When Economic Recovery is Valued: a Case for Expansionary Fiscal Policy in Open Economies

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Abstract

We show quantitatively that an expansionary fiscal policy that considers future borrowing can be a tool valued by individuals to stabilize open economies subject to infrequent but severe shocks in a flexible exchange rate context. We assume that fiscal spending is reused as subsidies to boost private spending and replace the selfish preferences with preferences in which households value economic recovery after a severe shock. These seemingly unrelated conditions jointly allow an expansionary fiscal policy to produce a genuine recovery of the economy and, in welfare terms, to outperform not only passive-rule monetary policy, but also an arbitrarily expansionary monetary policy. Thus, a faster recovery would be preferable to targets such as inflation and/or debt, which can still be maintained, but to preserve long-term stability.

JEL Codes: D91, F31; F32; F37; F41; F44, F47.

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Introduction

The contribution of our article is to show quantitatively in a group of open economies some apparently unconnected conditions that jointly cause that an increase in fiscal spending, adequately financed in the future, used to deal with infrequent but severe external shocks not only produces a genuine recovery of the economy but is also superior to monetary policy in terms of welfare. The conditions we explore are the following: first, whether the increase in fiscal spending is reused as subsidies to stimulate private spending and, second, whether the economic recovery produced by fiscal policy is valued by households and, thus, included in their preferences.

In general terms, the macroeconomic mechanism and welfare impact underlying these conditions is straightforward and can be summarized succinctly. First, instead of assuming that the increase in government spending is completely useless, it can be assumed that a percentage can be transferred in the form of different types of subsidies to households and investors. So that these differentiated subsidies partially offset the increase in the interest rate in relative prices (crowding-out effect) that these agents consider when making their intertemporal decisions and directly on the spending of financially constrained households.

Second, the expansion of the economy could produce a cost in welfare: the increment in labor may reduce the welfare of optimizing households because, these households are still able to smooth their consumption more than constrained households. On the contrary, if we consider that the utility function incorporates the valuation of the recovery of the economy, the aforementioned cost is compensated because now the difference between consumption and labor is widened by the economic recovery and, therefore, the welfare of optimizing households also increases.

Both conditions operate in tandem to produce a genuine recovery of the economy, i.e., neither condition alone is sufficient to achieve this recovery. To the extent that subsidies help maintain private investment and consumption of restricted households, the valuation of the recovery in consumption of optimizing households boosts this spending and vice versa.

We show numerically for different cases (different types of utility, absence or not of the social component in the utility function, and different subsidy alternatives, including the absence of subsidies) that it is this joint mechanism that ensures a recovery of the economy (and is formalized in proposition 2).

We find that the simultaneous increase in welfare in both types of households that is achieved with fiscal policy has two characteristics: (i) it cannot be obtained with an expansionary monetary policy or a standard Taylor rule because both (in different types of utility functions) tend to benefit only optimizing agents, and (ii) the increase in welfare is similar to that which would be obtained in a hypothetical case of flexible prices, without restricted households, with or without consideration of the economic recovery in preferences, without any type of fiscal and monetary policy, and with households internalizing the cost of external indebtedness (the Pareto constrained equilibrium).

In more concrete terms, and in conjunction with a series of targeted subsidies that alter marginal consumption and investment decisions, we propose to add to the difference between consumption and labor a measure of the state of the economy to represent the valuation of the recovery in a standard GHH utility function (initially proposed by Mendoza (1991) and lately extended by García-Cicco, Pancrazi, and Uribe (2010) to analyze open economies) and, in this way, reinforce the mechanism that characterizes this function: a lower disutility of labor, which in terms of labor supply translates into the absence of the wealth effect to replicate the volatility observed in open economies (see proposition 1).

The rationale for including this indicator of economic recovery in the GHH function comes from the behavioral economics literature. Schmidt (2011) points out that in the case of aggregate risk and incomplete financial markets, it is feasible to assume that social preferences do not behave as if they were purely selfish. In an economy in which agents can be fully insured, concern for other agents is left to insurance, and the selfish preferences would be appropriate. In the absence of such insurance, however, the GHH utility function could include an indicator of the state of the economy that represents at the macroeconomic level concepts such as strong reciprocity (see Bowles and Gintis (2011), and Bowles (2012)) and inequity aversion (Ferh and Schmidt (1999)).

