.

Figure A4: SVAR - World productivity shocks in Canada



Note: The plain line indicates the median IRF. The areas defined by the red dashed lines report the 68% credible intervals.

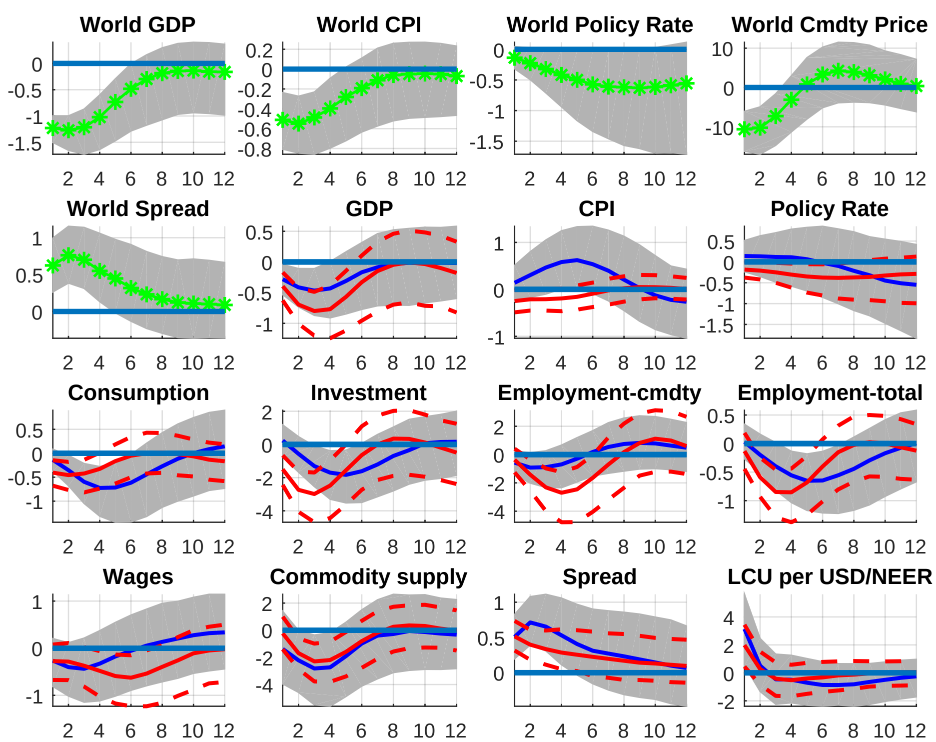
A.3. Robustness checks

Our SVAR results are robust to changes in the lag structure, identification scheme, and dataset. In each of these three cases, foreign aggregate demand shocks have a similar impact on South Africa and Canadian variables, as discussed in the paper.

A.3.1. Lag structure

Below, we show our results with 4 lags instead to 2 lags used for the benchmark results in the paper:

Figure A.3.1: Dynamic response to foreign aggregate demand shocks with 4 lags

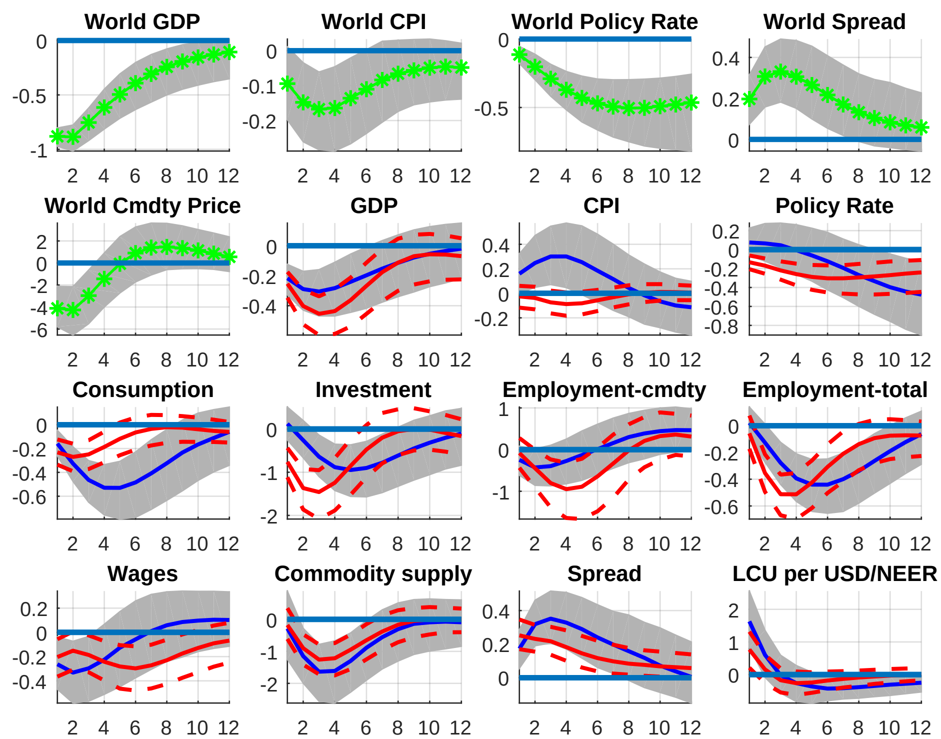


Note: The green line indicates the median IRF for the world. The blue and red lines indicate the median IRF in South Africa and Canada, respectively. The shaded areas and areas defined by the red dashed lines report the 68% credible intervals.

A.3.2. Identification of foreign aggregate demand shocks with Cholesky

Below, we use an alternative identification schemes for the world demand shock using the Cholesky approach as an alternative to sign restriction. We identify world demand shocks by the shock to world GDP where the US series are ordered first and the world commodity price is ordered after and then followed by the commodity exporter series. The co-movements between domestic and foreign variables are similar to those described in the paper.

Figure A.3.2: Dynamic response to foreign aggregate demand shocks with Cholesky

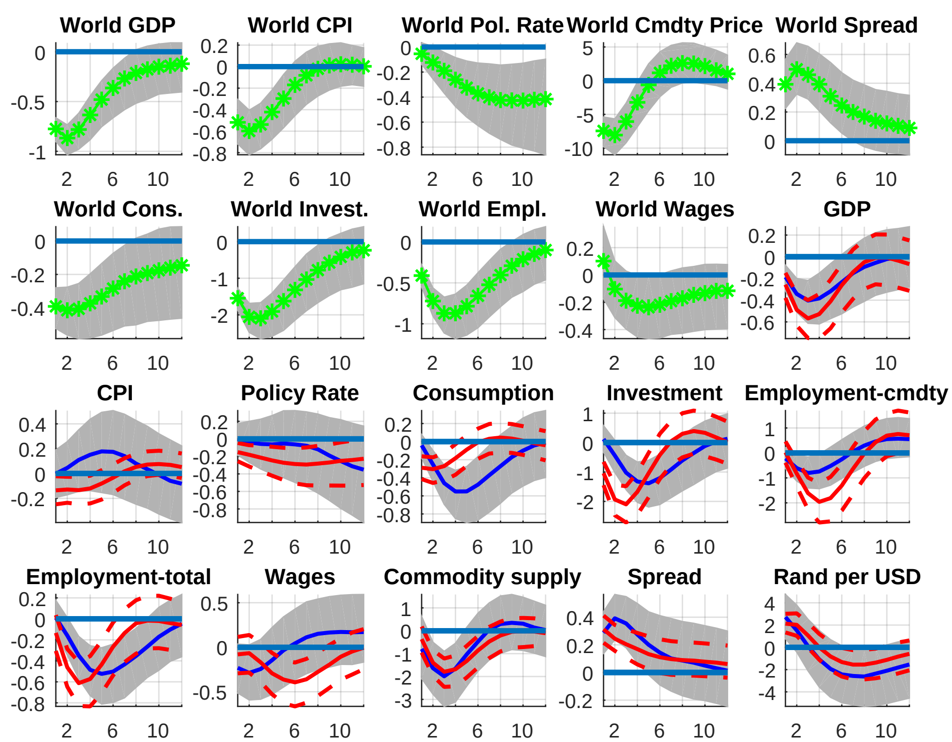


Note: The green line indicates the median IRF for the world. The blue and red lines indicate the median IRF in South Africa and Canada, respectively. The shaded areas and areas defined by the red dashed lines report the 68% credible intervals.

A.3.3. Larger dataset

Finally, we add 4 foreign variables to our SVAR (with two lags and shocks identified with sign restrictions as in the paper): Wages, hours, consumption, and investment for the US. In this case, we use the same variables for the US as in our DSGE analysis (in addition to the same domestic variables). The results presented below show that our conclusions remain robust.

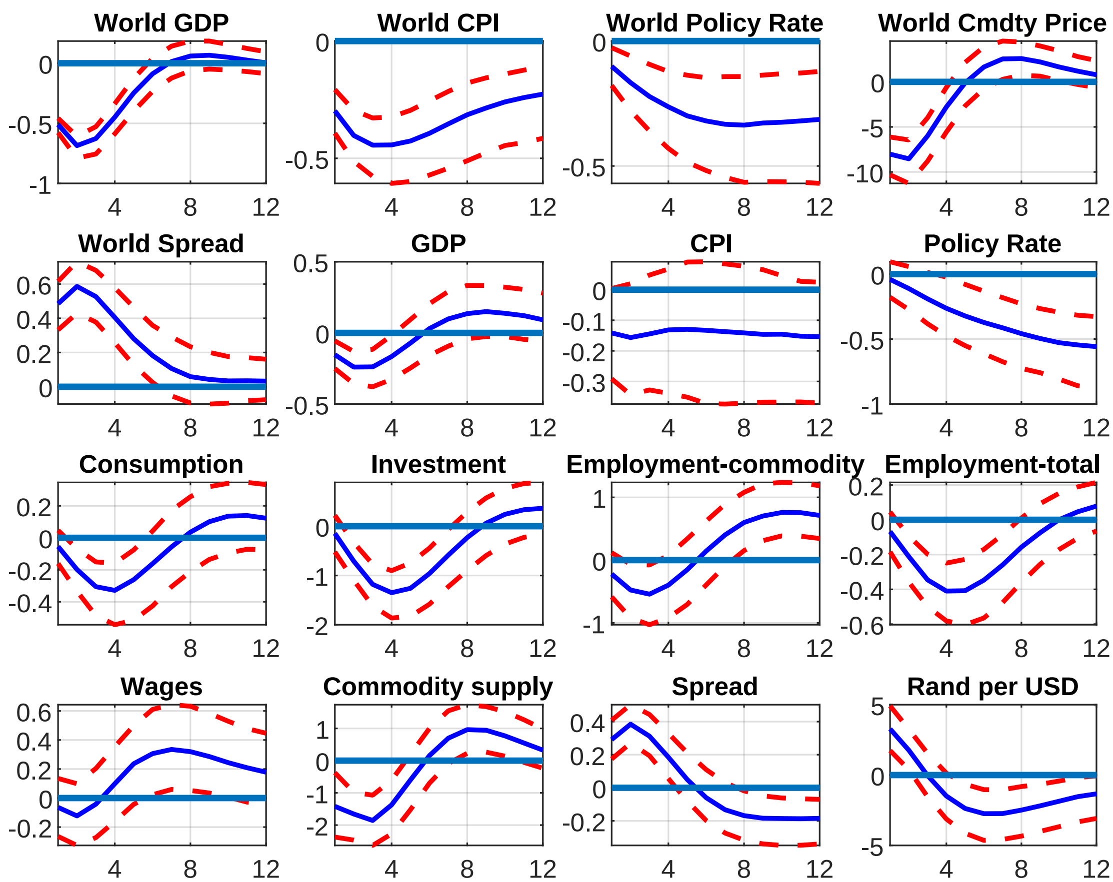
Figure A.3.3: Dynamic response to foreign aggregate demand shocks with 20 variables used in DSGE



Note: The green line indicates the median IRF for the world. The blue and red lines indicate the median IRF in South Africa and Canada, respectively. The shaded areas and areas defined by the red dashed lines report the 68% credible intervals.

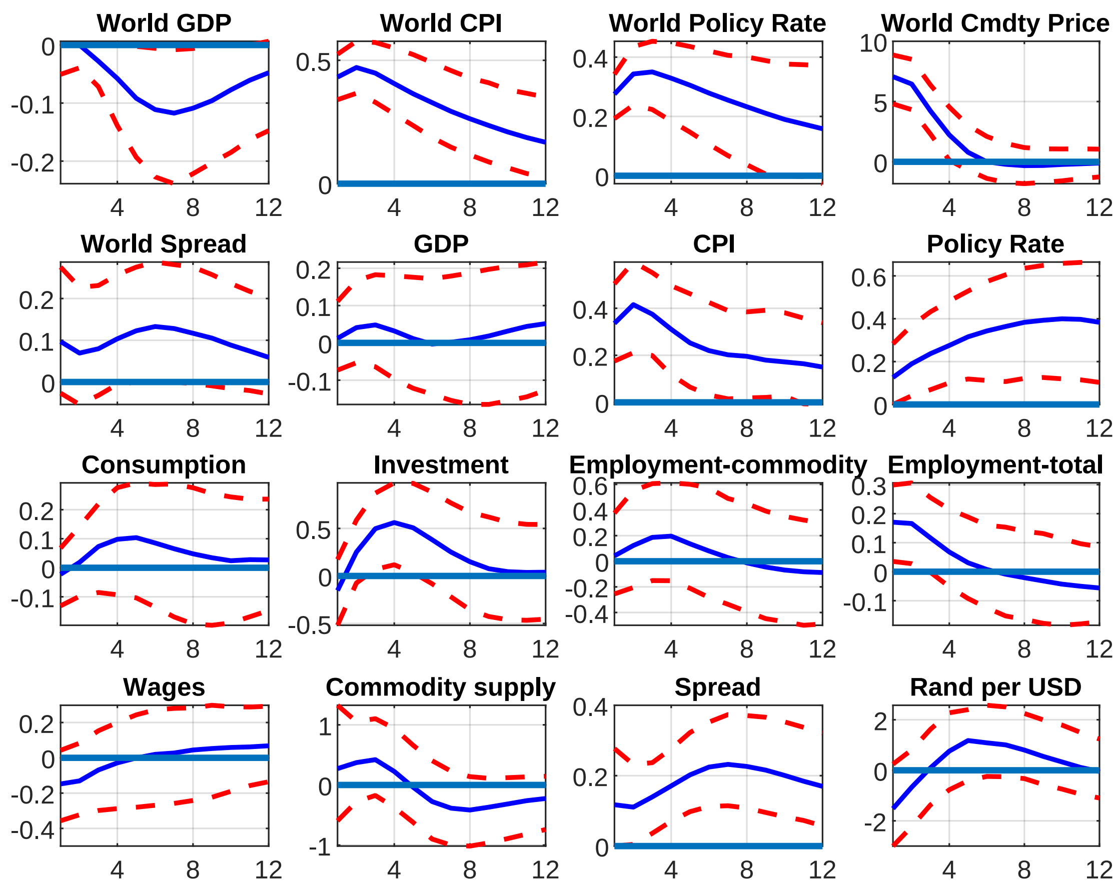
Appendix B: SVAR analysis with OECD-BRIIC

Figure B1: SVAR - World aggregate demand shocks in South Africa



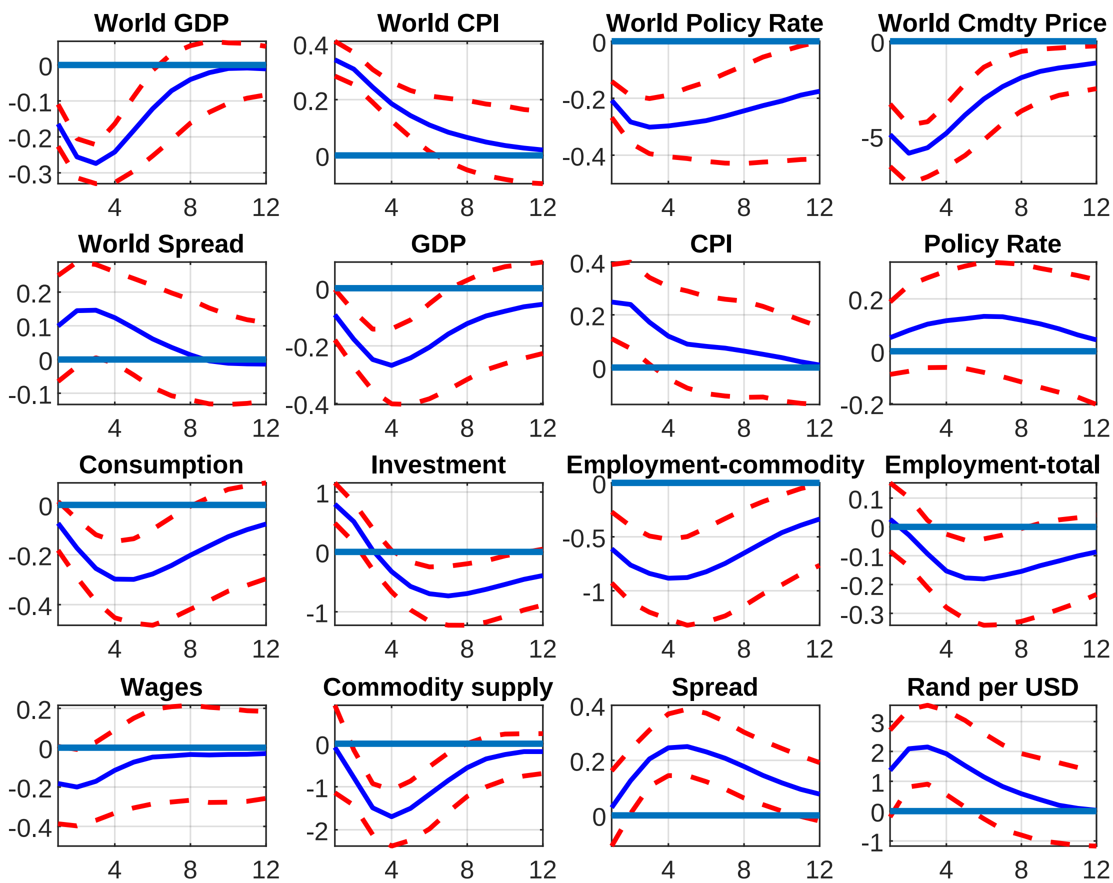
Note: The plain line indicates the median IRF. The areas defined by the red dashed lines report the 68% credible intervals.

Figure B2: SVAR - World commodity shocks in South Africa



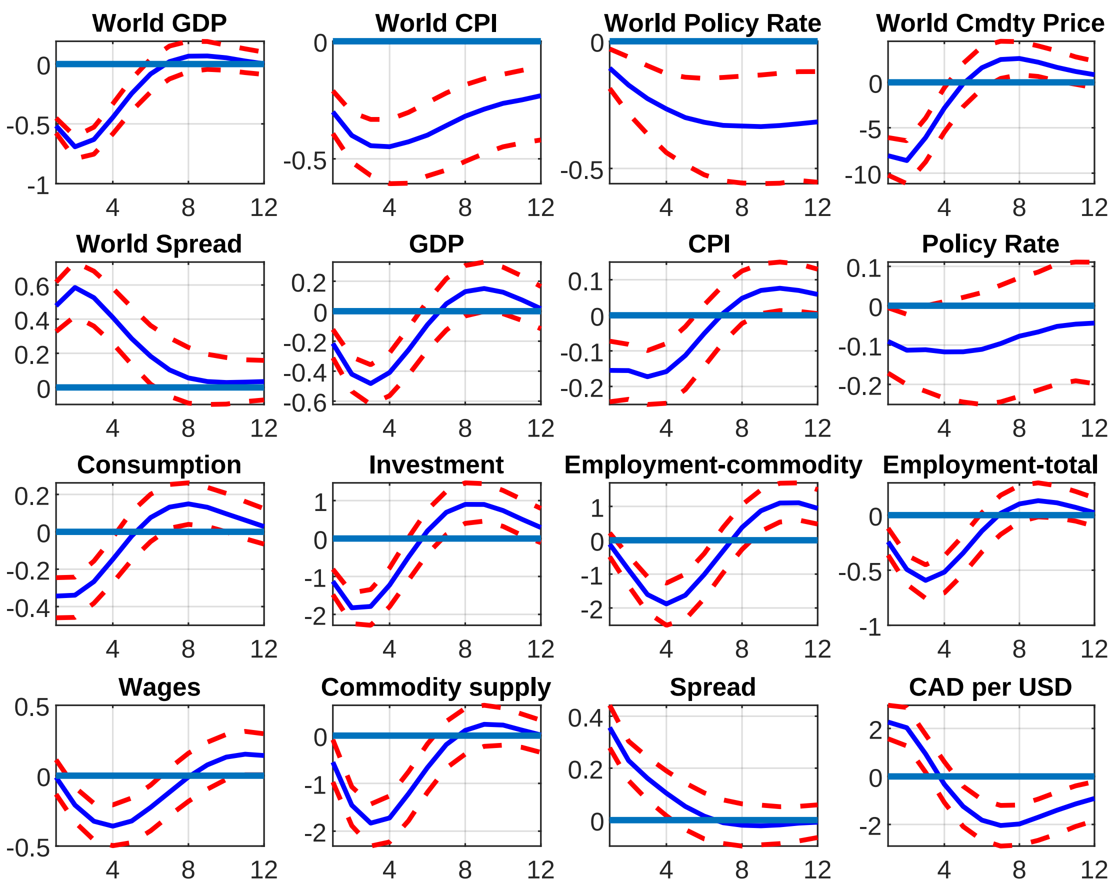
Note: The plain line indicates the median IRF. The areas defined by the red dashed lines report the 68% credible intervals.