Despite the rationality of including this social component in the utility function, the question remains to what extent the new assumption of the utility function is realistic and, if so, its policy implications. In case of crisis, there is circumstantial evidence that the population has repeatedly demanded a more active government policy to regain full employment, and governments strive to meet these demands, as in the case of COVID (OCDE (2020)) or the 2008 international financial crisis (Schwartz, Andres, and Dragoiu (2009)). Thus, the GHH preferences with a social component could be consistent with this informal evidence relative to the purely selfish preferences. This point is controversial, since there is abundant literature indicating that collective actions occur if and only if individuals receive some benefit (Olson (1971)). However, more recently, there is evidence from neuroeconomics that would support this social component, as it has been found that economic rationality is moderated by social rationality (Declerck and Boone (2015)), that is, by the valuation of belonging to a group, having networks and avoiding ostracism. Elements that can be preserved by a genuine economic recovery through policies, as there are a number of distortions and externalities that limit and hinder cooperation in crisis circumstances.

If so, we conclude that expansionary fiscal policy implemented in a precise manner would prove to be a more valued response by the population to cope with an externally induced shock and thus return to full employment than simple rules that ensure compliance with limited targets such as inflation or debt control, although these are still necessary to ensure medium and long-term stability.

Although the macroeconomic mechanism is simple, novel, and could potentially be present in cases of severe but infrequent external shocks, it has important limitations. First, the social component in the preferences is still a reduced element, so more research on its connection with the rest of the model and empirical corroboration are needed. Second, the segmentation between restricted and optimizing households is an important simplification that can be substantially improved by incorporating a more realistic structure of heterogeneous agents. Third, the feasibility of the proposed subsidies should be further analyzed in terms of transfers to households and public investment. We hope to advance future research on these limitations and issues.

Finally, in terms of methodological aspects, the average size model used in the quantitative analysis is calibrated nonlinearly with parameters estimated from a linearized version of the same model (we implicitly assume that in normal times the shocks are moderate and frequent, and we can thus recover the microfounded parameters) for several countries: Australia, Canada, Chile, Colombia, Mexico, and New Zealand. The medium-sized model has several standard features, including price and wage rigidity, restricted agents, use of endogenous capital, and adjustment costs at different levels. This imposes a strong challenge: omitting certain structures or overemphasizing others may ultimately bias the results in favor of the study's central hypothesis.

Therefore, we introduce a wide range of available structures that have been developed in the literature in recent years to understand the dynamics of open economies and to be as accurate as possible in measuring welfare effects: (i) financial frictions and country risk premium (Gertler, Gilchrist and Natalucci (2007); Céspedes, Chang and Velasco (2004); and Schmitt-Grohé, and Uribe (2003)); (ii) an international liquidity shock in the uncovered interest rate parity (UIP) (Bräuning and Ivashina (2020); Itskhoki and Mukhin (2019); and Gabaix and Maggiori (2015));[1] (iii) exports that are fixed in dollars in international markets and also independent of the currency in the destination market (Gopinath et al (2020) and Devereux and Engel (2003)); and (iv) delayed portfolio adjustment (Bacchetta and van Wincoop (2019)).

The paper is organized as follows. Section 1 presents the medium-sized model. The results of the simulations of this model are summarized in section 2. We conclude of the study in section 3.

[1] See also Miranda-Agrippino and Rey (2020); Di Giovanni and others (2017); Bruno and Shin (2015); Razin (2014), chapter 8; Bekaert and others (2013); and Rey (2013).

1 Model

1.1 Households

The model considers a continuum of family units, indexed by $i \in [0,1]$. There are two types of families: a fraction $(1-\lambda_c)$ of families has access to the national and international capital markets, and a fraction λ_c is restricted to income from work. Preferences are of two types: the selfish separable preferences and the GHH preferences with a social component.

The selfish separable utility function:

$$\max_{\left\{C_t^o(i), N_t^o(i), B_{t+1}^o(i), B_{t+1}^{o*}(i)\right\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{\left(C_t^o(i) - \gamma C_{t-1}^o\right)^{1-\sigma} - 1}{1-\sigma} - \frac{\Psi N_t^o(i)^{\varphi}}{\varphi} \right]. \tag{1}$$

The GHH utility function with a social component:

$$\max_{\left\{C_t^o(i), N_t^o(i), B_{t+1}^o(i), B_{t+1}^{o*}(i)\right\}_{t=0}^{\infty}} E_0 \sum_{t=0}^{\infty} \beta^t \left[\frac{\left(C_t^o(i) - \gamma C_{t-1}^o + \theta_t - \frac{\Psi N_t^o(i)^{\varphi}}{\varphi}\right)^{1-\sigma} - 1}{1-\sigma} \right], \tag{2}$$

where C_t^o is consumption, N_t^o is the labor supply, σ measures relative risk aversion, $\varphi - 1$ measures the disutility of working, γ measures exogenous habit formation, which depends on the lagged aggregate consumption of Ricardian families, and Ψ is a parameter for calibrating hours worked.

The function θ_t measures the effect of growth on the GHH preferences with a social component, and it assumed that families take this function as given. The explicit form of this function used in the article is:

$$\theta_t = \frac{\theta_{GHH\_1}^S}{1 + e^{-\theta_{GHH\_2}^S \left(\frac{GDP_t}{GDP_{t-1}} - 1\right)}},$$

where the parameter $\theta_{GHH\_1}^S$ is 0.8, which is the maximum value found in the literature (Dhami (2016)), and the parameter $\theta_{GHH\_2}^S$ is 4.0 to express the growth in annual terms.

Thus, the function is around 0.4, which is the average value found in this literature. The specific form selected is a logistic function, so that the social component has an upper limit.

The effect of including the function θ_t in the utility functions is compactly explained in proposition 1.

Proposition 1. (The social component and disutility of labor). The inclusion of the social component measured by the growth of the economy in the GHH utility function further reduces the marginal disutility of labor relative to a selfish separable utility function (or a purely selfish GHH function).

Proof. The marginal disutility of labor in a selfish separable function is (omitting the superscript "o" for consumption and labor of optimizing households):

$$U_t^{N,S} = U_t^{C,S} \frac{dC_t}{dN_t} - \Psi N_t^{\varphi-1} = U_t^{C,S} \left(\frac{dC_t}{dN_t^o} - \frac{\Psi N_t^{\varphi-1}}{U_t^{C,S}} \right),$$

where $U_t^{C,S} = (C_t - \gamma C_{t-1})^{-\sigma}$ is the marginal utility of consumption. In contrast, in a GHH function with a social component the marginal disutility of labor is, without the superscript "o":

$$U_t^{N,GHH\ social} = U_t^{C,GHH\ social} \left(\frac{dC_t}{dN_t} - \Psi N_t^{\varphi-1} \right) + U_t^{C,GHH\ social} \frac{d\theta_t}{dN_t},$$

the term $U_t^{C,GHH\ social} = \left(C_t\left(i\right) - \gamma C_{t-1} + \theta_t\left(i\right) - \frac{\Psi N_t(i)^{\varphi}}{\varphi} \right)^{-\sigma}$ is the marginal utility of consumption in case that the GHH utility function is social.

The difference between the two expressions (in addition that $U_t^{C,GHH\ social}$ is less decreasing than $U_t^{C,S}$) is $U_t^{C,GHH\ social} \frac{d\theta_t}{dN_t} > 0$, therefore, in absolute value we have that:

$$\left| U_t^{N,GHH\ social} \right| > \left| U_t^{N,S} \right|.$$

□

The proposition 1 shows that including the social component encourages households to work more. In other words, households prefer endogenously to work and consume more so that the economy recovers more quickly from a negative shock.