Figure B3: SVAR - World productivity shocks in South Africa



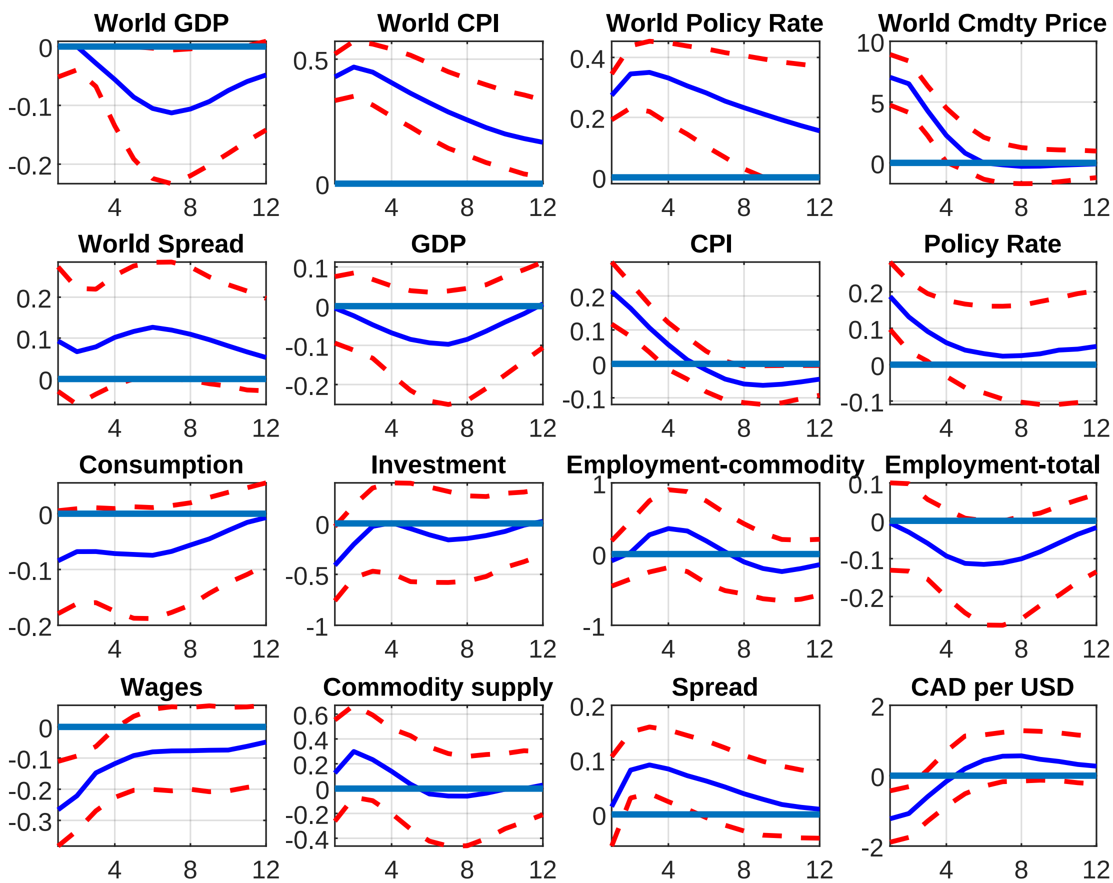
Note: The plain line indicates the median IRF. The areas defined by the red dashed lines report the 68% credible intervals.

Figure B4: SVAR - World aggregate demand shocks in Canada



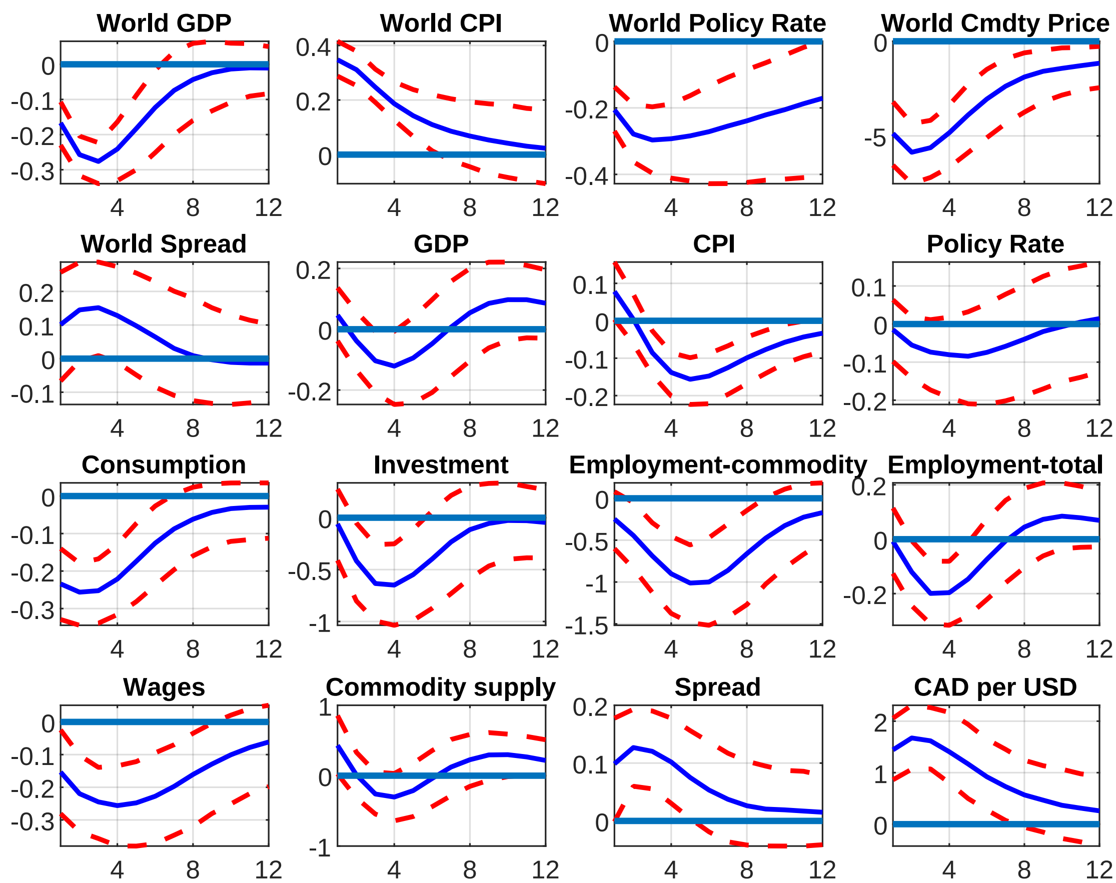
Note: The plain line indicates the median IRF. The areas defined by the red dashed lines report the 68% credible intervals.

Figure B5: SVAR - World commodity shocks in Canada



Note: The plain line indicates the median IRF. The areas defined by the red dashed lines report the 68% credible intervals.

Figure B6: SVAR - World productivity shocks in Canada



Note: The plain line indicates the median IRF. The areas defined by the red dashed lines report the 68% credible intervals.

Appendix C: model's FOC

We present the First Order Conditions (FOC) for savers, entrepreneurs and firms. The central bank, the government and rule-of-thumb households do not optimize but follow simple rules described in the paper. FOC from the financial sector are presented in the core of the paper but we here detail our simple agency problem and compare it to Bernanke et al. (1999).

C.1 Households

The consumption demand functions for the domestic and the imported goods are given by:

$$C_t^d = (1-\omega_c)\left[\frac{P_t}{P_t^c}\right]^{-\eta} C_t, \tag{1}$$

$$C_t^m = \omega_c\left[\frac{P_t^m}{P_t^c}\right]^{-\eta} C_t, \tag{2}$$

where P_t is the domestic good price, P_t^m the imported good price and P_t^c represents the consumer price index (CPI) and is given by:

$$P_t^c = \left[(1-\omega_c)(P_t)^{1-\eta} + \omega_c(P_t^m)^{1-\eta}\right]^{1/(1-\eta)}.$$

C.1.1 Savers

Savers maximize their utility w.r.t. domestic and foreign bonds holding and consumption. The FOC (with shadow value υ_t^s on their budget constraint) are given by:

$$w.r.t.\ C_t^I \quad : \quad \left(C_t^s - bC_{t-1}^s\right)^{-\sigma_c} = \psi_t^s \frac{P_t^c}{P_t} \tag{3}$$

$$w.r.t.\ B_{t+1} \quad : \quad \psi_t^s = \beta \mathrm{E}_t \frac{\psi_{t+1}^s}{\pi_{t+1}} \varepsilon_{b,t} R_t \tag{4}$$

$$w.r.t.\ B_{t+1}^* \quad : \quad \psi_t^s = \beta \mathrm{E}_t \frac{\psi_{t+1}^s}{\pi_{t+1}} \varepsilon_{b,t} R_t^* \Phi(A_t, \tilde{\phi}_t) \frac{S_{t+1}}{S_t} \tag{5}$$

where the Lagrange multiplier is redefined as $\psi_t^s = \upsilon_t^s P_t$.

Country risk premium Combining the FOC w.r.t. domestic and foreign bonds gives the uncovered interest rate parity (UIP) condition

$$R_t = R_t^* \Phi(A_t, \tilde{\phi}_t) \mathrm{E}_t \frac{S_{t+1}}{S_t} \tag{6}$$

This equality shows that the spread between domestic and foreign nominal risk free rates depends on the anticipated domestic currency depreciation, the country-wide foreign debt, and an UIP shock.

Wage setting Every household (except entrepreneurs) is a monopoly supplier of a differentiated labor service in the primary and secondary sectors and sets its own wage with an adjustment rule following Erceg et al. (2000). Optimization in the primary and secondary sector are similar, and simply gives two standard wage-Phillips curves. We thus drop the p of f indexes from the wage and hours to simplify the notations. Every household sells its labor services ($h_{j,t}$) to a labor packer, which transforms it into a homogeneous input H using the following technology

$$H_t = \left[\int_0^1 (h_{j,t})^{\frac{1}{\lambda_{w,t}}} dj\right]^{\lambda_{w,t}}, \; 1 \leq \lambda_{w,t} < \infty, \tag{7}$$

where $\lambda_{w,t}$ is a time-varying wage markup. This labor packer takes the input price of the j^{th} differentiated labor input as given, as well as the price of the homogeneous labor services.

Each household has a probability $(1-\xi_w)$ to be allowed to optimally reset the nominal wage. Otherwise, the wage is indexed on previous period consumer price inflation: $W_{j,t+1} = (\pi_t^c)^{\kappa_w} W_{j,t}$. Households that can re-optimize their wage maximize the objective bellow w.r.t. the new wage W_t^{new}. Note that this is only optimal from the point of view of savers. Rule-of-thumb mimic savers and set the same wage (we keep a standard wage Phillips curve).

$$max \sum_{s=0}^{\infty} (\beta\xi_w)^s \left(\upsilon_{t+s}^s W_{j,t+s} h_{j,t+s} - A_h \frac{(h_{j,t+s})^{1+\sigma_h}}{1+\sigma_h}\right)$$

where

$$\begin{aligned} W_{j,t+s} &= W_{j,t}^{new} \left(\pi_t^c ... \pi_{t+s-1}^c\right)^{\kappa_w} \\ h_{j,t+s} &= \left(\frac{W_{j,t+s}}{W_{t+s}}\right)^{-\epsilon_w} H_{t+s} = \left(\frac{W_{j,t}^{new}\left(\pi_t^c ... \pi_{t+s-1}^c\right)^{\kappa_w}}{W_{t+s}}\right)^{-\epsilon_w} H_{t+s} \end{aligned}$$

It is also useful to define

$$\begin{aligned} \Pi_{t,t+s-1}^c &= \left(\pi_t^c ... \pi_{t+s-1}^c\right) \\ \Pi_{t+1,t+s} &= \left(\pi_{t+1} ... \pi_{t+s}\right) \end{aligned}$$

Rearranging using the above equations gives:

$$\begin{aligned} max \sum_{s=0}^{\infty} (\beta\xi_w)^s & \left[\upsilon_{t+s}^s W_{j,t}^{new} \left(\Pi_{t,t+s-1}^c\right)^{\kappa_w} \left(\frac{W_{j,t}^{new}\left(\Pi_{t,t+s-1}^c\right)^{\kappa_w}}{W_{t+s}}\right)^{-\epsilon_w} H_{t+s} \right. \\ & \left. -\frac{A_h}{1+\sigma_h}\left(\frac{W_{j,t}^{new}\left(\Pi_{t,t+s-1}^c\right)^{\kappa_w}}{W_{t+s}}\right)^{-(1+\sigma_h)\epsilon_w} (H_{t+s})^{1+\sigma_h}\right] \end{aligned}$$

Expressing it in term of real wage and simplifying gives:

$$\begin{aligned} max \sum_{s=0}^{\infty} (\beta\xi_w)^s & \left[\psi_{t+s}^s \left(\frac{\bar{w}_{j,t}^{new}\left(\Pi_{t,t+s-1}^c\right)^{\kappa_w}}{\Pi_{t+1,t+s}}\right)^{1-\epsilon_w} (\bar{w}_{t+s})^{\epsilon_w} H_{t+s} \right. \\ & \left. -\frac{A_h}{1+\sigma_h}\left(\frac{\bar{w}_{j,t}^{new}\left(\Pi_{t,t+s-1}^c\right)^{\kappa_w}}{\bar{w}_{t+s}\Pi_{t+1,t+s}}\right)^{-(1+\sigma_h)\epsilon_w} (H_{t+s})^{1+\sigma_h}\right] \end{aligned}$$

The FOC w.r.t. W_t^{new} reads:

$$(\epsilon_w - 1)\left(\bar{w}_{j,t}^{new}\right)^{-\epsilon_w} \sum_{s=0}^{\infty} (\beta\xi_w)^s \psi_{t+s}^s \left(\frac{\left(\Pi_{t,t+s-1}^c\right)^{\kappa_w}}{\Pi_{t+1,t+s}}\right)^{1-\epsilon_w} (\bar{w}_{t+s})^{\epsilon_w} H_{t+s}$$

$$= \epsilon_w \left(\bar{w}_{j,t}^{new}\right)^{-(1+\sigma_h)\epsilon_w - 1} \sum_{s=0}^{\infty} (\beta\xi_w)^s A_h \left(\frac{\left(\Pi_{t,t+s-1}^c\right)^{\kappa_w}}{\bar{w}_{t+s}\Pi_{t+1,t+s}}\right)^{-(1+\sigma_h)\epsilon_w} (H_{t+s})^{1+\sigma_h}$$

which simplifies to (we drop the j as all re-optimising households set the same wage):

$$(\bar{w}_t^{new})^{1+\sigma_h\epsilon_w} = \frac{\epsilon_w}{\epsilon_w - 1} \frac{\sum\limits_{s=0}^{\infty} (\beta\xi_w)^s A_h \left(\frac{\left(\Pi_{t,t+s-1}^c\right)^{\kappa_w}}{\bar{w}_{t+s}\Pi_{t+1,t+s}}\right)^{-(1+\sigma_h)\epsilon_w} (H_{t+s})^{1+\sigma_h}}{\sum\limits_{s=0}^{\infty} (\beta\xi_w)^s \psi_{t+s}^s \left(\frac{\left(\Pi_{t,t+s-1}^c\right)^{\kappa_w}}{\Pi_{t+1,t+s}}\right)^{1-\epsilon_w} (\bar{w}_{t+s})^{\epsilon_w} H_{t+s}}$$

This last equation is the wage-Phillips curve with partial indexation. In Dynare, the infinite sum can be rewritten as a set of three equations:

$$(\bar{w}_t^{new})^{1+\sigma_h\epsilon_w} = \left(\frac{\epsilon_w}{\epsilon_w - 1}\right) \frac{X_{1,t}^H}{X_{2,t}^H} \tag{8}$$

$$X_{1,t}^H = A_h \bar{w}_t^{(1+\sigma_h)\epsilon_w} (H_t)^{1+\sigma_h} + \beta\xi_w \left(\frac{(\pi_t^c)^{\kappa_w}}{\pi_{t+1}}\right)^{-(1+\sigma_h)\epsilon_w} \mathrm{E}_t X_{1,t+1}^H \tag{9}$$

$$X_{2,t}^H = \psi_t^s \bar{w}_t^{\epsilon_w} H_t + \beta\xi_w \left(\frac{(\pi_t^c)^{\kappa_w}}{\pi_{t+1}}\right)^{-(\epsilon_w - 1)} \mathrm{E}_t X_{2,t+1}^H \tag{10}$$

The real aggregate wage index evolves according to

$$\bar{w}_t^{1-\epsilon_w} = (1 - \xi_w)(\bar{w}_t^{new})^{1-\epsilon_w} + \xi_w \left(\frac{(\pi_{t-1}^c)^{\kappa_w} \bar{w}_{t-1}}{\pi_t}\right)^{1-\epsilon_w} \tag{11}$$

C.1.2 Rule-of-thumb households and hours aggregation

Rule-of-thumb households mimic savers in setting their wages (and thus work the same number of hours on average). Their aggregate level of consumption is thus given by

$$C_t^r = \frac{W_t^p}{P_t^c} H_t^p + \frac{W_t^f}{P_t^c} H_t^f. \tag{12}$$

C.1.3 Entrepreneurs

Each entrepreneur j maximizes her utility w.r.t. consumption and borrowing with shadow value υ_t^e on the budget constraint:

$$w.r.t.\ C_t^e \quad : \quad \left(C_t^e - bC_{t-1}^e\right)^{-\sigma_c} = \psi_t^e \frac{P_t^c}{P_t} \tag{13}$$

$$w.r.t.\ B_{t+1}^e \quad : \quad \psi_t^e = \beta_E \mathrm{E}_t \frac{\psi_{t+1}^e}{\pi_{t+1}} R_t^L \tag{14}$$

Entrepreneurs also maximize their utility w.r.t. the capital stock and investment in every sector q:

$$w.r.t.\ K_{t+1}^q \quad : \quad \psi_t^e \frac{P_t^{k,q}}{P_t} = \beta_E \psi_{t+1}^e \left(r_{t+1}^{k,q} + (1-\delta) \frac{P_{t+1}^{k,q}}{P_{t+1}} \right) \tag{15}$$

$$\begin{aligned} w.r.t.\ I_t^q \quad : \quad & -\psi_t^e \frac{P_t^i}{P_t} + \frac{P_t^{k,q}}{P_t} \psi_t^e \Upsilon_t \left(1 - \tilde{S}\left(\frac{I_t^q}{I_{t-1}^q}\right) - \tilde{S}'\left(\frac{I_t^q}{I_{t-1}^q}\right) \frac{I_t^q}{I_{t-1}^q} \right) \\ + \quad & \beta_E \mathrm{E}_t \left(\frac{P_{t+1}^{k,q}}{P_{t+1}} \psi_{t+1}^e \Upsilon_{t+1} \tilde{S}'\left(\frac{I_{t+1}^q}{I_t^q}\right) \left(\frac{I_{t+1}^q}{I_t^q}\right)^2 \right) = 0 \end{aligned} \tag{16}$$

where $r_t^k \equiv \frac{R_t^k}{P_t}$ is the real rental rate of capital.

Investment Basket Domestic and imported investments are given by:

$$I_t^{d,q} = (1-\omega_i) \left[\frac{P_t}{P_t^i} \right]^{-\eta} I_t^q, \tag{17}$$

$$I_t^{m,q} = \omega_i \left[\frac{P_t^m}{P_t^i} \right]^{-\eta} I_t^q, \tag{18}$$

where P_t^i is the aggregate investment price given by:

$$P_t^i = \left[(1-\omega_i)(P_t)^{1-\eta} + \omega_i (P_t^m)^{1-\eta} \right]^{1/(1-\eta)}$$

C.2 Firms

Here we present the profit maximization problem of the firms in the commodity and secondary sectors.

C.2.1 Domestic commodity supply channel

We first derive the FOC that we will use to discuss the domestic commodity supply channel. Commodity producers combine capital K_t^p, labor H_t^p and land L_t^p (which is always fixed) to produce a commodity input. Profit maximization gives the labor and capital demand equations:

$$\bar{w}_t^p \quad = \quad (1-\alpha_p-\beta_p) \left(\frac{\varepsilon_{hp,t} Y_0^p}{H_0^p} \right)^{\frac{\sigma_p - 1}{\sigma_p}} \left(\frac{Y_t^p}{H_t^p} \right)^{1/\sigma_p} \frac{S_t P_t^{*P}}{P_t} \tag{19}$$

$$r_t^{k,p} \quad = \quad \alpha_p \left(\frac{\varepsilon_{p,t} Y_0^p}{K_0^p} \right)^{\frac{\sigma_p - 1}{\sigma_p}} \left(\frac{Y_t^p}{K_t^p} \right)^{1/\sigma_p} \frac{S_t P_t^{*P}}{P_t} \tag{20}$$

where variables wit a subscript 0 correspond to their values at steady-state.