The budget constraint is given by

$$\frac{P_t}{T_t^{S,o}} C_t^o(i) \leq W_t N_t^o(i) + B_t^o(i) - S_t B_t^{o^*}(i) + D_t^o - T_t - \frac{B_{t+1}^o(i)}{R_t} + \frac{S_t B_{t+1}^{o^*}(i)}{\Phi_t R_t^*}, \tag{3}$$

where W_t is the wage rate, B_t^o and $B_t^{o^*}$ are the domestic and external debt of households, S_t is the nominal exchange rate, D_t^o corresponds to dividends, Φ_t is the country risk premium function, and $T_t^{S,o}$, T_t, R_t, and R_t^* are subsidies, lump-sum taxes, the gross domestic interest rate, and the gross foreign interest rate, respectively.

The introduction of a subsidy $T_t^{S,o}$ can offset the crowding-out effect because the relevant interest rate for optimizing households is now $\frac{T_{t+1}^{S,o}}{T_t^{S,o}} \tilde{R}_t$ in the Euler equation of consumption, where $\tilde{R}_t$ is real interest rate, thus, a specific and exogenous sequence of this subsidy can partially compensate the increases of G_t over $\tilde{R}_t$:

$$1 = E_t \left(\frac{U_{t+1}^{C,GHH\ social}}{U_t^{C,GHH\ social}} \beta \frac{T_{t+1}^{S,o}}{T_t^{S,o}} \tilde{R}_t \right).$$

The specific form of the subsidy sequence must be such that the subsidy at time t must be higher than at $t+1$, thus, we assume a specific functional form to connect this sequence with the reused government expenditure is:

$$\frac{T_{t+1}^{S,o}}{T_t^{S,o}} = \frac{1}{\left[1 + \kappa_1 \left(G_t/\bar{G} \ - 1\right)\right]},$$

in other words, a fraction $\kappa_1 \in (0,1)$ of the increase in spending over its steady-state value is reused to increase the subsidy by t with respect to its $t+1$ value. Thus, the fraction $\frac{T_{t+1}^{S,o}}{T_t^{S,o}}$ moves in the opposite direction than $\tilde{R}$.

Households are not price takers in the labor market, we assume that there is a union that acts as a wage setter on behalf of each family to negotiate with the firms that produce noncommodity goods. Wages are staggered à la Calvo (1983):

$$\max_{\left\{\widetilde{W}_t\right\}_{k=0}^{\infty}} E_t \sum_{k=0}^{\infty} \theta_W^k \left\{ \Lambda_{t,t+k} \left[\frac{\widetilde{W}_t \Pi_{l=1}^k (1+\pi_{t+l-1})^{\delta_W}}{P_{t+k}} - \left(t^W MRS_{t+k} \right) \right] N_{t+k}^o(i) \right\}, \tag{4}$$

subject to:

$$N_{t+k}^o(i) = \left(\frac{\widetilde{W}_t}{W_{t+k}} \right)^{-\epsilon_W} \int_0^1 N_{t+k}(j) dj, \tag{5}$$

where θ_w is the probability that a given wage can be re-optimized in any particular period, δ_w measures the level of indexation, $\Lambda_{t,t+k}$ is the stochastic discount factor, MRS_t is the marginal rate of substitution of leisure for consumption for each type of preference, t^W is a subsidy to eliminate the non-competitive markup in the labor market and concentrate only on the effects of wage rigidity, and ϵ_w is the elasticity of substitution between any two households.

Constrained families have a utility function like (1) and (2), i.e., proposition 1 is also satisfied for these families, but they are subject only to their labor income net of taxes and plus subsidies:

$$P_t C_t^r(i) \leq \left(W_t N_t^r(i) - T_t \right) T_t^{S,r}. \tag{6}$$

Again, constrained households receive a subsidy $T_t^{S,r}$, which is a fraction $\kappa_2 \in (0,1)$ that is reused from fiscal spending G_t, and which follows the same logic as the subsidy for optimizing households:

$$T_t^{S,r} = \left(1 + \kappa_2 \left(G_t / \bar{G} \ - 1 \right) \right).$$

1.2 Firms

We assume two types of firms, those producing intermediate goods, which are not competitive, and those producing capital or investment goods, which are competitive.

Intermediate goods. Firms that produce intermediate goods –indexed by $j \in [0,1]$– have a Cobb-Douglas production function with diminishing returns to scale in the short term, which depends on three inputs—namely, capital utilization, $\widetilde{K}_t(j)$; labor, $N_t(j)$; and imported inputs, $M_t(j)$:

$$Y_t(j) = A_t(j)\widetilde{K}_t^{\alpha_1}(j)N_t^{\alpha_2}(j)M_t^{\alpha_3}(j), \tag{7}$$

where $A_t(j)$ is total factor productivity (TFP).

As mentioned, the firms that produce intermediate goods are not competitive. To make the estimation as simple as possible, we assume that firms set prices in a similar way to wage setting, and prices are staggered à la Calvo (1983):

$$\max_{\left\{\widetilde{P}_t(j)\right\}_{k=0}^{\infty}} E_t \sum_{k=0}^{\infty} \theta_D^k \left\{\Lambda_{t,t+k}\left[Y_{t+k}(j)\widetilde{P}_t(j)\Pi_{l=1}^k\left(1+\pi_{t+l-1}\right)^{\delta_D} - t^P MC_{t+k}\left(Y_{t+k}(j)\right)\right]\right\}, \tag{8}$$

subject to

$$Y_{t+k}(j) = \left(\frac{\widetilde{P}_t(j)}{P_{t+k}}\right)^{-\epsilon_D} Y_{t+k}, \tag{9}$$

where θ_D is the probability that a given price can be re-optimized in any particular period, δ_D measures the level of indexation, $\Lambda_{t,t+k}$ is the stochastic discount factor, ϵ_D is the elasticity of substitution between any two firms, t^P is a subsidy to eliminate the non-competitive markup in the intermediate good market and concentrate only on the effects of price rigidity, and MC_{t+k} is marginal cost.

As usual, there is an aggregator that competitively produces an aggregate good from intermediate goods, which is used for consumption, investment, exports, and so forth.

Investment goods. In contrast, only competitive firms, indexed by $l \in [0,1]$, are involved in the production of capital. We assume a remarkably simple form of capital accumulation, in which these firms maximize the benefits of leasing capital subject to market prices, adjustment costs, and depreciation at every moment in time. These firms decide not only the quantity of capital to build, but also the intensity of its use, measured by the variable $\mu_t(l)$. Thus, the capital stock used by firms that produce investment goods is $\widetilde{K}_t(l) = \mu_t(l)K_t(l)$. We define investment and adjustment costs as $I_t(l)$ and $\phi_t(l)$, with the standard properties that $\phi_t(\delta) = \delta$ and $\phi_t'(\delta) = 1.0$, respectively. The maximization problem of capital-producing firms in terms of the Bellman equation is:

$$v_t = \max_{\{I_t(l)\}} \left(Z_t \mu_t\left(l\right) K_t\left(l\right) - \frac{P_t}{T_t^{S,i}} I_t\left(l\right) \right) + E_t\left(\Lambda_{t,t+1} v_{t+1}\right), \tag{10}$$

subject to

$$K_{t+1}(l) = (1 - \delta_t(l))K_t(l) + \phi\left(\frac{I_t(l)}{K_t(l)}\right) K_t(l), \; and \tag{11}$$

$$\delta_t(l) = \delta + \xi \left(\frac{\mu(l)^{\eta^{MU}+1} - 1}{\eta^{MU} + 1} \right), \tag{12}$$

where Z_t, P_t, $T_t^{S,i}$, and $\Lambda_{t,t+1}$ are the capital rental price, the investment price, a subsidy, and the stochastic discount rate, respectively; and $\delta_t(l)$ is the depreciation rate of the capital stock, which depends on capital utilization $\mu_t(l)$ (see equation (12)) and the parameter η^{MU}. We arbitrarily set the parameter ξ such that $\mu = 1$ in steady state.