We now discuss the implication of these FOC for the domestic commodity supply channel. This channel operates when domestic production of commodities responds to changes in commodity price: a key concept is thus the price-elasticity of domestic commodity supply. To discuss this elasticity analytically, we linearize and rearrange our FOC and the production function described in the paper. We denote a variable x expressed in percentage deviation from its steady-state with a hat ($\hat{x}$). Commodity production, labor demand, and capital demand are given by these three equations (ignoring exogenous shocks for simplicity):

$$\hat{Y}_t^p = \alpha_p \hat{K}_{t-1}^p + (1 - \alpha_p - \beta_p)\hat{H}_t^p \tag{21}$$

$$\hat{H}_t^p = \hat{Y}_t^p + \sigma_p(\hat{\gamma_t^p} - \hat{w}_t^p) \tag{22}$$

$$\hat{K}_{t-1}^p = \hat{Y}_t^p + \sigma_p(\hat{\gamma_t^p} - \hat{r}_t^{k,p}) \tag{23}$$

where $\gamma_t^p = \frac{S_t P_t^{*p}}{P_t}$ is the world price of commodities expressed in domestic currency and the $t-1$ subscript for capital indicates that this variable is predetermined.

The commodity production function (21) shows that the higher the labor (capital) share, the more sensitive commodity supply is to a change in this production factor. The land share β thus reduces the elasticity of domestic commodity supply.

The labor demand equation (22) shows that hours increase when the world commodity prices to domestic wage ratio increases. The elasticity of substitution between production factors in the primary sector (σ_p) plays a crucial role for labor demand: the higher σ_p, the stronger the response of hours to changes in commodity prices, and the higher the price-elasticity of commodity supply.

Equation (23) shows that demand for capital increases when commodity prices increase more than the rental rate of capital. As capital is fixed in the short-run, an increase in capital demand increases its rental rate which stimulates investment in the primary sector.

If we focus on the immediate response of commodity supply (on impact), we can abstract from changes in capital in the commodity production function (because investment affect capital only with a lag). By combining the production and labor demand equation and assuming that $\hat{K}_{t-1}^p = 0$, we can give further intuition on the short-run elasticity of commodity supply:

$$\hat{Y}_t^p = \sigma_p \left(\frac{1 - \alpha_p - \beta_p}{\alpha_p + \beta_p} \right) (\hat{\gamma_t^p} - \hat{w}_t^p). \tag{24}$$

The short-run elasticity of commodity supply is thus increasing in the elasticity of substitution between production factors in the primary sector σ_p and in the share of labor (thus decreasing in the share of land β_p).

While the analysis of the price-elasticity of commodity supply usually focuses on the real price of commodities (for example with a commodity price to CPI or GDP deflator ratio), an analysis based on the world commodity price to domestic wage ratio is analytically simple and yields a similar conclusion because fluctuations in wages, CPI and GDP deflator are very small compared to fluctuations in commodity prices. This is what we observe in our analysis. In the case of foreign shocks, changes in world commodity prices are always much more pronounced than changes in domestic wages (in the SVAR and DSGE). As an illustration, we compute the empirical short-run elasticity by dividing the response of domestic commodity output on impact (in percentage deviation from steady-state) by the response of real commodity prices expressed in domestic currency (also in deviation from steady-state) after a foreign aggregate demand shock. We find a value of 0.142 when the model is calibrated as in section 5 of the paper. Using equation (24) to compute this elasticity, we find a value of 0.144. The difference is explained by the endogenous response of wages, but this response is so small compared to the change in commodity prices that it can be ignored at a very low cost when it comes to estimating the short-run elasticity of commodity supply.

Why do we need a CES production function? In fact, one could reach any level of short-run elasticity of commodity supply with a standard Cobb-Douglas production function ($\sigma_p = 1$) by adjusting the labor share. However, this may not be desirable. Indeed, in order to target a realistic short-run elasticity of 0.14, one would need to calibrate the labor share to 0.12, which might be at odd with the data (the labor share is 0.37 and 0.23 in South Africa and Canada, respectively). Moreover, with a Cobb-Douglas production function, one could easily overestimate the elasticity of commodity supply. In an influential paper, Kose (2002) calibrates the labor share to 0.37 (with a Cobb-Douglas production function). This implies a short-run price elasticity of 0.59 (as long as real wages remain constant) that might be too large for many commodities such as oil or agricultural crops (Caldara et al., 2016; De Winne and Peersman, 2016). In addition, imposing $\sigma_p = 1$ would make labor incomes in the primary sector extremely volatile. Rearranging the labor demand equation shows that labor incomes would be as volatile as commodity incomes: $\hat{H}_t^p + \hat{w}_t^p = \hat{Y}_t^p + \hat{\gamma}_t^p$ when $\sigma_p = 1$.

In the paper, we present a simplified version of equation (24) to provide some intuition on the domestic commodity supply channel. To obtain equation (28) in the paper, we further assume that labor supply is perfectly elastic at a real wage rate fixed in foreign currency units. In this case, the firm maximizes

$$S_t P_t^{*p} Y_t^p - R_t^{k,p} K_t^p - W_t^p H_t^p$$

and equation (24) becomes:

$$\hat{Y}_t^p = \frac{\sigma_p \left(1 - \alpha_p - \beta_p\right)}{\alpha_p + \beta_p} \hat{\gamma}_t^{p*} \ .$$

as in the paper. This has the advantage of allowing us to abstract from wages and exchange rate dynamics in our discussion. When wages rise or the domestic currency appreciates in response to an increase in commodity prices, the domestic commodity supply channel gets weaker, but the intuition presented in the paper remains valid. In our empirical application, wages and exchange rates dynamics potentially weakens but never fully cancels this channel.

Finally, while the capital share α_p and land share β_p have the same impact on the short-run elasticity of commodity supply (if they affect the labor share $1 - \alpha_p - \beta_p$), they have a different impact on the long-run elasticity. While capital can be build over time to gradually increase commodity supply, land is a fixed production factor limiting both the short and long-run elasticities of commodity supply.

C.2.2 Secondary sector

Secondary good producers In the first step, cost minimization problem for the intermediate firm i in period t gives the capital to labor ratio:

$$\frac{K_t^f}{H_t^f} = \frac{\alpha \bar{w}_t^f}{(1-\alpha) r_t^{k,f}}, \tag{25}$$

As well as the equilibrium real marginal cost of the domestic input mc_t^{nd}, which, using the steady-state relationships described in the next subsection simplifies to:

$$mc_t^{nd} = \left(\frac{r_t^{k,f}}{r^{k,f}}\right)^{\alpha} \left(\frac{\bar{w}_t^f}{\epsilon_{h,t}\bar{w}^f}\right)^{1-\alpha} \tag{26}$$

The second step, yields the domestic to foreign input ratio

$$\frac{N_t^m}{N_t^d} = \left(\frac{\omega_n}{1-\omega_n} \frac{mc_t^{nd}}{P_t^{m,n}/P_t}\right)^{\sigma_n} \left(\frac{N_0^d}{N_0^m}\right)^{\sigma_n - 1}, \tag{27}$$

as well as the real marginal cost mc_t of the final good:

$$mc_t = \frac{1}{\lambda_d}\left[\omega_n \left(\frac{P_t^{m,n}}{P_t}\right)^{1-\sigma_n} + (1-\omega_n)\left(mc_t^{nd}\right)^{1-\sigma_n}\right]^{\frac{1}{1-\sigma_n}} \tag{28}$$

where $\frac{P_t^{m,n}}{P_t}$ is the real price of the imported input (see the importing distributors subsection for more details).

Domestic Distributors There are two types of domestic distributors (intermediate and final). There is a continuum of intermediate distributors, indexed by $i \in [0,1]$. Each intermediate distributor buys a homogeneous secondary good Y^f; turns it into a differentiated intermediate good (using a brand-naming technology) and then sells it to a final distributor at price $P_{i,t}$. Every intermediate distributor is assumed to be a price taker in the secondary goods market (it purchases secondary goods at their marginal costs) and a monopoly supplier of its own variety. At every period t, with probability $(1-\xi_d)$, any intermediate distributor i is allowed to re-optimize its price by choosing the optimal price $P_{i,t}^{new}$. With probability ξ_d, it cannot re-optimize, and it simply indexes its price for period $t+1$ according to the following rule: $P_{i,t+1} = (\pi_t)^{\kappa_d} P_{i,t}$, where $\pi_t = \frac{P_t}{P_{t-1}}$ is last period's inflation.

The final distributor is an aggregator which uses a continuum of differentiated intermediate goods to produce the final homogeneous good, which is then used for consumption and investment by domestic households, public consumption, and exports, and sold at price P_t. The final distributor is assumed to have the following CES production function:

$$Y_t^f = \left[\int_0^1 \left(Y_{i,t}^f\right)^{\frac{1}{\lambda_{d,t}}} di\right]^{\lambda_{d,t}}, \ 1 \le \lambda_{d,t} < \infty, \tag{29}$$

where $\lambda_{d,t}$ is a stochastic process determining the time-varying markup in the domestic goods market.

The profit maximization problem for the final good distributor gives the following first order condition:

$$\frac{Y_{i,t}^f}{Y_t^f} = \left(\frac{P_t}{P_{i,t}}\right)^{\frac{\lambda_{d,t}}{\lambda_{d,t}-1}} \tag{30}$$

where P_t is the price for the homogeneous final good and $P_{i,t}$ is the input price for the intermediary good i, taken as given by the final good firm. The price index P_t is given by:

$$P_t = \left[\int_0^1 P_i^{\frac{1}{1-\lambda_{d,t}}} di\right]^{(1-\lambda_{d,t})} \tag{31}$$

The optimization problem faced by the intermediate distributor i when setting its price at time t taking aggregator's demand as given reads:

$$\max_{P_t^{new}} \mathrm{E}_t \sum_{s=0}^{\infty} (\beta_E \xi_d)^s v_{t+s}^e [((\pi_t \pi_{t+1} \ldots \pi_{t+s-1})^{\kappa_d} P_t^{new}) \, Y_{i,t+s}^f - MC_{i,t+s} Y_{i,t+s}^f], \tag{32}$$

where $(\beta_E \xi_d)^s v_{t+s}^e$ is a stochastic discount factor, v_{t+s}^e the marginal utility of entrepreneurs' nominal income in period $t+s$ and $MC_{i,t}$ is the firm's nominal marginal cost. Using (30) the first order condition for this optimization problem can be written as:

$$\mathrm{E}_t \sum_{s=0}^{\infty} (\beta_E \xi_d)^s \psi_{t+s}^e \left(\frac{(\pi_t \pi_{t+1} \ldots \pi_{t+s-1})^{\kappa_d}}{(\pi_{t+1}\pi_{t+2} \ldots \pi_{t+s})}\right)^{-\frac{\lambda_{d,t+s}}{\lambda_{d,t+s}-1}} Y_{t+s}^d \times \left[\frac{(\pi_t \pi_{t+1} \ldots \pi_{t+s-1})^{\kappa_d}}{(\pi_{t+1}\pi_{t+2} \ldots \pi_{t+s})} \frac{P_t^{new}}{P_t} - \frac{\lambda_{d,t} MC_{\iota,t+s}}{P_{t+s}}\right] = 0. \tag{33}$$

which gives a standard price Phillips-Curve.

Importing and exporting distributors The intermediate importing (exporting) distributor buys a homogeneous foreign (domestic) secondary good, turns it into a type-specific good using a differentiating technology and then sells it in the domestic (foreign) market to an aggregator. The aggregator uses a continuum of differentiated intermediate goods to produce a final homogeneous good, which is then sold for consumption and investment to domestic (foreign) households at price P_t^m (P_t^x). The price setting behavior of the importing and exporting distributors also follows a standard Calvo (1983) setting.

The importing firms price setting problem is thus similar to the domestic good price setting problem presented above. In particular, the final good import price setting problem follows Adolfson et al. (2007) and gives a standard Phillips-Curve for P_t^m[1]. We thus refer to their paper for the details on the derivations. The input import price setting is also standard with one point of attention. The imported input is Leontief basket composed of commodities and foreign intermediate inputs. When setting the imported input price $P_t^{m,n}$, distributors thus consider the following marginal cost: $MC_t^{m,n} = \omega_p S_t P_t^* + (1-\omega_p) S_t \frac{MC_t^*}{MC^*}$ where MC_t^* is the marginal cost in the foreign economy. Note the presence of the steady-state marginal cost in this expression: this is equivalent to imposing a mark-up on the foreign imported intermediate input, and implies that the import price is equal to one at steady-state. Optimization in the exporting firms price setting problem is similar to the domestic good price setting problem presented above and also follows Adolfson et al. (2007).

C.2.3 World commodity price channel

We first derive the FOC of foreign secondary good producers and then discuss the world commodity price channel. In the first step, cost minimization problem for the foreign secondary good producer in period t gives a capital to labor ratio analogue to equation (25) and the marginal production cost:

$$mc_t^{n*} = \frac{MC_t^{n*}}{P_t^*} = \left(\frac{r_t^{k,*}}{r^{k,*}}\right)^{\alpha^*} \left(\frac{\bar{w}_t^*}{\epsilon_{h,t}^* \bar{w}^*}\right)^{1-\alpha^*} \tag{34}$$

In the second step, firms combine this intermediate input with commodities. Demand for commodities thus derive from:

$$\frac{P_t^{*P}}{P_t^*} = \beta^* \left(\frac{Y_0^*}{Y_0^{p*}}\right)^{\frac{\sigma_p^*-1}{\sigma_p^*}} \left(\frac{Y_t^*}{Y_t^{p*}}\right)^{1/\sigma_p^*} \frac{MC_t^*}{P_t^*} \tag{35}$$

which can be linearized as

$$\hat{Y}_t^{p*} = \hat{Y}_t^* - \sigma_p^*(\hat{\gamma}_t^{p*} - \hat{mc}_t^*) \tag{36}$$

where $\gamma_t^{p*} = \frac{P_t^{*P}}{P_t^*}$ is the real price of commodities and $mc_t^* = \frac{MC_t^*}{P_t^*}$ is the real marginal cost of the foreign secondary good given by $\hat{mc}_t^* = \beta^* \hat{\gamma}_t^{p*} + (1-\beta^*)\hat{mc}_t^{n*}$. The elasticity of commodity demand is σ_p^*.

On the world commodity market, demand and supply are thus given by (abstracting from commodity supply shocks):

$$\textit{Commodity Demand} \; : \quad \hat{Y}_t^{p*} = \hat{Y}_t^* - \sigma_p^*(\hat{\gamma}_t^{p*} - \hat{mc}_t^*) \tag{37}$$

$$\textit{Commodity Supply} \; : \quad \hat{Y}_t^{p*} = 0 \tag{38}$$

Solving these two equations give the price of commodities:

$$\hat{\gamma}_t^{p*} = \hat{mc}_t^* + \frac{1}{\sigma_p^*}\hat{Y}_t^* \tag{39}$$

[1] The only difference with Adolfson et al. (2007) is that they make a distinction between final consumption and final investment goods, while we only consider one Phillips curve for final good imports.

Equation (39) thus shows that when the elasticity of commodity demand σ_p^* is low, changes in aggregate demand translate into large commodity price fluctuations. Intuitively, when firms try to increase production $\hat{Y}_t^* > 0$, demand for commodity input increases. Because commodity supply is fixed, equilibrium on the commodity market must be reached with an increase in commodity prices. The lower the demand elasticity, the harder it is for foreign firms to substitute commodities with other productive inputs, and the stronger the increase in commodity prices required to eliminate the excess demand.

If σ_p^* is sufficiently low, as we find in our empirical application (and consistent with a low elasticity of commodity demand), changes in world GDP dominates changes in marginal costs in driving commodity prices. In a perfectly competitive economy with flexible prices, $\hat{mc}_t^* = 0$ at all times and equation (39) simplifies to $\hat{\gamma}_t^{p*} = \frac{1}{\sigma_p^*}\hat{Y}_t^*$ as in the paper where the intuition over σ_p^* remains valid.

C.3 Financial sector

C.3.1 The agency problem in the financial sector

We first present the domestic bank problem and then discuss foreign banks. We assume that entrepreneurs have the option to cheat: they can default on their loans and run-away with a fraction of their assets. Banks thus requires entrepreneurs to pledge their assets as collateral, and the fraction of assets that entrepreneurs can divert is a function of the banks' monitoring efforts. Banks choose the fraction of entrepreneur's assets under monitoring, and this fraction is impossible to divert. Entrepreneur j cheats when the value of divertable assets is larger than the value of its total assets net of its debt, when

$$(1 - \vartheta_{j,t})V_{j,t} > V_{j,t} - B_{j,t} \tag{40}$$

where $V_{j,t} = P_t^k K_{j,t}$ is the value of entrepreneur j assets, $B_{j,t}$ the debt (bank loan) and $\vartheta_{j,t}$ the fraction of its assets under monitoring. Since monitoring is costly (see below), the bank sets its monitoring effort such that this expression holds with equality (and entrepreneurs have no incentives to cheat):

$$\vartheta_{j,t} = \frac{B_{j,t}}{V_{j,t}} \tag{41}$$

In this expression, we can drop the j as all entrepreneurs are identical (due to trade in state contingent securities).

We assume that banks take this monitoring rate as given and that their total monitoring cost is a function of the monitoring rate and their total loan books. Banks thus maximize:

$$\left(R_t^{L,d} - \Phi(\vartheta_t)R_t\right) B_t \tag{42}$$

where $R_t^{L,d}$ is the domestic bank lending rate and $\Phi(\vartheta_t)$ captures monitoring costs:

$$\Phi(\vartheta_t) = \phi_{fc}\,(\vartheta_t)^{\phi_{nw}}\,\varepsilon_{R_L,t} \tag{43}$$

where ϕ_{fc} is a fixed lending cost (allowing us to calibrate the spread at steady-state), ϕ_{nw} is the spread elasticity to leverage capturing a financial accelerator, and $\varepsilon_{R_L,t}$ is a credit supply shock. The FOC (w.r.t. B_t) gives the domestic bank lending rate:

$$R_t^{L,d} = \Phi(\vartheta_t) R_t = \phi_{fc} \left(\frac{B_t}{V_t} \right)^{\phi_{nw}} \varepsilon_{R_L,t} R_t \tag{44}$$

which is equivalent to the equation presented in the paper.

Foreign banks face an identical agency problem on the foreign market and thus set a spread based on foreign entrepreneurs' leverage as described in the paper:

$$R_t^{L,*} = \phi_{fc}^* \left(\frac{B_t^*}{V_t^*} \right)^{\phi_{nw}^*} \varepsilon_{R_L,t}^* R_t^* \tag{45}$$

Now, remember our assumption that the SOE is too small to have an impact on foreign banks, and that foreign banks do not discriminate between domestic and foreign borrowers when setting their spread. Foreign banks thus set the same spread when lending to domestic or foreign entrepreneurs for domestic currency loans:

$$R_t^{L,f} = \phi_{fc}^* \left(\frac{B_t^*}{V_t^*} \right)^{\phi_{nw}^*} \varepsilon_{R_L,t}^* R_t \tag{46}$$

One interpretation is that foreign banks are free-riders in the domestic market as they ignore monitoring-costs when setting the rate at which domestic entrepreneurs can borrow at the foreign bank. As every entrepreneur borrows a fixed share ω_b of its credit need at foreign banks and the rest at a domestic bank, every domestic entrepreneur is monitored and has no incentive to divert assets.

How do our assumptions compare to BGG? Once linearized, equation (44) yields

$$\hat{R}_t^{L,d} = \hat{R}_t + \phi_{nw} \left(\hat{B}_t - \hat{V}_t \right) + \hat{\varepsilon}_{R_L,t}. \tag{47}$$

Combined with the linearized version of (46), one can get the average spread paid by domestic entrepreneurs:

$$\hat{R}_t^L = \hat{R}_t + (1 - \omega_b) \left[\phi_{nw} \left(\hat{B}_t - \hat{V}_t \right) + \hat{\varepsilon}_{R_L,t} \right] + \omega_b \left[\phi_{nw}^* \left(\hat{B}_t^* - \hat{V}_t^* \right) + \hat{\varepsilon}_{R_L,t}^* \right]. \tag{48}$$

where ω_b is the share of foreign banks in the domestic economy. Combined with the entrepreneurs FOC, we have

$$\mathrm{E}_t \hat{R}_{t+1}^K = \hat{R}_t + (1 - \omega_b) \left[\phi_{nw} \left(\hat{B}_t - \hat{V}_t \right) + \hat{\varepsilon}_{R_L,t} \right] + \omega_b \left[\phi_{nw}^* \left(\hat{B}_t^* - \hat{V}_t^* \right) + \hat{\varepsilon}_{R_L,t}^* \right]. \tag{49}$$

where R_t^K is the nominal return on capital.