To explain the effect of the subsidy $T_t^{S,i}$ to compensate for the crowding-out effect, we show the first order condition for investment:

$$1 = E_t\left(Q_t^T {\phi'}_t\right),$$

where $Q_t^T = \frac{\tilde{\Lambda}_{t,t+1} v_{t+1}^k T_t^{S,i}}{P_{t+1}}$ is the Tobin's Q, and $\tilde{\Lambda}_{t,t+1}$ is the stochastic discount factor (in real terms), and v_{t+1}^K is the derivative of v_{t+1} with respect to K. Then, by using the envelope condition we obtain the equation that determines the dynamic of Q_t^T:

$$Q_t^T = E_t \left\{ \tilde{\Lambda}_{t,t+1} \left[\frac{Z_{t+1}\mu_{t+1}\left(l\right)}{P_{t+1}} + Q_{t+1}^T \frac{1}{T_{t+1}^{S,i}} \left(\left(1 - \delta\left(l\right)\right) + \phi_{t+1} - {\phi'}_{t+1} \frac{K_{t+1}}{I_{t+1}} \right) \right] \right\} T_t^{S,i}$$

The expression for Tobin's Q clarifies the role of the subsidy $T_t^{S,i}$: this must increase Tobin's Q in both periods to incentivize investment in t, if fiscal spending rises. To achieve this goal, and recalling that the subsidy sequence is defined exogenously by the government in each period, we propose in this study these functional forms for the subsidy for t and $t+1$:

$$T_t^{S,i} = \left(1 + \kappa_3 \left(G_t/\bar{G} \ - 1\right)\right), \quad T_{t+1}^{S,i} = \frac{1}{\left(1 + \kappa_3 \left(G_{t+1}/\bar{G} \ - 1\right)\right)}.$$

Where $\kappa_3 \in (0,1)$.

1.3 Exports

Export modeling for small open economies assumes that the price of exports –including both noncommodity and commodity exports– is fixed in dollar terms. Therefore, noncommodity exports are

$$X_t^D = \left(X_{t-1}^D\right)^{\Omega_X} \left(\left(\frac{P_t^X}{P_t^*}\right)^{-\eta^d} GDP_t^*\right)^{1-\Omega_X}, \tag{13}$$

where P_t^X is the dollar price of domestic exports and P_t^* is the international price level (specifically, the U.S. consumer price index). We further assume that prices in dollars are fixed à la Calvo (1983), but for the sake of simplicity, we do not repeat the pricing equations (they are similar to equations (8) and (9)).

Total exports are

$$X_t = \frac{E_t P_t^X}{P_t^*} X_t^D + E_t P_t^{CM} X_t^{CM}, \tag{14}$$

where E_t is the real exchange rate, P_t^{CM} is the commodity price in real terms, and X_t^{CM} is commodity exports.

While the price of domestic exports is fixed in dollars –and thus determines their demand in international markets– the total value of exports remains dependent on the real exchange rate (see equation (14)). To close the export block, we assume that commodity exports depend on the commodity price:

$$X_t^{CM} = \left(X_{t-1}^{CM}\right)^{\Omega_{X^{CM}}} \left[\left(P_t^{CM}\right)^{\phi_{X^{CM}}}\right]^{1-\Omega_{X^{CM}}}. \tag{15}$$

We assume that the commodity export price is fixed in dollar terms. We maintain this assumption for the larger economies as well, so the commodity supply depends on the international price in dollars expressed in real terms (equation (15)).