This is close to BGG key equation $\mathrm{E}_t \hat{R}_{t+1}^K = \hat{R}_t + \phi_{BGG} \left(total\ \hat{assets}_t - net\ \hat{worth}_t \right)$ with two important differences. First, we use an alternative measure of leverage: while BGG uses a total asset to net worth ratio, we use a credit to collateral ratio. The second (and most important to our paper) difference with BGG is that we combine domestic and foreign banks. The spread paid by domestic entrepreneurs is thus affected by both domestic and foreign financing conditions.

C.3.2 Financial channels

The financial channel works through entrepreneurs and rule-of-thumb households. First, it transmits changes in the risk premium (developed in the previous section) to domestic entrepreneurs' investment and consumption. Linearizing the FOC from the entrepreneurs, one can find the consumption and investment equations (abstracting from the wedge shock):

$$\hat{C}_t^e = \frac{1}{1+b}\hat{C}_{t+1}^e + \frac{b}{1+b}\hat{C}_{t-1}^e - \frac{1-b}{\sigma_c(1+b)}\left(\hat{R}_t^L - \hat{\pi}_{t+1}^c\right) \tag{50}$$

$$\hat{I}_t = \frac{\beta_E}{1+\beta_E}\hat{I}_{t+1} + \frac{1}{1+\beta_E}\hat{I}_{t-1} + \frac{1}{(1+\beta_E)2\phi_i}\left(\hat{p}_t^k - \hat{\gamma}_t^i\right) \tag{51}$$

$$\hat{p}_t^k = \hat{\pi}_{t+1} - \hat{R}_t^L + (1-\beta_E(1-\delta))\hat{r}_t^{k+1} + \beta_E(1-\delta)\hat{p}_{t+1}^k \tag{52}$$

where $p_t^k = \frac{P_t^k}{P_t}$ is the real price of capital and $\gamma_t^i = \frac{P_t^i}{P_t}$ the real price of investment. Note we dropped the p or f indexes in the investment equations because the mechanism is similar for investment in the primary and final good sectors.

In equation (50), a drop in the lending rate (potentially coming from a drop in the domestic or foreign interest rate spread) have a positive impact on entrepreneurs' consumption. In equation (52), a drop in the lending rate causes an increase the real price of capital which transmits to investment through equation (51).

Second, rule-of-thumb households (who are financially constrained) directly transmit labor income fluctuations to consumption. Linearizing their budget constraint gives:

$$\hat{C}_t^r = \omega_h\left(\hat{w}_t^p + \hat{H}_t^p\right) + (1-\omega_h)\left(\hat{w}_t^f + \hat{H}_t^f\right) \tag{53}$$

which shows that changes in hours or real wages (in the primary or secondary sector) lead to a direct adjustment in consumption. The larger ω_h, the stronger the impact of a change in primary labor income.

Appendix D: model's steady state

Here we provide the details on the computation of steady-state for the domestic economy.

Calibration and choice of units First we fix some values reflecting some freedom in the choice of units:

$$\begin{aligned} y^f &= Y_0^f = 1 \\ h &= h^f + h^p = 0.3 \end{aligned}$$

where $Y_0^f = 1$ is a normalization and $h = 0.3$ ensures that agents devote on average 30% of their time to labor activities. It implies that hours worked by savers and rule-of-thumb consumers in each sectors is given by $H^p = \omega_h h$ and $H^f = (1 - \omega_h)h$. We calibrate $A_{h,p}$ and $A_{h,f}$ to match these targets.

We assume that inflation and the risk-free rates are the same in the domestic and foreign economies ($\pi = \pi^* = 1$ and $R = R^* = 1/\beta$). These assumptions imply that $dS = 1$ (through the UIP condition). Therefore, all inflation rates are equal to one. We then calibrate R^L to match a target for the spread. With entrepreneurs FOC we thus get $\beta_E = \frac{1}{R^L}$

Entrepreneurs Turning to entrepreneurs FOC, the assumptions presented above allow to pin down the real price of capital and its rental rate to

$$\begin{aligned} p_{k'} &= \frac{P^k}{P} = \frac{P^i}{P} = 1 \\ r^k &= \frac{p_{k'}(1 - (1 - \delta)\beta_E)}{\beta_E} \end{aligned}$$

Final good sector Turning to final good distributors, the marginal costs are given by:

$$mc = mc^x = mc^m = 1/\lambda_d$$

Of course, in the perfectly competitive producing sectors, real marginal cost is given by

$$mn^{nd} = 1$$

The normalized CES production function in the final good sector implies that

$$\frac{MC}{P} Y^f = \frac{P^{m,n}}{P} N^m + \frac{MC^{nd}}{P} N^d$$

where the domestic and foreign input shares are given by

$$\begin{aligned} \frac{P^{m,n}}{P} N^m &= \omega_n \frac{MC}{P} Y^f \\ \frac{MC^{nd}}{P} N^d &= (1 - \omega_n) \frac{MC}{P} Y^f \end{aligned}$$

and thus:

$$\begin{aligned} N^m &= \omega_n mc\, Y^f \\ N^d &= (1-\omega_n) mc\, Y^f \end{aligned}$$

Similarly,

$$\begin{aligned} r^{k,f} K^f &= \alpha \frac{MC^{nd}}{P} N^d \\ \bar{w}^f H^f &= (1-\alpha) \frac{MC^{nd}}{P} N^d \end{aligned}$$

such that

$$\begin{aligned} K^f &= \frac{\alpha mc^{nd} N^d}{r^k} \\ \bar{w}^f &= \frac{(1-\alpha) mc^{nd} N^d}{H^f} \end{aligned}$$

and wages are equal across sectors at steady-state so $\bar{w} = \bar{w}^p = \bar{w}^f$. It also implies that we can find the value of investment

$$I^f = \delta K^f$$

Commodity producers The primary commodity sector's share in GDP is calibrated to ω_p to match its empirical counterpart. It implies that $Y^p = \omega_p Y = \omega_p(Y^f - N^m + Y^P) = \omega_p(N^d + Y^P)$ and thus: $Y^p = \frac{\omega_p}{1-\omega_p} N^d$.

Turning to commodity producers, we know $\bar{w}^p$ and Y^p. Using once again a Normalized CES implies that

$$Y^p = r^{k,l} L^p + \bar{w} H^p + r^k K^p$$

with the following capital and labor income shares:

$$\begin{aligned} r^k K^p &= \alpha_p Y^p \\ \bar{w} H^p &= (1-\alpha_p-\beta_p) Y^p \end{aligned}$$

It implies that

$$K^p = \frac{\alpha_p Y^p}{r^k}$$

and that

$$\beta_p = 1 - \alpha_p - \frac{\bar{w} H^p}{Y^p}$$

where β_p is fixed such that the labor income share matches our assumption on hours worked in the primary sector. Therefore,

$$I^p = \delta K^p$$

and $I = I^f + I^p$, $I^m = \omega_i I$ and $I^d = (1-\omega_i) I$.

Aggregate resource constraints The aggregate resource constraint evaluated at steady state reads

$$Y^f - G = C^d + I^d + X^f$$

Plugging, steady state domestic consumption values from households yields

$$Y^f - G = (1 - \omega_c)C + I^d + X^f$$

Assuming we can calibrate the net foreign asset position $A = 0$, the assets accumulation rule gives

$$C^m + I^m + N^m = Y^p + X^f + (R - 1)\, A$$

Knowing steady state value of imported consumption, we have

$$\omega_c C + I^m + N^m = Y^p + X^f$$

We now have two equations with only X^f and C unknown. Solving yields

$$C = Y^f - (I^m + I^d + N^m + G) + Y^p$$

such that $C^m = \omega_c C$, $C^d = (1 - \omega_c)C$ and

$$X^f = (Y^f - G - C^d - I^d)$$

We have the value of aggregate consumption $C = C^s + C^e + C^r$. The consumption of rule-of-thumbs households is given by their budget constraint: $C^r = \bar{w}H$. We calibrate the credit to GDP ratio of entrepreneurs, so we also know B^e. Since all terms in their budget constraint have been found, we know C^e and $C^s = C - C^e - C^r$.

Appendix E: Observation Equations

Here we describe our observation equations for the US/South Africa pair when estimating the model with some variables expressed in year-on-year growth rates (South Africa is an interesting choice considering the use of employment and labor compensation instead of hours worked and wages as in the US and Canada). We have a set of 20 observed variables linked to the model:

$$
\begin{pmatrix}
100\log\left(GDP_t/GDP_{t-4}\right)\\
100\log\left(CONS_t/CONS_{t-4}\right)\\
100\log\left(INV_t/INV_{t-4}\right)\\
100\log\left(COM_t/COM_{t-4}\right)\\
100\log\left(EMP_t/EMP_{t-4}\right)\\
100\log\left(EMP^p_t/EMP^p_{t-4}\right)\\
REPO_t\\
100\log\left(CPI_t/CPI_{t-4}\right)\\
-100\log\left(NEER_t/NEER_{t-1}\right)\\
SPREAD_t\\
100\log\left(\frac{LABCOMP_t/CPI_t}{LABCOMP_{t-4}/CPI_{t-4}}\right)\\
---\\
100\log\left(GDP^*_t/GDP^*_{t-4}\right)\\
100\log\left(CONS^*_t/CONS^*_{t-4}\right)\\
100\log\left(INV^*_t/INV^*_{t-4}\right)\\
100\log\left(H^*_t/H^*_{t-4}\right)\\
FFR_t\\
100\log\left(CPI^*_t/CPI^*_{t-4}\right)\\
100\log\left(WAGE^*_t/WAGE^*_{t-4}\right)\\
SPREAD^*_t\\
100\log\left(\frac{CP^*_t/CPI^*_t}{CP^*_{t-4}/CPI^*_{t-4}}\right)
\end{pmatrix}
=
\begin{pmatrix}
\bar{\gamma}^y\\ \bar{\gamma}^c\\ \bar{\gamma}^i\\ \bar{\gamma}^p\\ \bar{\gamma}^e\\ \bar{\gamma}^{e,p}\\ \bar{\gamma}^r\\ \bar{\gamma}^\pi\\ \bar{\gamma}^{\Delta S}\\ \bar{\gamma}^s\\ \bar{\gamma}^w\\ -\\ \bar{\gamma}^{y*}\\ \bar{\gamma}^{c*}\\ \bar{\gamma}^{i*}\\ \bar{\gamma}^{h*}\\ \bar{\gamma}^{r*}\\ \bar{\gamma}^{\pi*}\\ \bar{\gamma}^{\pi w*}\\ \bar{\gamma}^{s*}\\ \bar{\gamma}^{cp*}
\end{pmatrix}
+
\begin{pmatrix}
100\log\left(y_t/y_{t-4}\right)\\
100\log\left(c_t/c_{t-4}\right)\\
100\log\left(i_t/i_{t-4}\right)\\
100\log\left(y^p_t/y^p_{t-4}\right)\\
100\log\left(E_t/E_{t-4}\right)\\
100\log\left(E^p_t/E^p_{t-4}\right)\\
400R_t\\
100\log\left(\pi^c_t\pi^c_{t-1}\pi^c_{t-2}\pi^c_{t-3}\right)\\
100\log\left(\Delta S_t\right)\\
400\left(R^L_t-R_t\right)\\
100\log\left(\frac{\bar{w}_tH_tP_t/P^c_t}{\bar{w}_{t-4}H_{t-4}P_{t-4}/P^c_{t-4}}\right)\\
---\\
100\log\left(y^*_t/y^*_{t-4}\right)\\
100\log\left(c^*_t/c^*_{t-4}\right)\\
100\log\left(i^*_t/i^*_{t-4}\right)\\
100\log\left(H^*_t/H^*_{t-4}\right)\\
400R^*_t\\
100\log\left(\pi^*_t\pi^*_{t-1}\pi^*_{t-2}\pi^*_{t-3}\right)\\
100\log\left(\pi^{w*}_t\pi^{w*}_{t-1}\pi^{w*}_{t-2}\pi^{w*}_{t-3}\right)\\
400\left(R^{L*}_t-R^*_t\right)\\
100\log\left(\gamma^{p*}_t/\gamma^{p*}_{t-4}\right)
\end{pmatrix}
+
\begin{pmatrix}
\epsilon^y_t\\ \epsilon^c_t\\ \epsilon^i_t\\ \epsilon^p_t\\ \epsilon^e_t\\ \epsilon^{e,p}_t\\ \epsilon^r_t\\ \epsilon^\pi_t\\ \epsilon^{\Delta S}_t\\ \epsilon^s_t\\ \epsilon^w_t\\ -\\ \epsilon^{y*}_t\\ \epsilon^{c*}_t\\ \epsilon^{i*}_t\\ \epsilon^{h*}_t\\ \epsilon^{r*}_t\\ \epsilon^{\pi*}_t\\ \epsilon^{\pi w*}_t\\ \epsilon^{s*}_t\\ \epsilon^{cp*}_t
\end{pmatrix}
$$

where $\bar{\gamma}$ are constants calibrated at the corresponding observed series mean. This departs from the traditional view that the trend in real variables should be identical. However, considering that trade shares have been growing in South Africa over the estimation period (starting after the end of the apartheid), and that growth rates were higher in South Africa than in the US, we decided to allow for different means in the observation equations. Similar arguments hold for average inflation and interest rates. Measurement errors ϵ are calibrated to explain about 1% of the variance in observed variables..

In the model, we have used hours worked while in the data only employment is available. In order to capture labor hoarding we define employment following Adolfson et al. (2007) as

$$E_t = \frac{1}{1+\beta}E_{t-1} + \frac{\beta}{1+\beta}E_{t+1} + \frac{(1-\xi_e)(1-\beta\xi_e)}{(1+\beta)\xi_e}\left(H_t - E_t\right) \tag{54}$$

where $1-\xi_e$ is the probability of a firm to be allowed to readjust employment. We do the same for employment in the primary sector.

Appendix F: Data

Some specific data transformations are detailed here. Data sources and transformations applied to other variables in Table F1.

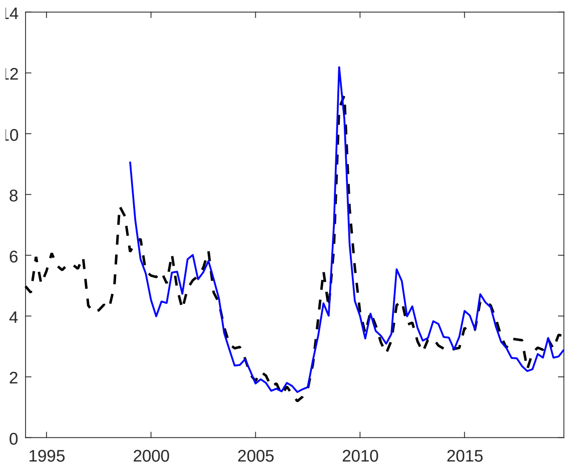
World Commodity Prices We build a global commodity price index as an average of three sub-indexes: crude oil, metals and agricultural prices. Our index is then deflated with US CPI. The metal price index is borrowed from Barchart and includes Copper, lead and steel scraps, tin, and zinc. The agricultural price is a weighted average of agricultural raw material (26%) and food price and tropical beverage (84%) indexes from HWWI (Hamburg Institute of International Economics). These weights capture the relative importance of industrial raw materials and food in the aggregate HWWI index.

South African spread proxy We proxy the South African spread using the predicted values obtained from regressing an emerging market spread index on South African variable. The emerging market spread considered is the Option-Adjusted Spread for the ICE BofAML Emerging Markets Corporate Plus Index. The South African variables used as independent variables are the number of insolvencies, the spread between EKSOM bonds and 10-year domestic government bond yield, the spread between domestic and US 10-year government bond yield, the OECD-MEI manufacturing business confidence indicator and the OECD-MEI share price index. Figure F1(a) shows the emerging market spread index together with the fitted values from its regression on South Africa variables. The regression is performed on quarterly data over the 1999Q1 to 2019Q4 period. Predicted values are then computed based on this relation for the 1994Q1 to 2019Q4 period.

South African commodity export proxy Commodity exports are proxied by total mining sales from the Stat SA database divided by the export price index from the SARB database. Since about 70% of mining production is exported, this measure gives a good proxy of mining exports. For illustrative purposes, it is compared to the growth rate in real total exports in Figure F1(b) below. Considering the large weight of commodities in total exports, it is reassuring to see some degree of co-movements in these two variables. In a robustness exercise, we also proxy commodity exports with mining production volumes (green).

Figure F1. Data proxies

(a) Spread proxy (dashed black) compared to emerging market spread index (blue). Rates annualised.



(b) Mining export volumes proxied with mining sales (dashed black) and mining production (dashed green) compared to total exports volumes (blue). YoY growth rates.

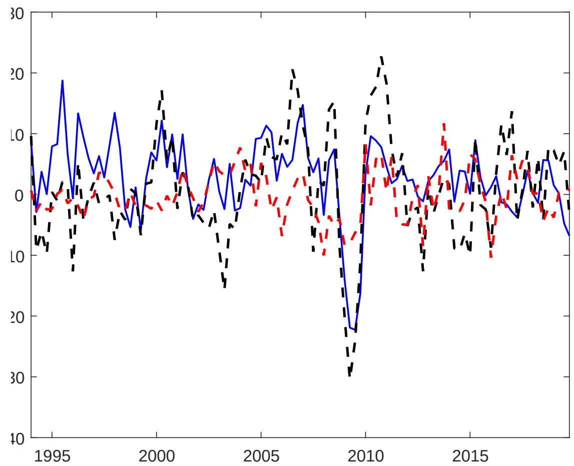


Table F1. Data sources and transformations

Data	Source	Transformation
SA GDP	Stat SA	GDP. Constant price. YoY.
SA Employment	SARB	Employment in the private sector (index). YoY.
SA Consumption	Stat SA	Final Consumption Expenditure, Households. Constant price. YoY.
SA Investment	Stat SA	Gross Fixed Capital Formation. Constant price. YoY.
SA Cmdty exports	Stat SA	Total value of mineral sales deflated by export prices. YoY. Note: Mining production volumes (Stat SA) in robustness check
SA Cmdty employment	SARB	Employment in mining sector. YoY.
SA CPI	Stat SA	Consumer Price Index, Urban Areas, Headline. YoY.
SA Labor comp.	Stat SA	Compensation of Employees. Deflated by CPI. YoY.
SA Risk-free rate	SARB	Repo Rate. Annual rate in level.
SA Spread	Own computations	See appendix.
SA Exchange rate	SARB	Nominal effective exchange rate. QoQ.
CA GDP	Stat Can	GDP. Constant price. YoY.
CA Hours	Stat Can	Hours worked, Business sector. YoY.
CA Consumption	Stat Can	Final Consumption Expenditure, Households. Constant price. YoY.
CA Investment	Stat Can	Gross Fixed Capital Formation. Constant price. YoY.
CA Cmdty exports	Stat Can	Export volumes of primary commodities (categories C11 to C16). YoY. Note: Pre-1998: Export of primary commodities deflated by export price index
CA Cmdty employment	Stat Can	Employment in mining, oil and gas extraction. YoY.
CA CPI	Stat Can	Consumer Price Index, All items. YoY.
CA Wage	Stat Can	Compensation Per Hour Worked, Business sector. YoY.
CA Risk-free rate	Stat Can	3 Month Treasury Bills rate. Annual rate in level.
CA Spread	ICE BofA	1-5 Year BBB Canada Corporate yield minus 3 years CA treasury yield. Note: Backcasted pre-1997 with a regression of the spread on Canadian variables.
CA Exchange rate	Stat Can	Canadian-US dollars exchange rates. QoQ.
World Cmdty Price	Own computations	See appendix
US GDP	US Bureau of Eco. Analysis	GDP. Constant price. YoY
US Consumption	US Bureau of Eco. Analysis	Personal Consumption Expenditure. Constant price. YoY.
US Investment	OECD-MEI	Gross Fixed Capital Formation. Constant price. YoY.
US Hours	US Burea of labor statistics	Hours worked, Business sector, Total Private. YoY.
US CPI	US Burea of labor statistics	Consumer Price Index, All Urban Consumers, U.S. City Average, All Items Less Shelter. YoY.
US Wage	US Burea of labor statistics	Business sector, Hourly Compensation. YoY.
US Risk-free rate	Wu and Xia (2016) and Fred	Effective Fed Fund rate replaced by its shadow rate over the 2009Q3 to 2015Q4 period.
US Spread	ICE BofA	1-3 Year BBB US Corporate Index - Option-Adj Spread. Annual rates in levels. Note: pre-2000: 1-3 Year BBB US Corporate yield minus 2 years US treasury yield

YoY = growth rate same quarter of the previous year. QoQ = quarter on quarter growth rate.

Appendix G: Additional DSGE results

G1. More IRFs from the calibrated model (section 5)

This section shows the IRFs to each category of shocks in the full model calibrated as in section 5 of the paper. Figures G1.1 to G1.4 show the IRFs to foreign shocks, while figure G1.5 to G1.11 display domestic shocks. We draw a few general conclusions from this more detailed analysis.

G1.1. Foreign shocks transmission channels

Figures G1.1 to G1.3 demonstrate that our extended model is capable to generate a higher degree of synchronicity between the domestic and foreign economy compared to simpler versions where we shut-down our main transmission channels. The results presented in the core of the paper (with foreign wedge shocks) do not depend on the particular shock we selected but extend to most non-commodity specific shocks (which includes aggregate demand, aggregate supply, monetary, and credit supply shocks).

G1.2. Wedge shocks

In SW, the wedge shock only affects one type of bond. In our context, restricting this shock to bonds held by savers would fail to generate the positive correlation between consumption and investment that wedge shocks typically produce. We therefore apply this shock to both the returns on savers' assets and costs of entrepreneurs' liabilities, as explained in the paper. Figure G1.5 shows that wedge shocks behave as a typical aggregate demand shocks (as in SW).

G1.3. Capital and land-augmenting productivity shock

We use a combined capital and land-augmenting productivity shock because it allows us to annalyze foreign shocks transmission channels (in section 6.3 of the paper) more consistently. In one experiment, we set $\sigma_p = 0$ to shut our domestic commodity supply channel. Under this calibration, a pure land-augmenting productivity shock causes a large investment response that is not observed in the baseline estimation and would bias our estimation of the domestic commodity supply channel. Figure G1.11 illustrates why we do not use a land specific shock: for some values of σ_p, this shock would cause unrealistically high investment responses, which would impair our channel-based analysis with variance decompositions. Also note that our main results (other than those presented in section 6.3) are similar with a pure land-augmenting productivity shock.

G1.4. Foreign commodity supply shocks

Figure G1.4 shows that foreign commodity supply shocks generate a negative co-movement between the commodity exporter and the rest of the world. In our empirical analysis, this shock captures all unanticipated changes in commodity prices that are not related to shocks originating from the foreign non-commodity sectors. Hence, the shock includes exogenous changes in world commodity supply and commodity-specific demand shocks (related to factors such as precautionary demand, speculative trading, and extreme weather conditions, ...) that we do not explicitly model in our framework. When studying international spillovers to commodity exporters, what matters is the dynamics of commodity prices and their comovements with foreign GDP. The origin of commodity-specific shocks (weather caused by commodity supply or commodity-specific demand shocks) is less important because these specific shocks generate similar comovements between commodity prices and foreign activity. For this reason, we do not include commodity-specific demand shocks. Other papers also use a similar strategy with SOE-SVAR (Charnavoki and Dolado, 2014) and SOE-DSGE (Bergholt et al., 2019) models.

Figure G1.1. IRFs - Foreign aggregate supply (TFP) shocks in the full model

Note: Variables expressed in percentage deviation from steady-state, inflation rates, interest rates and spreads annualized. Horizon in quarters.
Grey: Baseline with open financial and commodity supply channels in the SOE ($\sigma_p = 0.33$)
Blue: Semi-open financial channel in the SOE (domestic banks, foreign banks, ~~ROTHs~~,$\sigma_p = 0.33$*)*
Red: Semi-open financial channel in the SOE (domestic banks, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$*)*
Green: Closed financial channel in the SOE (~~domestic banks~~, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$*)*
Black: Closed financial and commodity supply channels in the SOE ($\sigma_p = 0$)

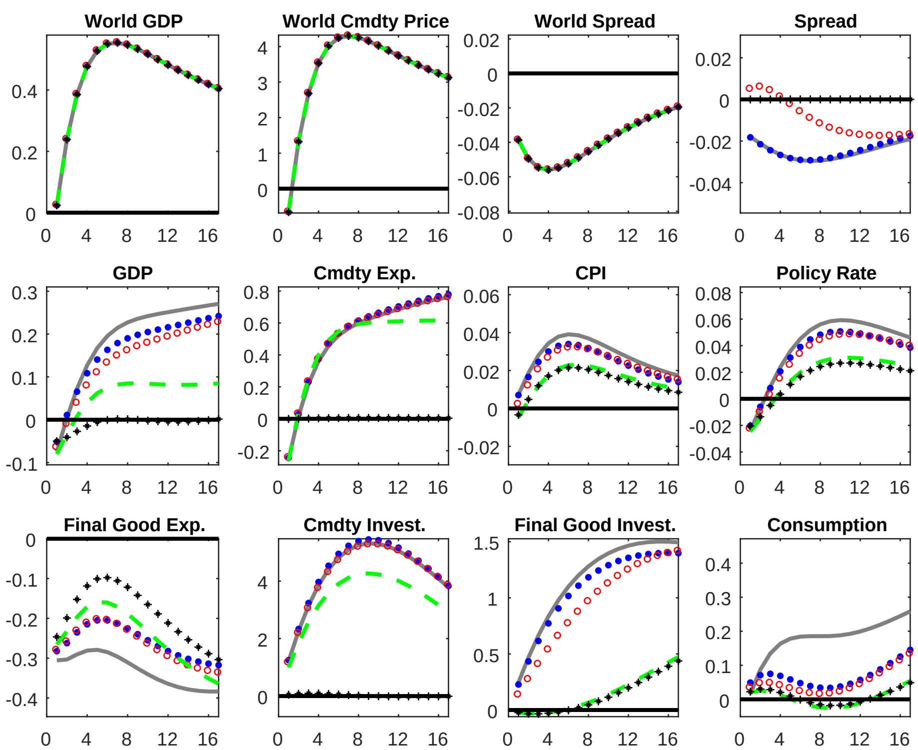


Figure G1.2. IRFs - Foreign monetary policy shocks in the full model

Note: Variables expressed in percentage deviation from steady-state, inflation rates, interest rates and spreads annualized. Horizon in quarters.
Grey: Baseline with open financial and commodity supply channels in the SOE ($\sigma_p = 0.33$)
Blue: Semi-open financial channel in the SOE (domestic banks, foreign banks, ~~ROTHs~~,$\sigma_p = 0.33$)
Red: Semi-open financial channel in the SOE (domestic banks, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Green: Closed financial channel in the SOE (~~domestic banks~~, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Black: Closed financial and commodity supply channels in the SOE ($\sigma_p = 0$)

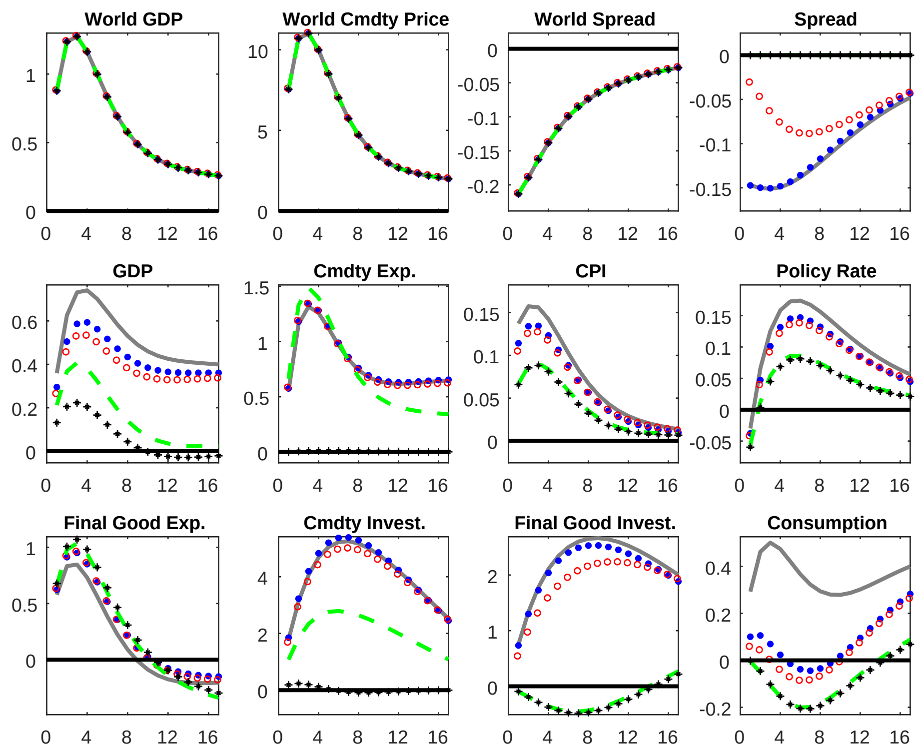


Figure G1.3. IRFs - Foreign credit supply shocks in the full model

Note: Variables expressed in percentage deviation from steady-state, inflation rates, interest rates and spreads annualized. Horizon in quarters.
Grey: Baseline with open financial and commodity supply channels in the SOE ($\sigma_p = 0.33$)
Blue: Semi-open financial channel in the SOE (domestic banks, foreign banks, ~~ROTHs~~,$\sigma_p = 0.33$)
Red: Semi-open financial channel in the SOE (domestic banks, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Green: Closed financial channel in the SOE (~~domestic banks~~, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Black: Closed financial and commodity supply channels in the SOE ($\sigma_p = 0$)

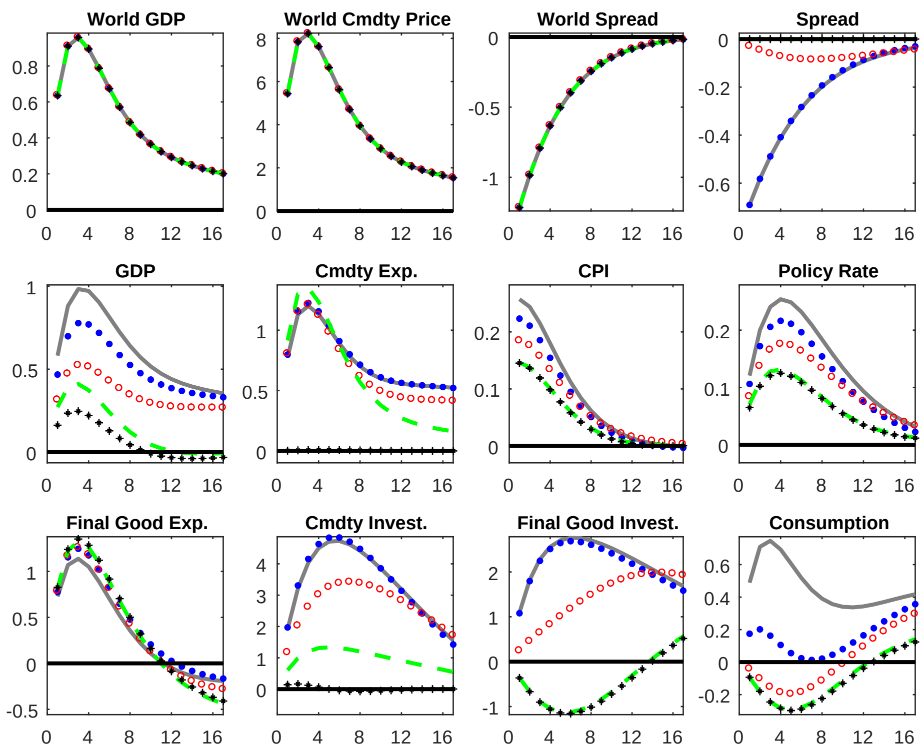


Figure G1.4. IRFs - Foreign commodity supply shocks in the full model

Note: Variables expressed in percentage deviation from steady-state, inflation rates, interest rates and spreads annualized. Horizon in quarters.
Grey: Baseline with open financial and commodity supply channels in the SOE ($\sigma_p = 0.33$)
Blue: Semi-open financial channel in the SOE (domestic banks, foreign banks, ~~ROTHs~~,$\sigma_p = 0.33$)
Red: Semi-open financial channel in the SOE (domestic banks, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Green: Closed financial channel in the SOE (~~domestic banks~~, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Black: Closed financial and commodity supply channels in the SOE ($\sigma_p = 0$)

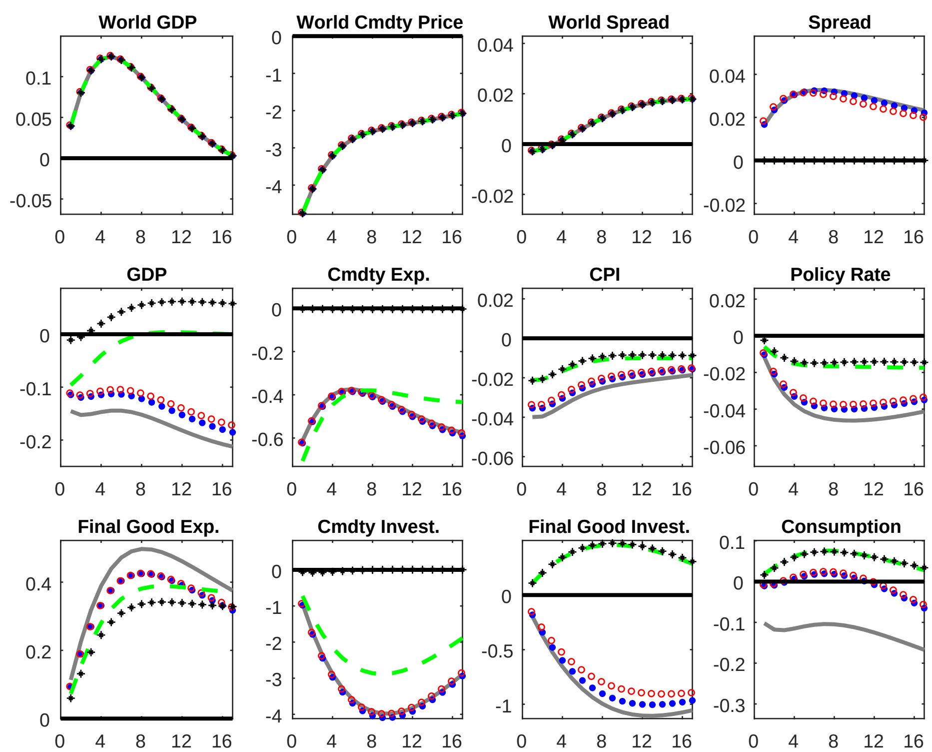


Figure G1.5. IRFs - Domestic aggregate demand (wedge) shocks in the full model

Note: Variables expressed in percentage deviation from steady-state, inflation rates, interest rates and spreads annualized. Horizon in quarters.
Grey: Baseline with open financial and commodity supply channels in the SOE ($\sigma_p = 0.33$)
Blue: Semi-open financial channel in the SOE (domestic banks, foreign banks, ~~ROTHs~~,$\sigma_p = 0.33$*)*
Red: Semi-open financial channel in the SOE (domestic banks, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$*)*
Green: Closed financial channel in the SOE (~~domestic banks~~, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$*)*
Black: Closed financial and commodity supply channels in the SOE ($\sigma_p = 0$)

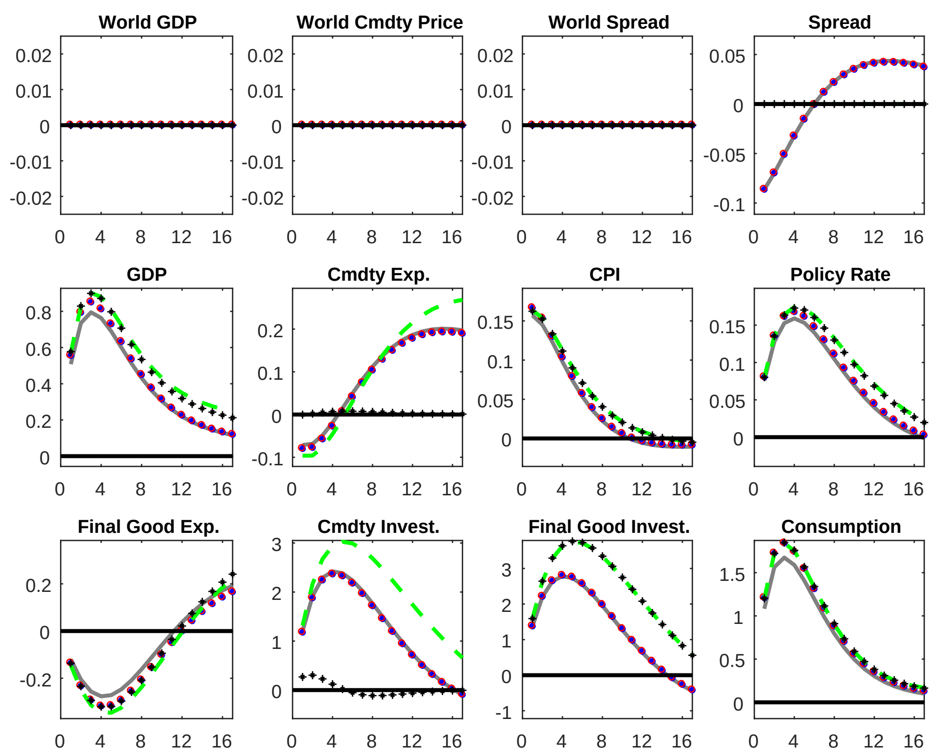


Figure G1.6. IRFs - Domestic aggregate supply (TFP final good) shocks in the full model

Note: Variables expressed in percentage deviation from steady-state, inflation rates, interest rates and spreads annualized. Horizon in quarters.
Grey: Baseline with open financial and commodity supply channels in the SOE ($\sigma_p = 0.33$)
Blue: Semi-open financial channel in the SOE (domestic banks, foreign banks, ~~ROTHs~~,$\sigma_p = 0.33$)
Red: Semi-open financial channel in the SOE (domestic banks, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Green: Closed financial channel in the SOE (~~domestic banks~~, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Black: Closed financial and commodity supply channels in the SOE ($\sigma_p = 0$)

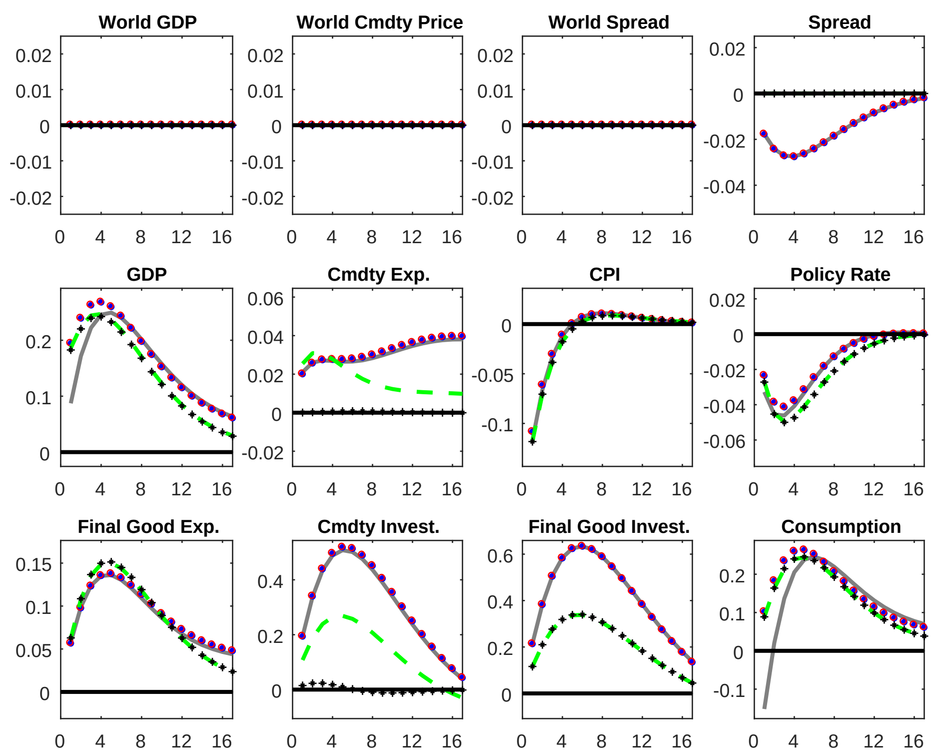


Figure G1.7. IRFs - Domestic monetary policy shocks in the full model

Note: Variables expressed in percentage deviation from steady-state, inflation rates, interest rates and spreads annualized. Horizon in quarters.
Grey: Baseline with open financial and commodity supply channels in the SOE ($\sigma_p = 0.33$)
Blue: Semi-open financial channel in the SOE (domestic banks, foreign banks, ~~ROTHs~~,$\sigma_p = 0.33$)
Red: Semi-open financial channel in the SOE (domestic banks, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Green: Closed financial channel in the SOE (~~domestic banks~~, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Black: Closed financial and commodity supply channels in the SOE ($\sigma_p = 0$)

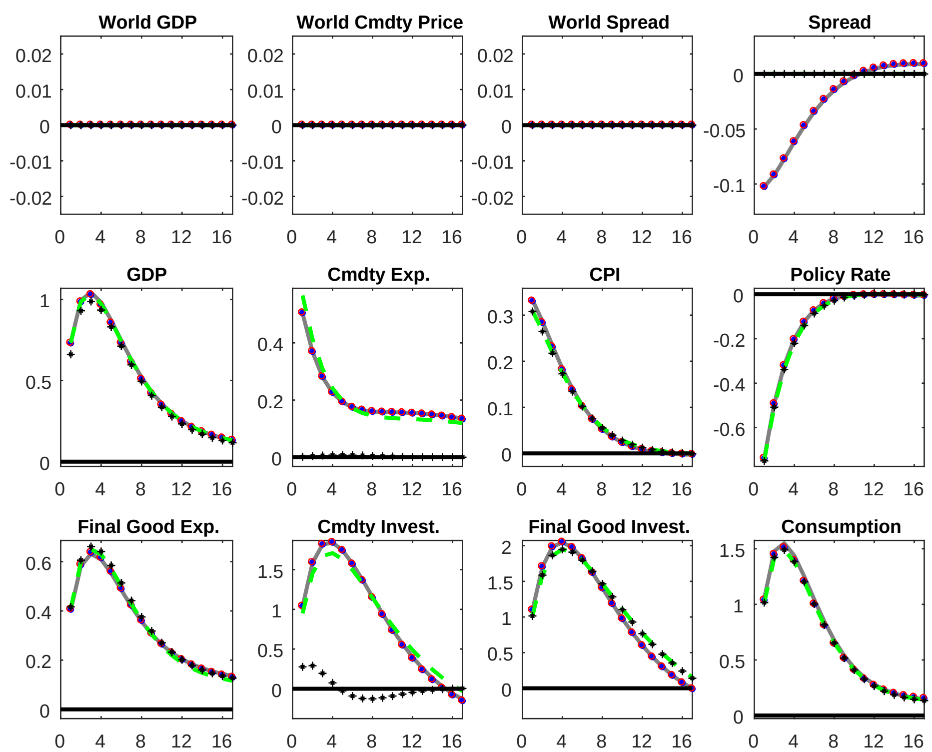


Figure G1.8. IRFs - Domestic credit supply shocks in the full model

Note: Variables expressed in percentage deviation from steady-state, inflation rates, interest rates and spreads annualized. Horizon in quarters.
Grey: Baseline with open financial and commodity supply channels in the SOE ($\sigma_p = 0.33$)
Blue: Semi-open financial channel in the SOE (domestic banks, foreign banks, ~~ROTHs~~,$\sigma_p = 0.33$)
Red: Semi-open financial channel in the SOE (domestic banks, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Green: Closed financial channel in the SOE (~~domestic banks~~, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Black: Closed financial and commodity supply channels in the SOE ($\sigma_p = 0$)

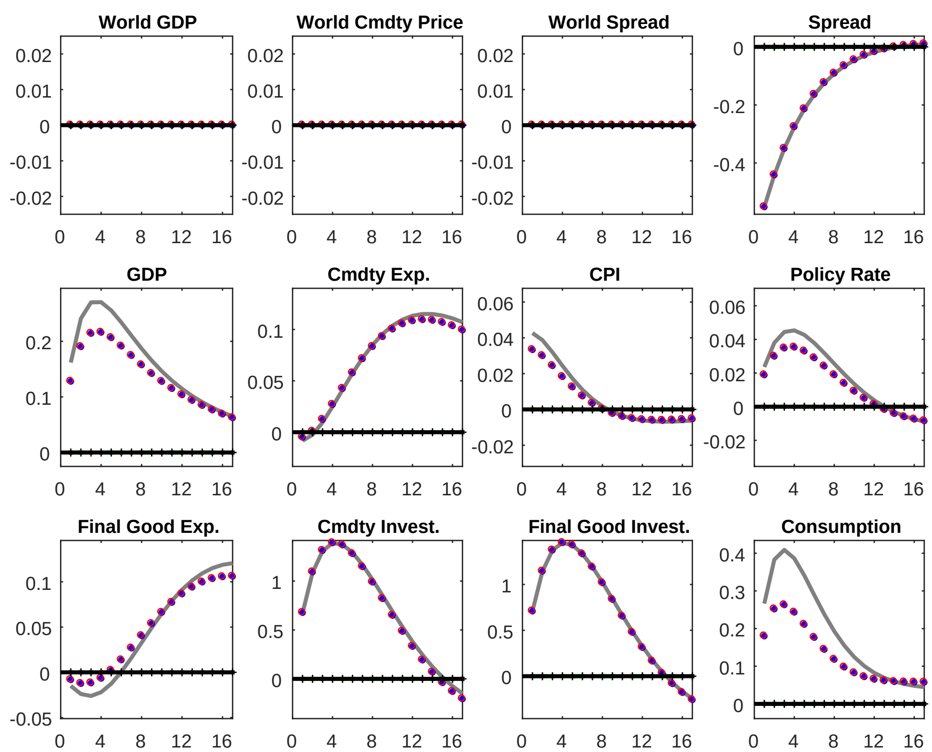


Figure G1.9. IRFs - Domestic commodity supply (labor prod) shocks in the full model

Note: Variables expressed in percentage deviation from steady-state, inflation rates, interest rates and spreads annualized. Horizon in quarters.
Grey: Baseline with open financial and commodity supply channels in the SOE ($\sigma_p = 0.33$*)*
Blue: Semi-open financial channel in the SOE (domestic banks, foreign banks, ~~ROTHs~~,$\sigma_p = 0.33$*)*
Red: Semi-open financial channel in the SOE (domestic banks, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$*)*
Green: Closed financial channel in the SOE (~~domestic banks~~, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$*)*
Black: Closed financial and commodity supply channels in the SOE ($\sigma_p = 0$*)*

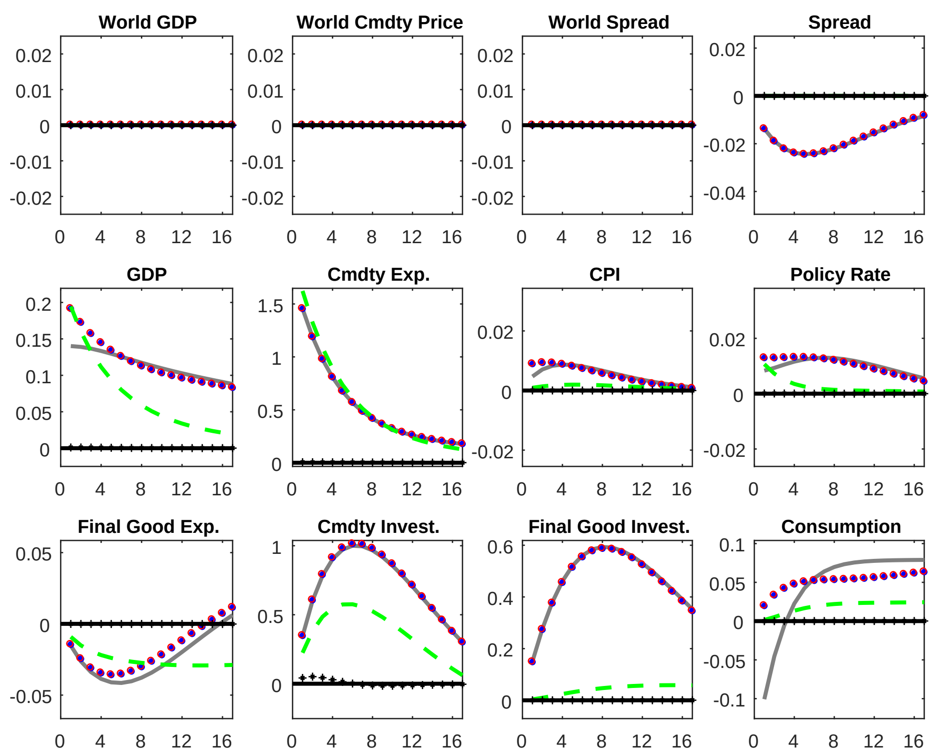


Figure G1.10. IRFs - Domestic commodity supply (land/capital prod) shocks in the full model

Note: Variables expressed in percentage deviation from steady-state, inflation rates, interest rates and spreads annualized. Horizon in quarters.
Grey: Baseline with open financial and commodity supply channels in the SOE ($\sigma_p = 0.33$)
Blue: Semi-open financial channel in the SOE (domestic banks, foreign banks, ~~ROTHs~~,$\sigma_p = 0.33$*)*
Red: Semi-open financial channel in the SOE (domestic banks, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$*)*
Green: Closed financial channel in the SOE (~~domestic banks~~, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$*)*
Black: Closed financial and commodity supply channels in the SOE ($\sigma_p = 0$)

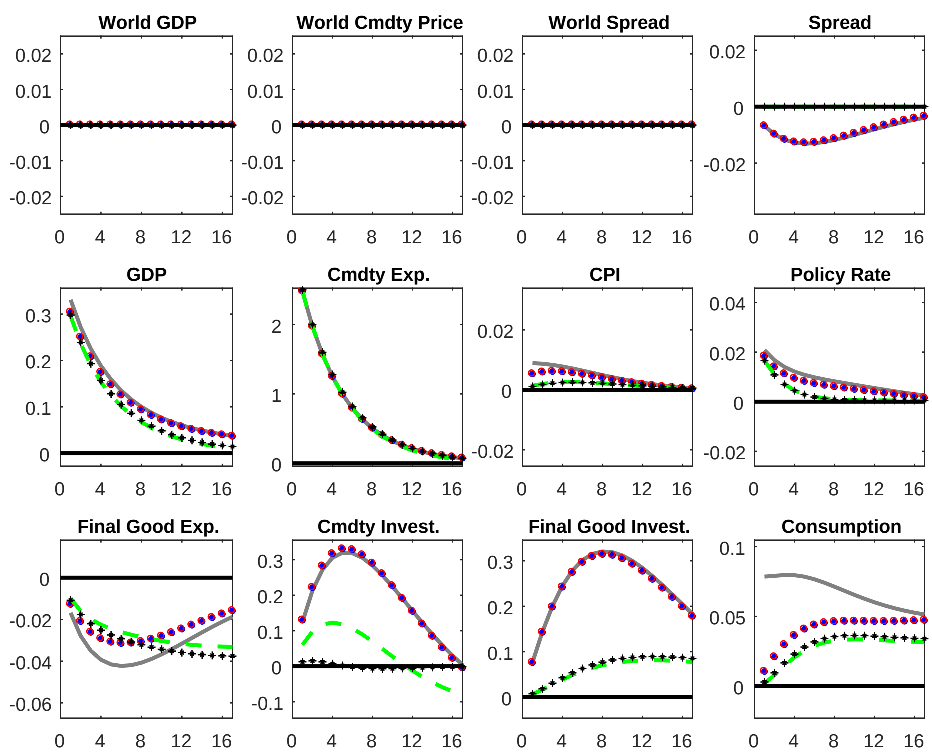
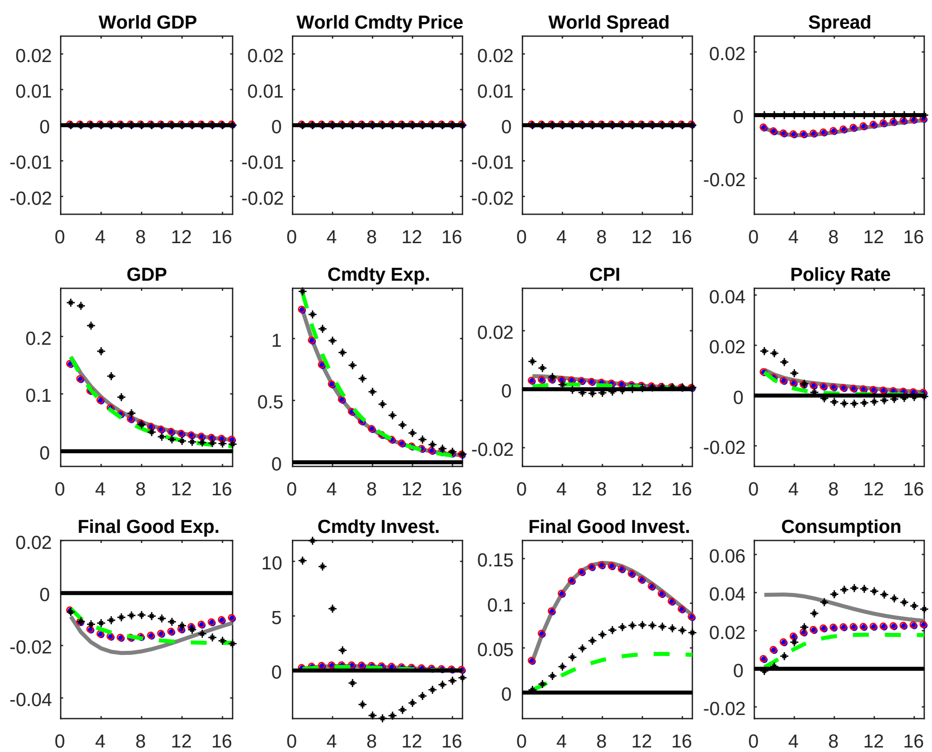


Figure G1.11. IRFs - Domestic commodity supply (land prod only) shocks in the full model

Note: Variables expressed in percentage deviation from steady-state, inflation rates, interest rates and spreads annualized. Horizon in quarters.
Grey: Baseline with open financial and commodity supply channels in the SOE ($\sigma_p = 0.33$)
Blue: Semi-open financial channel in the SOE (domestic banks, foreign banks, ~~ROTHs~~,$\sigma_p = 0.33$)
Red: Semi-open financial channel in the SOE (domestic banks, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Green: Closed financial channel in the SOE (~~domestic banks~~, ~~foreign banks~~, ~~ROTHs~~,$\sigma_p = 0.33$)
Black: Closed financial and commodity supply channels in the SOE ($\sigma_p = 0$)



G2. Identification and the mode of key estimated parameters

Here, we briefly discuss the value of some key parameters related to our main transmission channels.

In the foreign block, the mode of the elasticity of substitution between commodity and other (labor and capital) inputs (σ_p^*) is estimated at 0.09. This parameter governs our world commodity price channel and low elasticity of substitution implies that commodity prices respond relatively strongly to the foreign business cycle through firms' demand.

In the domestic block, we estimate the elasticity of substitution between production factors in the primary sector (σ_p) and find values of 0.21 and 0.15 for South Africa and Canada, respectively. The use of a CES production function with decreasing returns to scale (due to the introduction of a fixed production factor), a low labor income share (0.37 and 0.23) and a low factor elasticity of substitution between production factors imply short-run domestic commodity supply price-elasticities of 0.12 and 0.04 in these economies.

The estimated share of foreign banks (ω_b) is 0.76 in South Africa (much larger than its prior mean of 0.22) and 0.40 in Canada (close to its prior mean). The lower estimate value in Canada may come as a surprise, considering the higher prior value, the close links with the US, and the large observed correlation between Canadian and US spreads. Here, the relative volatility of the Canadian and US spreads explains those results. In our data, the US spread is more volatile and a large share of foreign banks in Canada would result in overfitting the Canadian spread volatility. The estimation thus captures the trade-off between the high observed correlation in the spread with the different volatilities. Nevertheless, the estimation does a decent job at reproducing the correlation between the Canadian and US spreads.

We estimate a low value for the spread elasticity to borrower net worth ratio in the domestic (ϕ_{nw}) and foreign (ϕ_{nw}^*) economies (fixing their prior mean to 0.05; e.g. as in Bernanke et al., 1999) to about 0.025 in South Africa, 0.030 in Canada and 0.031 in the US. Other papers also report a low spread elasticity to net worth ratio. Alpanda and Aysun (2014) report low values for the US and Euro Area. In Christiano et al. (2014), risk shocks explain 95% of the fluctuations in the spread, while the endogenous response of net worth to other shocks only accounts for 5%, in an estimated model with US data.

Finally, the methodologies proposed by Andrle (2010) and Iskrev (2010) implemented in Dynare show that key estimated parameters (σ_p^*, σ_p, ω_b, ϕ_{nw} and ϕ_{nw}^*) governing our three main transmission channels are well identified.

G3. IRFs in estimated model (section 6)

Figure G3.1. IRFs - Foreign aggregate demand shocks channels in Canada

Note: Variables expressed in percentage deviation from steady-state. Inflation rates, interest rates and spreads annualized. Horizon in quarters. We sequentially shut transmission channels as in section 6.3. of the paper.
Black: Baseline estimation.
Blue: No fin (1) = Financial channel is closed in the domestic economy.
Red: No CS (2) = Domestic commodity supply channel is closed ($\sigma_p = 0$).
Green: Cst CP (3) = Commodity prices are constant (in dollar term) in the SOE. Note the foreign economy is left unchanged (commodity prices are still endogenous in the foreign economy). This closes the world commodity price channel from the point of view of the SOE while leaving the fluctuations in other foreign variables unchanged.
Grey: All (1,2,3) = No fin. + No CS + Cst CP in SOE.

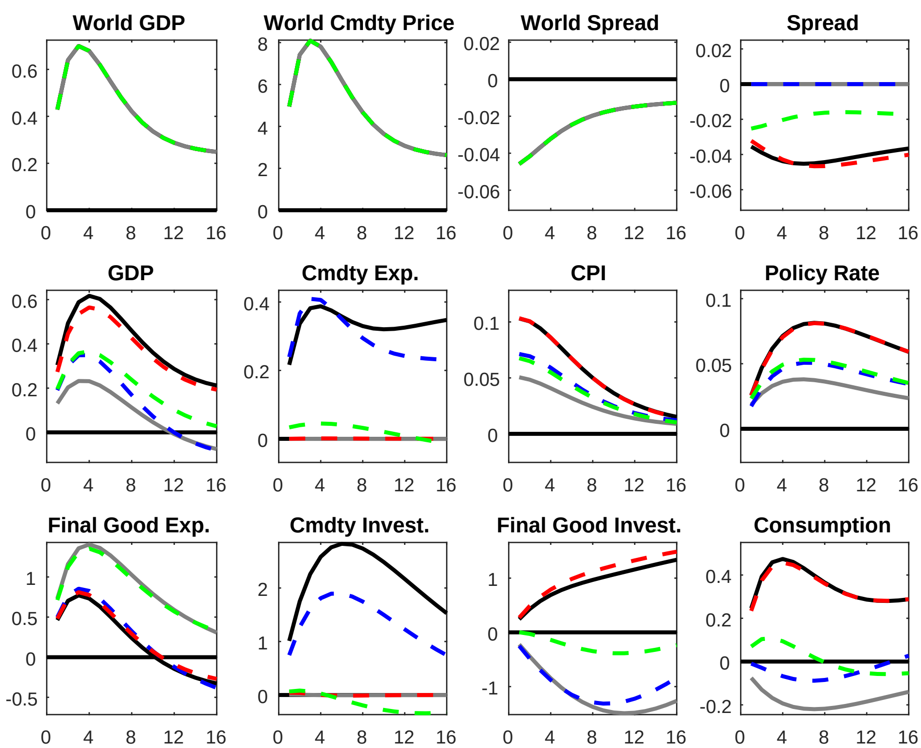
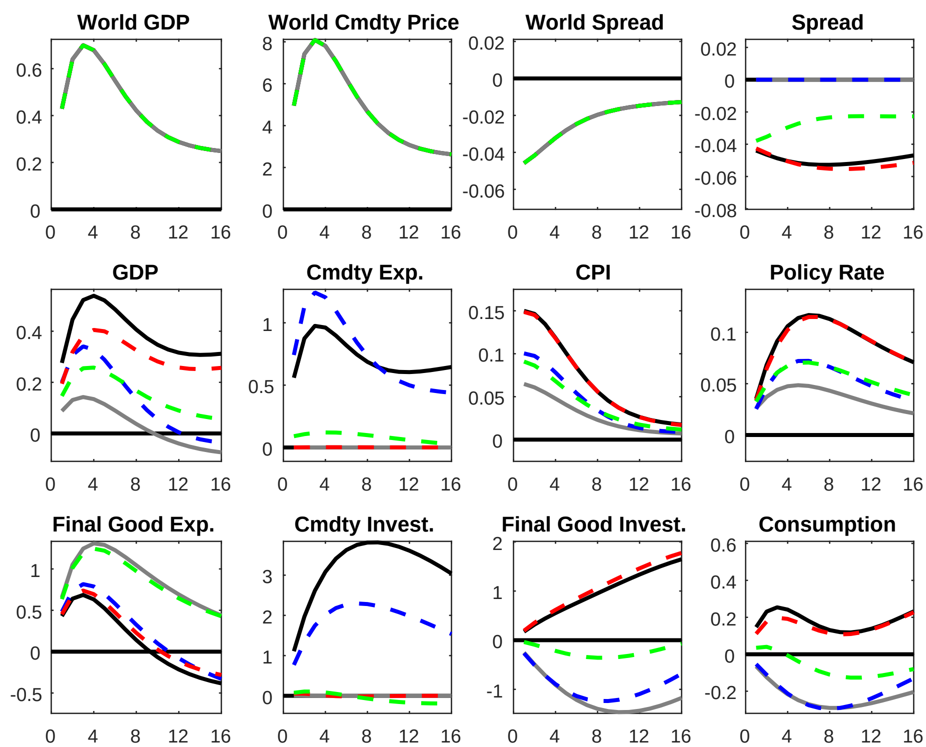


Figure G3.2. IRFs - Foreign aggregate demand shocks channels in South Africa

Note: Variables expressed in percentage deviation from steady-state. Inflation rates, interest rates and spreads annualized. Horizon in quarters. We sequentially shut transmission channels as in section 6.3. of the paper.
Black: Baseline estimation.
Blue: No fin (1) = Financial channel is closed in the domestic economy.
Red: No CS (2) = Domestic commodity supply channel is closed ($\sigma_p = 0$).
Green: Cst CP (3) = Commodity prices are constant (in dollar term) in the SOE. Note the foreign economy is left unchanged (commodity prices are still endogenous in the foreign economy). This closes the world commodity price channel from the point of view of the SOE while leaving the fluctuations in other foreign variables unchanged.
Grey: All (1,2,3) = No fin. + No CS + Cst CP in SOE.



G4. Variance decomposition: South Africa and the OECD + BRIIC

Here, we present our variance decomposition analysis for South Africa, where the foreign economy is captured by an OECD plus BRIIC (Brazil, Russia, India, Indonesia, and China) aggregate. Specifically, we build weighted averages for foreign variables, where the weights are based on every countries' GDPs. Exceptions are made for the interest rate and spread, for which we keep US data. US risk-free rates and spreads have a major importance to the world economy. Moreover, in the case of the spreads, data availability also dictated that choice. The following table shows that our results are robust to using an alternative characterization of the foreign economy: foreign shocks remain important drivers for South African variables.

Table G3. Foreign shocks contribution to foreign and domestic variables

South Africa	AD*	AS*	MP*	Com*	Cred*	All*
GDP	11.14	2.86	2.21	1.88	4.19	22.28
Employment	15.65	1.89	3.24	2.25	6.25	29.28
Consumption	4.05	5.95	1.33	0.96	2.66	14.95
Investment	2.42	7.55	1.50	1.04	2.09	14.60
Exports	15.24	4.08	2.33	2.78	2.41	26.84
Imports	2.50	7.00	0.70	0.51	0.86	11.57
Mining exports	8.10	4.79	1.59	3.38	1.38	19.24
Mining Empl	17.31	7.82	3.49	3.41	3.28	35.31
CPI	25.76	3.30	1.98	1.70	3.78	36.52
Wage	8.57	2.86	2.10	1.74	3.63	18.90
Risk-free rate	33.23	6.37	1.74	1.98	3.35	46.67
Spread	17.73	5.66	1.99	2.15	18.53	46.06
Exchange rate	1.15	9.27	3.89	0.54	0.42	15.27
OECD + BRIIC	AD*	AS*	MP*	Com*	Cred*	All*
GDP	50.99	19.34	14.97	3.96	9.89	99.15
Consumption	48.59	20.01	14.70	5.82	10.43	99.55
Investment	48.17	23.00	18.86	2.41	7.18	99.62
Hours	53.60	12.87	9.03	6.57	17.23	99.30
CPI	74.29	6.92	10.09	2.00	5.92	99.22
Wage	65.46	21.75	7.31	1.03	3.77	99.32
Risk-free rate	86.98	2.51	3.09	1.78	4.86	99.22
Spread	8.42	26.80	2.24	2.32	59.56	99.34
(World) Commodity Price	43.62	15.14	12.87	19.35	8.49	99.47

Note: Risk-free rate and spread in levels; Exchange rate in Q/Q growth rate; all other variables in Y/Y growth rates. Stars stand for foreign shocks. See the methodology section of the paper for a description of the shocks classification. The last column is the total contribution of all foreign shocks. South Africa data in the upper panel and the foreign economy (OECD+BRIIC) in the lower panel. Note that the sum of variances does not add up to 100 due to the inclusion of small calibrated measurement errors in the estimation.

G5. MCMC: Correlations and VD with one-step estimation and parameter uncertainty

Table G5.1 Variance decomposition: 90% confidence bands for South Africa-US

	AD*	AS*	MP*	Com*	Cred*	All*
GDP	[7.75, 16.76]	[1.38, 2.79]	[0.95, 2.53]	[3.20, 7.95]	[2.08, 4.57]	[17.64, 31.23]
Employment	[10.14, 21.27]	[1.07, 2.32]	[1.31, 3.39]	[4.22, 10.30]	[2.01, 4.83]	[21.71, 37.54]
Consumption	[1.91, 4.76]	[0.62, 1.92]	[0.44, 1.31]	[1.72, 4.72]	[1.15, 2.86]	[6.87, 13.87]
Investment	[1.16, 4.97]	[2.10, 6.74]	[0.78, 2.56]	[1.28, 4.59]	[3.17, 8.64]	[10.47, 24.17]
Exports	[14.68, 28.99]	[1.30, 2.92]	[0.78, 3.69]	[2.39, 6.49]	[3.10, 6.16]	[25.29, 44.20]
Imports	[0.99, 4.07]	[1.02, 3.30]	[0.25, 1.10]	[0.37, 2.09]	[0.50, 1.72]	[4.44, 9.64]
Mining exports	[2.71, 8.64]	[1.37, 3.68]	[0.40, 1.35]	[0.52, 1.95]	[3.11, 8.14]	[9.07, 21.99]
Mining Empl	[7.37, 21.38]	[2.67, 6.86]	[1.27, 3.82]	[1.49, 5.22]	[5.33, 13.76]	[20.98, 46.23]
CPI	[12.03, 25.50]	[1.38, 3.74]	[0.97, 2.56]	[2.24, 7.29]	[3.24, 8.58]	[23.42, 41.90]
Wage	[5.76, 13.20]	[1.11, 2.36]	[0.86, 2.34]	[2.62, 6.68]	[1.54, 3.73]	[13.74, 25.60]
Risk-free rate	[12.51, 28.50]	[2.41, 6.24]	[0.88, 2.44]	[2.09, 7.29]	[5.51, 12.96]	[28.59, 49.88]
Spread	[8.31, 20.14]	[1.46, 4.71]	[0.99, 2.93]	[19.34, 39.55]	[5.76, 12.83]	[41.73, 69.51]
Exchange rate	[0.07, 0.98]	[1.31, 4.32]	[2.77, 6.40]	[0.02, 0.40]	[1.24, 3.81]	[6.75, 13.71]
US GDP	[43.08, 60.55]	[12.80, 23.28]	[9.08, 17.36]	[7.55, 16.69]	[3.04, 8.38]	[99.42, 99.64]
US Hours	[42.91, 59.04]	[15.34, 25.56]	[8.99, 17.20]	[7.69, 16.70]	[1.94, 5.49]	[99.53, 99.72]
US Consumption	[42.26, 61.56]	[12.19, 22.68]	[11.49, 21.87]	[6.24, 13.52]	[2.73, 7.56]	[99.53, 99.73]
US Investment	[32.51, 50.54]	[16.73, 28.45]	[5.65, 11.72]	[12.84, 29.29]	[3.74, 9.76]	[98.95, 99.38]
US CPI	[45.48, 63.61]	[8.54, 16.76]	[12.70, 25.47]	[5.18, 14.26]	[2.93, 6.97]	[99.58, 99.79]
US Wage	[17.07, 37.15]	[45.14, 70.21]	[5.76, 14.75]	[1.63, 5.65]	[0.99, 2.86]	[99.29, 99.58]
US Risk-free rate	[62.92, 80.77]	[2.07, 4.62]	[3.57, 8.68]	[5.65, 16.67]	[3.80, 10.21]	[97.81, 98.87]
US Spread	[3.72, 12.41]	[5.14, 12.52]	[0.66, 2.65]	[63.57, 80.99]	[5.77, 13.40]	[98.91, 99.37]
Commodity Price	[24.85, 42.18]	[8.05, 15.12]	[5.44, 11.38]	[4.79, 10.81]	[28.79, 50.37]	[99.05, 99.42]

Note: Risk-free rate and spread in levels; Exchange rate in Q/Q growth rate; all other variables in Y/Y growth rates. Stars stand for foreign shocks. See the methodology section of the paper for a description of the shocks classification. The last column is the total contribution of all foreign shocks. We compute 90% confidence bands. From a MCMC chain of 200 000 draws, we burn the first half and then select 1 000 draws with equal spacing.

Table G5.2 Variance decomposition: 90% confidence bands for Canada-US

	AD*	AS*	MP*	Com*	Cred*	All*
GDP	[18.32, 32.04]	[1.64, 3.30]	[1.21, 3.43]	[4.70, 12.38]	[2.18, 5.08]	[32.30, 49.82]
Employment	[20.24, 34.36]	[1.40, 2.81]	[1.35, 3.84]	[5.24, 13.44]	[2.02, 5.25]	[34.76, 52.70]
Consumption	[6.60, 16.22]	[1.01, 3.33]	[1.09, 3.39]	[3.51, 9.43]	[4.66, 11.24]	[20.79, 37.33]
Investment	[1.72, 8.20]	[2.30, 6.85]	[1.11, 3.59]	[1.92, 8.43]	[4.31, 11.03]	[15.08, 31.27]
Exports	[24.88, 41.44]	[2.15, 5.56]	[0.20, 2.48]	[2.97, 8.59]	[5.56, 12.25]	[41.78, 60.44]
Imports	[1.38, 4.53]	[1.79, 5.61]	[0.53, 2.18]	[0.91, 4.84]	[1.39, 4.21]	[7.97, 18.01]
Mining exports	[1.20, 4.98]	[0.75, 2.74]	[0.20, 0.79]	[0.22, 1.15]	[1.33, 5.25]	[4.01, 13.81]
Mining Empl	[5.92, 19.63]	[1.41, 4.49]	[0.88, 3.28]	[1.03, 4.65]	[3.40, 11.79]	[13.97, 40.21]
CPI	[17.63, 34.19]	[2.25, 6.27]	[1.29, 3.39]	[2.82, 11.85]	[5.35, 14.66]	[36.94, 58.64]
Wage	[12.54, 26.98]	[2.82, 7.75]	[1.33, 3.50]	[2.40, 9.44]	[6.19, 15.31]	[32.20, 52.37]
Risk-free rate	[14.84, 31.99]	[3.39, 9.53]	[0.94, 3.02]	[2.32, 10.87]	[8.84, 23.12]	[39.31, 64.17]
Spread	[9.86, 23.84]	[2.56, 9.30]	[1.13, 3.92]	[8.01, 23.01]	[14.84, 32.01]	[48.98, 72.38]
Exchange rate	[0.31, 2.44]	[2.27, 7.92]	[8.59, 16.58]	[0.04, 0.78]	[3.46, 10.88]	[18.04, 32.18]
US GDP	[47.38, 64.61]	[11.49, 21.10]	[8.47, 17.23]	[6.32, 15.76]	[2.59, 7.42]	[99.42, 99.66]
US Hours	[46.34, 61.79]	[14.74, 25.16]	[8.23, 16.99]	[6.21, 15.64]	[1.73, 4.84]	[99.55, 99.73]
US Consumption	[46.99, 65.80]	[11.63, 21.85]	[10.58, 21.69]	[4.49, 11.35]	[2.15, 6.12]	[99.52, 99.73]
US Investment	[34.14, 52.87]	[14.58, 26.21]	[5.37, 11.57]	[11.60, 32.03]	[3.62, 9.82]	[98.98, 99.42]
US CPI	[44.23, 62.10]	[8.28, 16.67]	[12.02, 25.09]	[5.35, 17.74]	[3.28, 8.84]	[99.59, 99.80]
US Wage	[15.81, 35.17]	[45.27, 70.97]	[5.71, 13.87]	[1.83, 8.01]	[1.46, 4.67]	[99.27, 99.59]
US Risk-free rate	[56.14, 76.43]	[2.31, 4.73]	[3.79, 8.85]	[6.23, 22.57]	[4.30, 13.97]	[97.78, 98.79]
US Spread	[5.27, 14.96]	[4.88, 12.30]	[0.71, 2.95]	[61.23, 80.24]	[5.17, 13.13]	[99.15, 99.54]
Commodity Price	[27.60, 45.36]	[7.84, 14.31]	[5.11, 11.68]	[3.83, 10.52]	[27.27, 49.39]	[99.07, 99.45]

Note: Risk-free rate and spread in levels; Exchange rate in Q/Q growth rate; all other variables in Y/Y growth rates. Stars stand for foreign shocks. See the methodology section of the paper for a description of the shocks classification. The last column is the total contribution of all foreign shocks. We compute 90% confidence bands. From a MCMC chain of 200 000 draws, we burn the first half and then select 1 000 draws with equal spacing.

Table G5.3 Correlation between domestic variables and foreign GDP, cmdty prices and spread: 90% confidence bands

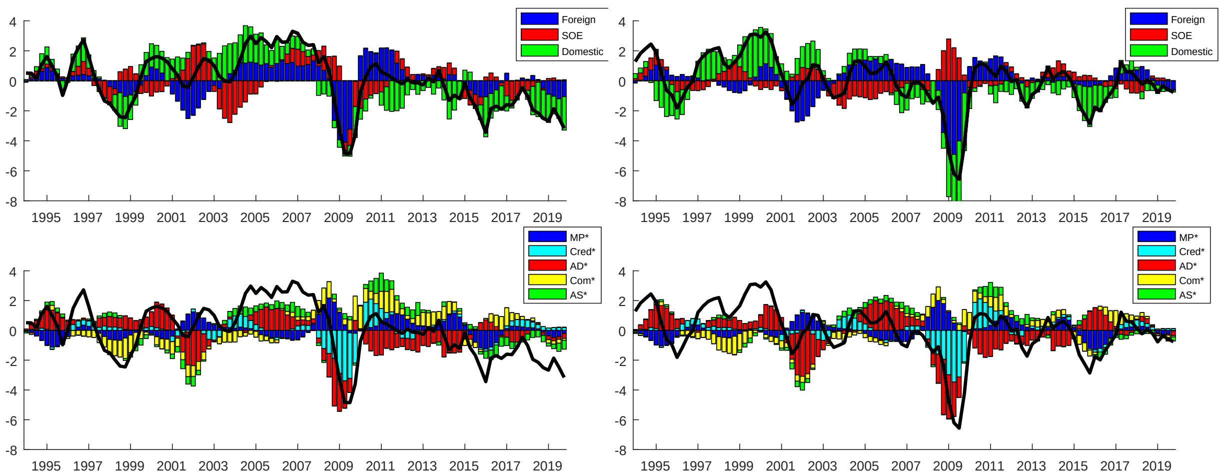
	Corr(x,GDP*)		Corr(x,CP*)		Corr(x,spr*)	
South Africa	Data	DSGE	Data	DSGE	Data	DSGE
GDP	0.37	$[0.28, 0.44]$	0.60	$[0.38, 0.52]$	-0.35	$[-0.23, -0.14]$
Employment	0.22	$[0.32, 0.48]$	0.38	$[0.40, 0.54]$	-0.40	$[-0.26, -0.17]$
Consumption	0.41	$[0.09, 0.20]$	0.51	$[0.17, 0.29]$	-0.48	$[-0.17, -0.10]$
Investment	0.14	$[0.00, 0.14]$	0.21	$[0.16, 0.26]$	-0.20	$[-0.26, -0.12]$
Exports	0.53	$[0.37, 0.58]$	0.36	$[0.33, 0.54]$	-0.56	$[-0.20, -0.11]$
Imports	0.46	$[-0.05, 0.10]$	0.49	$[-0.02, 0.15]$	-0.52	$[-0.18, -0.09]$
Mining exports	0.31	$[0.12, 0.27]$	0.54	$[0.25, 0.43]$	-0.40	$[-0.17, -0.11]$
Mining Empl.	-0.17	$[0.25, 0.44]$	0.49	$[0.37, 0.57]$	0.02	$[-0.24, -0.14]$
CPI	-0.22	$[0.09, 0.21]$	-0.13	$[0.14, 0.24]$	0.29	$[-0.33, -0.18]$
Labor compensation	0.25	$[0.25, 0.38]$	0.46	$[0.33, 0.46]$	-0.25	$[-0.17, -0.10]$
Risk-free rate	0.34	$[-0.10, -0.03]$	-0.10	$[-0.06, 0.00]$	-0.09	$[-0.29, -0.09]$
Spread	-0.28	$[-0.17, -0.07]$	-0.48	$[-0.13, -0.05]$	0.64	$[0.62, 0.78]$
Exchange rate	0.02	$[-0.07, -0.02]$	-0.17	$[-0.12, -0.07]$	-0.16	$[0.10, 0.14]$
Canada	Data	DSGE	Data	DSGE	Data	DSGE
GDP	0.78	$[0.44, 0.60]$	0.41	$[0.49, 0.64]$	-0.60	$[-0.30, -0.20]$
Hours	0.75	$[0.46, 0.62]$	0.45	$[0.51, 0.66]$	-0.66	$[-0.25, -0.16]$
Consumption	0.58	$[0.27, 0.44]$	0.60	$[0.39, 0.55]$	-0.51	$[-0.27, -0.17]$
Investment	0.65	$[0.08, 0.28]$	0.59	$[0.23, 0.38]$	-0.55	$[-0.31, -0.16]$
Exports	0.82	$[0.48, 0.70]$	0.25	$[0.27, 0.50]$	-0.67	$[-0.25, -0.12]$
Imports	0.78	$[0.05, 0.27]$	0.65	$[0.07, 0.31]$	-0.64	$[-0.28, -0.15]$
Mining exports	0.65	$[0.09, 0.22]$	0.38	$[0.16, 0.32]$	-0.62	$[-0.18, -0.11]$
Mining Empl.	0.22	$[0.28, 0.48]$	0.44	$[0.37, 0.59]$	-0.24	$[-0.23, -0.14]$
CPI	0.06	$[0.17, 0.29]$	0.43	$[0.16, 0.27]$	-0.07	$[-0.49, -0.33]$
Wage	0.18	$[0.08, 0.20]$	0.05	$[0.07, 0.18]$	-0.15	$[-0.42, -0.26]$
Risk-free rate	0.48	$[-0.07, 0.00]$	0.17	$[-0.07, -0.01]$	-0.32	$[-0.43, -0.24]$
Spread	-0.70	$[-0.21, -0.11]$	-0.39	$[-0.17, -0.07]$	0.75	$[0.57, 0.73]$
Exchange rate	0.00	$[-0.09, -0.02]$	-0.32	$[-0.18, -0.10]$	-0.02	$[0.09, 0.15]$

Note: Risk-free rate and spread in levels; Exchange rate in Q/Q growth rate; all other variables in Y/Y growth rates. Stars stand for foreign variables. South Africa data in the upper panel and Canada in the lower panel. The second column displays the correlation between foreign GDP and domestic variables listed in the first column. The third column shows the correlation between world commodity prices and domestic variables. The fourth column shows the correlation between foreign spread and domestic variables We compute 90% confidence bands. From a MCMC chain of 200 000 draws, we burn the first half and then select 1 000 draws with equal spacing.

G6. Historical decomposition

Figure G6. Historical Decomposition:

(a) South African GDP (b) Canadian GDP



Historical decomposition shows the role that structural shocks have played during key episodes. Figure G6 displays the historical decomposition for GDP in South Africa and Canada. The upper panels highlight the contributions of domestic, foreign, and UIP (SOE) shocks. The lower panels we present a detailed analysis across foreign shocks. Adverse commodity price shocks of the late 1990s (that coincided with the Asian financial crisis of 1997) had a negative impact on GDP growth in South Africa and Canada. In this period, South Africa also suffered from a Rand crisis. The SARB responded by tightening its monetary policy: the policy rate increased by almost 700 basis points in the space of six months, which contributed to amplifying the crisis. In contrast, domestic developments were supportive for activity in Canada. In the early 2000's, the burst of the dot-com bubble weighted on growth in South Africa and Canada with a negative contribution of foreign aggregate demand shocks. In the recovery phase that followed, strong foreign demand contributed to the sustained growth in these economies. The global financial crisis (GFC) of 2007/2008 and the great recession that followed translated into the largest drop in South African and Canadian GDP growth via adverse foreign aggregate demand and credit shocks, and their associated effects on commodity demand. Even though foreign monetary policy was accommodative, the total contribution of foreign shocks to domestic (year-on-year) GDP growth sunk to -4% in both economies at the depth of the GFC. Subsequently, favorable commodity supply shocks - together with positive monetary and credit supply shocks that possibly capture the impact of quantitative easing - contributed to the 2011 recovery before the recent commodity price reversal (with the contribution of foreign commodity supply shocks reaching a trough in 2015). The contribution of foreign monetary policy, which was accommodative until then, later turned into negative effects when the Fed started to increase its interest rate in late-2015. South African specific factors also contributed to the low GDP growth since 2015, while Canadian specific shocks contributed the low growth registered in 2016.

G7. Commodity supply channel sensitivity: Canada vs South Africa

In this section, we explain the stronger contribution of the commodity supply channel in South Africa compared to Canada. As explained in appendix C.2.1, the domestic commodity supply channel and the price-elasticity of commodity supply are closely related to three parameters: the elasticity of substitution between production factors in the primary sector σ_p, the labor share $\gamma_p = 1 - \alpha_p - \beta_p$, and the capital share α_p. We obtain the following values for Canada and South Africa:

Table G7: Commodity supply in South Africa and Canada

Selected parameters		South Africa	Canada
Factor substitutability	σ_p	0.21	0.15
Capital share	α_p	0.37	0.45
Land share	β_p	0.26	0.32
Labor share	γ_p	0.37	0.23

Table G7 shows that the factor substitutability and labor shares are lower in the Canadian commodity sectors. From equation (24), we know that these two differences will contribute to a lower short-run price-elasticity of commodity supply in Canada. In the medium to long-run, this elasticity is also positively affected by the capital share. Since the capital share is higher in Canada, this could mitigate this difference.

In order to understand the relative importance of each of these parameters, we perform a sensitivity analysis by varying sequentially their values. Starting from South African parameter values, we sequentially decrease the factor substitutability, decrease the labor share, and increase the capital share. We then contrast these different scenarios to the case where the commodity supply channel is fully-closed (σ_p). The gap between these different scenarios and the closed commodity supply channel case shows by how much varying these parameters affect the contribution of the commodity supply channel. Of course, the capital, land and labor shares must always sum to one ($\alpha_p + \beta_p + \gamma_p = 1$). When we vary the capital or labor share, we thus adjust the land share β such that $\beta_p = 1 - \alpha_p - \gamma_p$.

Figure G7 shows that the contribution of the commodity supply channel is sensitive to changes and these parameters. In black, we plot the impact of a foreign aggregate demand shock in South Africa in the baseline. In grey, we close the commodity supply channel ($\sigma_p = 0$). The difference between the black and grey lines shows the contribution of the commodity supply channel in South Africa. As detailed in the paper, an increase in commodity prices raises commodity supply and investment. This effect, that we label the commodity supply channel, strongly contributes to the increase in GDP in South Africa.

In dashed-blue, we lower the elasticity of substitution between land, labor and capital to the value obtained for Canada ($\sigma_p = 0.15$ instead of 0.21). The lower elasticity weakens the strength of the commodity supply channel. Indeed, decreasing the elasticity of substitution between production factors in commodity supply (in blue) mitigates the increase in commodity supply and investment. Visually, for GDP, the gap between the blue and grey lines is smaller than the gap between the black and grey lines: the commodity supply channel gets weaker when we decrease the factor substitutability.

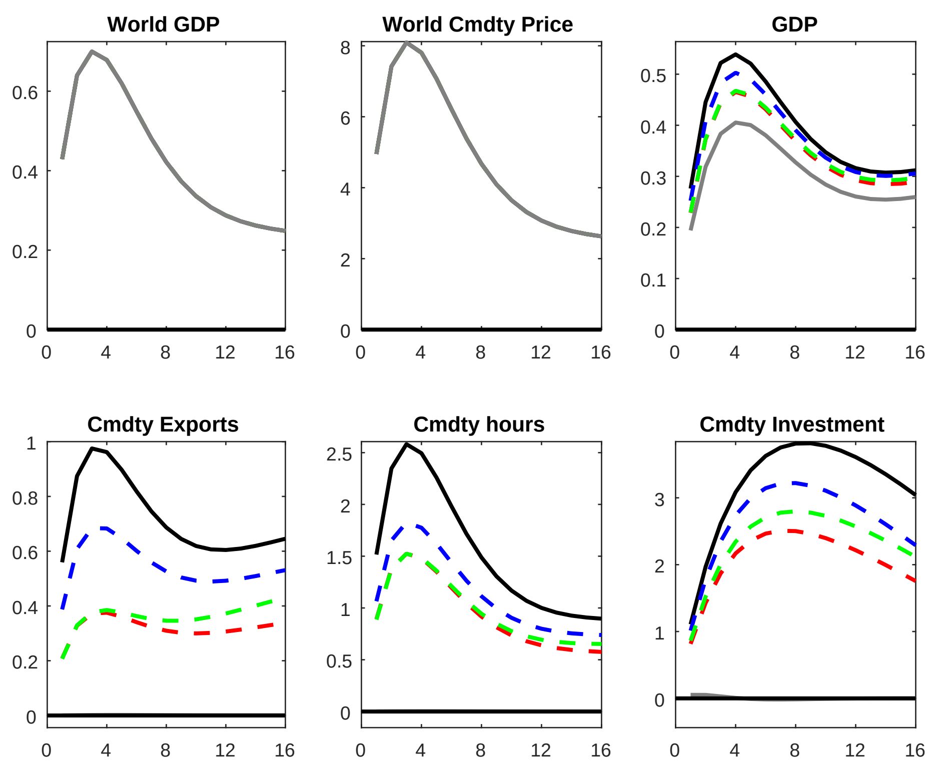
In dashed-red, we lower the labor share ($\gamma_p = 0.23$ instead of 0.37) while keeping a low factor substitutability ($\sigma_p = 0.15$). The difference between the blue and red-dashed lines shows that a smaller labor share further weakens the strength of the commodity supply channel. Indeed, the increase in commodity supply and investment is further reduced, and the gap between the red and grey line gets thinner.

In dashed-green, we increase the capital share ($\alpha_p = 0.45$ instead of 0.37) while keeping the lower factor substitutability and labor share. In this case, the commodity sector is fully calibrated to Canadian values (while all other parameters remain set to South Africa). The difference between the green and red-dashed lines shows that increasing the capital share amplifies the impact of the commodity supply channel in the medium and long-run. However, this only contributes marginally to the different strength of the commodity supply channel in South Africa compared to Canada.

In conclusion, the elasticity of substitution between land, labor and capital (σ_p) and the labor share ($1 - \alpha_p - \beta_p$) play important roles. They explain the different contribution of the commodity supply channel in Canada and South Africa and dominate the effect of a different capital share.

Figure G7 - Foreign aggregate demand shocks and the commodity supply channel

Note: Variables expressed in percentage deviation from steady-state. Horizon in quarters.
Black: All parameters calibrated to South Africa ($\sigma_p = 0.21$, $\alpha_p = 0.37$, $\beta_p = 0.26$, $\gamma_p = 0.37$).
Dashed-blue: Reduced elast. of subst. btw prod. fact. ($\sigma_p = 0.15$, $\alpha_p = 0.37$, $\beta_p = 0.26$, $\gamma_p = 0.37$).
Dashed-red: Reduced labor share ($\sigma_p = 0.15$, $\alpha_p = 0.37$, $\beta_p = 0.40$, $\gamma_p = 0.23$).
Dashed-green: Increased capital share ($\sigma_p = 0.15$, $\alpha_p = 0.45$, $\beta_p = 0.32$, $\gamma_p = 0.23$).
Grey: Closed commodity supply channel ($\sigma_p = 0$, $\alpha_p = 0.37$, $\beta_p = 0.26$, $\gamma_p = 0.37$). *All other parameters calibrated to South Africa.*



G8. Foreign demand shocks and the Canadian trade structure

Why do foreign shocks explain a larger share of macroeconomic fluctuations in Canada than in South Africa? To answer this question, we explore four potential explanation. First, while the commodity export to GDP ratio is (almost) identical in these two economies, the final good export to GDP ratio is larger in Canada. Canada is relatively more open than South Africa, with larger shares of imports in consumption and investment (and a slightly large share of imported inputs) as described in table G8. Second, looking at the estimated parameters' mode reported in the paper, we can see that domestic and import prices tend to be more rigid in Canada. Third, Taylor rules are also different, with stronger but delayed responses to GDP and inflation in Canada. Of course, some other parameters also played a role, but we here focus on these three important sets of parameters. Finally, domestic shocks tend to be larger in South Africa.

Table G8: Trade, price stickyness, and monetary policy

Trade structure		South Africa	Canada
Share of imports in consumption	ω_c	0.08	0.10
Share of imports in investment	ω_i	0.49	0.58
Share of foreign inputs in final good	ω_n	0.16	0.16
Share of final good exp. in GDP	$\frac{x^f}{y}$	0.18	0.23
Price stickyness		**South Africa**	**Canada**
Calvo final good (domestic)	ξ_d	0.76	0.87
Calvo final good impots	ξ_m	0.80	0.88
Calvo inputs imports	$\xi_{m,n}$	0.81	0.77
Calvo exports	ξ_x	0.80	0.66
Monetary policy		**South Africa**	**Canada**
Interest rate smooth.	ρ_r	0.89	0.92
CB inflation resp.	τ_π	1.88	2.08
CB NEER resp.	$\tau_{\Delta s}$	0.13	0.12
CB GDP growth resp.	$\tau_{\Delta y}$	0.37	0.42

Figure G8.1 shows the impact of an aggregate foreign demand shock in Canada (in black) and in South Africa (in grey) when parameters are set at their posterior modes. On impact, foreign shocks have a larger impact on Canada. Starting from the Canadian case, we perform a sensitivity analysis by sequentially setting the value of some parameters to the values obtained in South Africa.

First, in dashed-blue, we decrease the final good export to GDP ratio in Canada from 0.23 to 0.18 (which is the value of this ratio in South Africa). For this purpose, and because import and exports must balance each other's at steady-state, we increase the shares of imports in consumption (ω_c), investment (ω_c), and production(ω_c). As expected, this experiment reduces the impact of foreign aggregate demand shocks. Surprisingly, the magnitude of this impact is relatively modest. There are two reasons for this result: (1) South Africa is also relatively open and the difference in the final good export to GDP ratio is quite small, and (2) SOE-DSGE that rely on the final good trade channel have difficulties in explaining international spillovers. So, because our model extends the baseline SOE-DSGE in other dimensions than trade in final goods, we may be underestimating the final good trade channel.

Second, in dashed-red, we additionally set all Calvo stickiness parameters as in South Africa. This experiment increases CPI volatility. The central bank responds to the increase in prices by raising interest rates, which mitigates the increase in consumption of patient households. The increase in CPI also temporarily lowers real wages, and the increase in rule-of-thumb households' consumption is also mitigated. Note that investment volatility is not reduced, because the (unexpected) stronger increase in CPI lowers the value of entrepreneurs' debt and increases their incomes, which lowers the spread.

Third, in dashed-red, we adjust the Taylor rule (we assume that the central bank of Canada follows the same rule as the central bank of South Africa). In this case, the interest rate adjustment is faster, which slightly mitigates the increase in consumption. Overall, after adjusting the final good trade ratio, the Phillips curves, and the Taylor rule, we find that the GDP increase gets weaker than in South Africa. The responses in final good exports, investment, and consumption gets similar, but the weaker domestic commodity supply channel (described in the previous section) explains the difference between the dashed-green and grey IRFs.

Finally, with figure G8.2, we illustrate the fact that domestic shocks tend to be larger in South Africa than in Canada. The smaller domestic shocks in Canada also contribute the larger share of foreign shocks this economy.

Figure G8.1 - Foreign aggregate demand shocks in Canada and South Africa

Note: Variables expressed in percentage deviation from steady-state. Horizon in quarters.
Black: Canada.
Dashed-blue: Black + decreased final good export to GDP ratio (ω_c, ω_i, ω_n as in South Africa)
Dashed-red: Blue + adjusted Phillips curves (more volatile CPI with ξ as in South Africa)
Dashed-green: Red + adjusted Taylor rule (faster adjustment with τ and ρ_r as in South Africa)
Grey: South Africa.

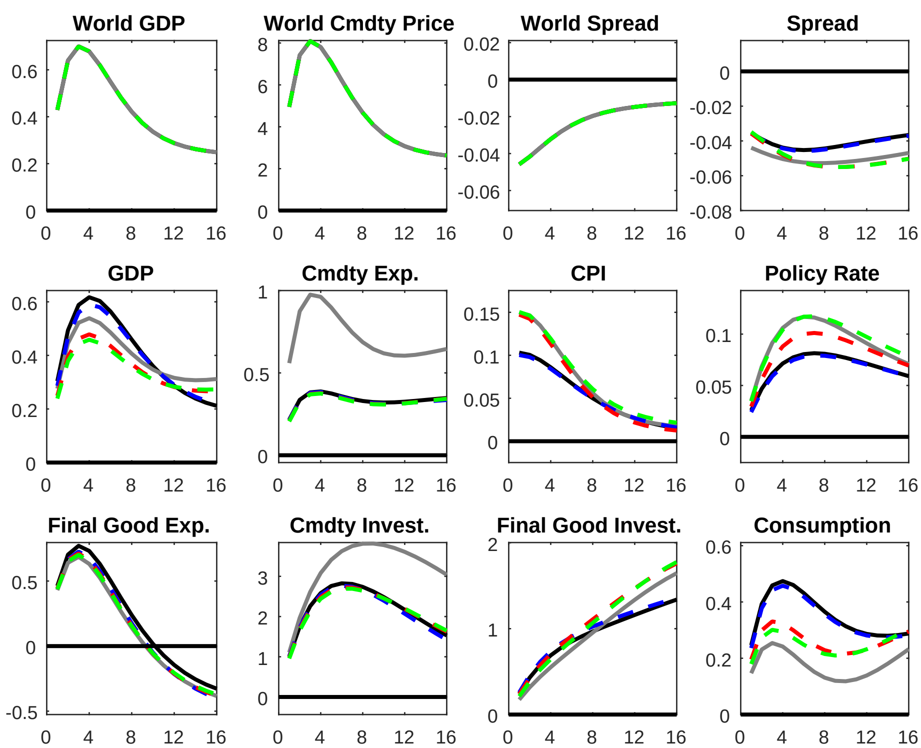
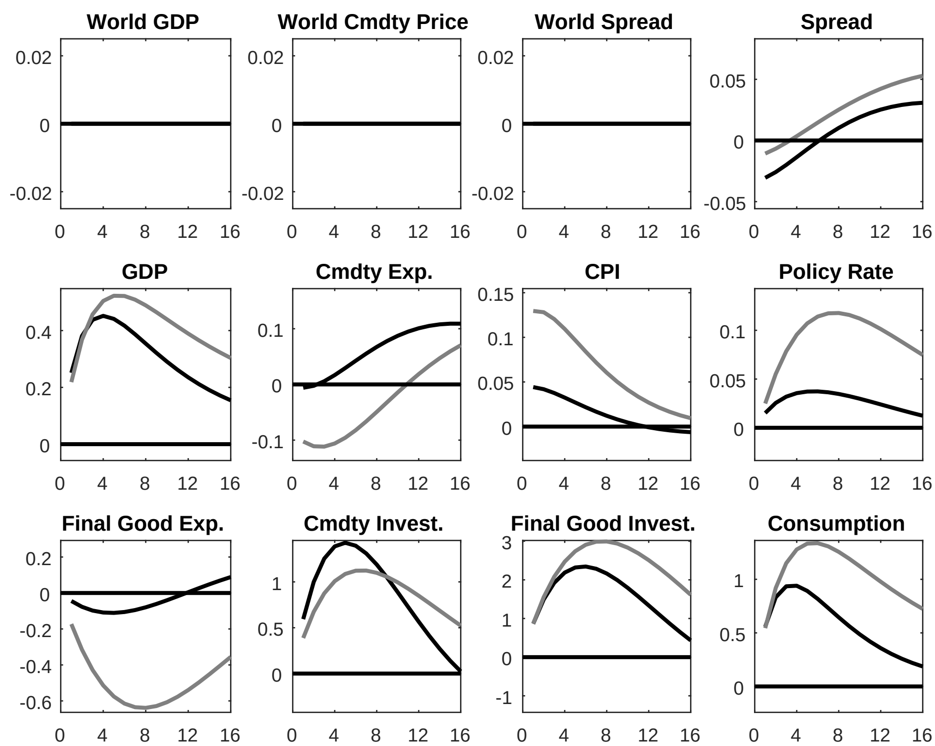


Figure G8.2 - Domestic aggregate demand shocks in Canada and South Africa

Note: Variables expressed in percentage deviation from steady-state. Horizon in quarters.
Black: Canada.
Grey: South Africa.



G9. Country-specific commodity prices (versus world commodity price) and commodity production (versus commodity exports)

We discuss two additional robustness checks as requested. First, initially we impose identical commodity prices in the foreign and domestic economies to simplify the analysis. We now estimate the model with the Canadian and South African aggregate commodity price indexes (in place of the world price index).

Second, we use data on commodity production instead of commodity exports. For South Africa, we use mining production volumes (Stat SA). For Canada, we use a weighted average of mining, oil, and gas extraction (Stat Can, weight = 0.62) and agriculture, forestry, fishing, and hunting contributions to GDP (weight = 0.38). The weights are based on their relative shares in commodity exports.

The results of these two robustness checks for each of the countries are presented below. They show that our results remain qualitatively unchanged:

Table G9. Variance decomposition of foreign shocks with country-specific commodity prices and commodity production compared to baseline results

	CAN baseline	CAN price	CAN prod	SA baseline	SA price	SA prod
GDP	40.94	38.71	39.68	26.54	23.81	25.10
Employment	43.87	41.68	42.95	31.20	28.84	28.72
Consumption	32.95	27.93	31.04	12.27	10.39	10.98
Investment	24.09	19.21	24.66	20.09	15.25	19.42
Exports	45.13	46.68	46.65	34.23	33.80	34.26
Imports	12.64	10.89	12.46	8.15	6.79	9.62
Mining exp.	9.98	9.78	10.54	19.05	17.48	11.07
Mining Empl	26.54	28.64	24.55	37.47	36.45	16.72
CPI	48.24	44.10	48.75	32.77	30.00	36.09
Wage	44.34	40.55	43.87	21.60	19.72	16.75
Risk-free rate	52.79	46.62	51.18	39.43	36.34	41.68
Spread	66.63	54.80	69.51	59.55	53.38	64.81
NEER	26.26	21.34	27.26	13.98	10.80	14.62

Note: Risk-free rate and spread in levels; Exchange rate in Q/Q growth rate; all other variables in Y/Y growth rates. Stars stand for foreign shocks. See the methodology section of the paper for a description of the shocks classification. The last column is the total contribution of all foreign shocks.
CAN price = Canadian country-specific commodity price used instead of world commodity prices.
CAN prod = Canadian commodity production used instead of commodity exports.
SA price = South African country-specific commodity price used instead of world commodity prices.
SA prod = South African commodity production used instead of commodity exports.

H. SOE assumption for Canada and South Africa

In the model, we assume that the domestic economy supply is too small to influence world commodity prices. This assumption is likely to hold looking at South African market shares in commodity exports such as gold (4.9% in 2019, data from the Observatory of Economic Complexity), diamonds (2.3%), coal briquettes (4%), iron ore (5.4%), aluminum (2.1%) and ferroalloys (10.9%). The only exceptions are platinum (23.6% in 2019, with a peak of 37.3% in 2015) and manganese ore (41.3%), but the latter has a relatively low weight in total South African exports (2.9% of total merchandise exports). Canada's market shares are also relatively low for exports of mineral fuels and oils (4.5%, or 6.9% for crude petroleum only), wood (8.5%), cereals (6.4%) and metals such as aluminum (4.7%), iron and steel (1.6%) or gold (4.3%). More broadly, Broda (2004) tests the terms of trade exogeneity assumption on a sample of 1000 goods in 75 developing countries. He finds that only 22 goods from 9 countries violate this assumption.

I. Calibration and estimation of standard parameters

Calibrated parameters A first subset of standard parameters are calibrated following the literature. The mark-ups parameters in the final good and labor markets (ϵ_d and ϵ_w) are set to 1.14 (equivalent to elasticities of demand across varieties of goods and labor inputs of 8) following JP. The depreciation rate of capital (δ) is set to 0.02 (in between the values used in ALLV and SW). When estimating the model, the capital income share in the primary and final good sectors (α_p and α) are calibrated to match the observed investment to GDP ratio, and the steady-state value of government spending ($\bar{g}$) is set to match the public consumption to GDP ratio. In the calibrated variant, we target ratios of 0.2 for both the investment and public consumption to GDP ratios (which is close to their empirical average in the US, Canada and South Africa). We fix the shares of imports in household consumption ω_c, investment ω_i and domestic production ω_n, and the share of commodities in imported inputs ω_p based on the methodology proposed by Kose (2002) and UNCTAD trade data. Taken together, those values imply an import-to-GDP ratio of about 34 and 29% as observed in Canada and South Africa.

Estimated parameters For standard parameters, we follow the literature when building our priors and set identical priors in the domestic and foreign economies. We set the price and wage contract parameters (ξ_d, ξ_w, ξ_x, ξ_m, and $\xi_{m,n}$) to 0.75 following Erceg et al. (2000). The wage indexation parameter (κ_w) is set to 0.5 as in JP. Habit (b) is set to 0.7 as in SW and the inverse of the inter-temporal elasticity of substitution for consumption (σ_c) is set to 1 as in JP. The investment adjustment (ϕ_i) cost is set to 3.5, close to the prior and posterior's mode in ALLV. The elasticity of substitution between domestic and foreign (consumption and investment) goods in the domestic economy (η) is set to 0.9 as in JP, and we use an identical value in the foreign economy (η_f) and for the elasticity of substitution between domestic and foreign inputs (η_n). For the Taylor rule, we set the inflation (τ_π) and output growth ($\tau_{\Delta y}$) responses to 1.8 and 0.3 respectively as in JP. We set the exchange rate response ($\tau_{\Delta s}$) to 0.125. This value is much smaller than the prior in JP, but is close the values reported in Lubik and Schorfheide (2007) and Ortiz and Sturzenegger (2007) that estimate the response of the South African and Canadian central banks. We set the interest rate smoothing parameter (ρ_r) to 0.8, close to the posterior mode in SW. Also note that a Taylor rule is consistent with the adoption of inflation-targeting which formally started in 2000 in South Africa, and in 1991 in Canada. Finally, priors' means of the autoregressive coefficients of shocks are all equal to 0.8.

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