1.4 Government and Monetary Policy

In relation to fiscal policy, we focus on public spending, G_t. We assume that there is a long-term level, G, which can be interpreted in different ways, such as a fiscal rule that fixes spending according to permanent tax revenues or a more general policy that seeks to keep the ratio of spending to GDP constant. Deviations from this long-term expenditure are financed by changes in public debt (both domestic and foreign):

$$G_t = G^{1-\rho_G} G_{t-1}^{\rho_G} \left(1 + \frac{B_{t+1}^*}{GDP_t} / \frac{B^*}{GDP}\right)^{\theta_B}. \tag{16}$$

We further assume that the government considers the excess borrowing of the economy when adjusting spending over time. The fiscal budget constraint is defined as

$$P_t G_t \leq \frac{S_t B_{t+1}^{G^*}}{\Phi_t R_t^*} + \frac{B_{t+1}^o}{R_t} + T_t - B_t^o - S_t B_t^{G^*}, \tag{17}$$

where $B_t^o = \int_{\lambda_c}^1 B_t^o(i) di$. As explained above, we assume subsidies that incentivize private spending, altering the first-order conditions of the Euler equations of both consumption and investment and restricted household net income, therefore, subsidies must satisfy the following constraint:

$$\kappa_1 + \kappa_2 + \kappa_3 \leq 1.$$

In the case of monetary policy, we assume a simple Taylor rule, which depends on the inflation rate, Π, and GDP and which also considers the level of the exchange rate, E_t, and its volatility, $\triangle E_t$:

$$R_t = R_{t-1}^{\Omega_R} \left[\Pi_t^{\psi_R} GDP_t^{\psi_y} E_t^{\psi_{01}} \left(\triangle E_t \right)^{\psi_{02}} \right]^{1-\Omega_R} . \tag{18}$$

The importance of all these parameters depends on the values obtained in the model estimates. However, ψ_π must be greater than one to ensure a unique sticky-price equilibrium.

1.5 Risk premium

As in Schmitt-Grohé and Uribe (2003), we close the model by assuming that the country risk premium function, Φ_t, depends on the country's total external debt over real GDP –that is, b_{t+1}^*/GDP_t, where $b_t^* = S_t B_t^*/P_t$ and $B_t^* = B_t^{o^*} + B_t^{G^*}$, $B_t^{o^*} = \int_{\lambda_c}^1 B_t^{o^*}(i)di$– as follows, where Δ represent differences from the steady state:

$$\Phi_t = \left[1 + \phi_{RP01} \left(e^{\Delta \left(\frac{b_{t+1}^*}{GDP_t} \right)} - 1 \right) + \phi_{RP02} \left(e^{\Delta \left(\frac{b_{t+1}^* E_t}{Q_t^T K_{t+1} E_{t+1}} \right)} - 1 \right) \right] . \tag{19}$$

The second term in the risk premium –that is, $\left(b_{t+1}^*/Q_t^T K_{t+1} \right) \left(E_t/E_{t+1} \right)$– corresponds to the financial accelerator proposed by Gertler, Gilchrist and Natalucci (2007) for a small open economy, where Q_t^T is Tobin's Q ratio. This term connects the exchange rate with financial distress—measured by the value of external debt, including expectations of real exchange rate depreciation—relative to the value of capital—as a measure of the collateral for the economy. Both effects produce an upward-sloping supply of funds, indicating that the economy faces financial frictions in the external credit markets. We measure the Schmitt-Grohé-Uribe effect and the financial accelerator effect by ϕ_{RP01} and ϕ_{RP02}, respectively.

In the first-order conditions of households, we assume that the contemporary real exchange rate depends on a lag in order to include a gradual portfolio adjustment in the UIP equation, which is measured by the parameter Ω_E.

1.6 Equilibrium

We assume that commodity exports affect the market for noncommodity goods in the equilibrium condition:

$$Y_t = C_t + I_t + G_t + X_t, \tag{20}$$

where $\int Y_t(j)\,dj = Y_t \int \left(\frac{P(j)}{P}\right)^{-\varepsilon_D} dj,\ I_t = \int I_t(l)dl,\ C_t = \int_0^{\lambda_c} C_t^r(i)di + \int_{\lambda_c}^1 C_t^o(i)di$, and $N_t = \int N_t(j)dj = \int_0^{\lambda_c} N_t^r(i)di + \int_{\lambda_c}^1 N_t^o(i)di$. The rationale behind this simplifying assumption is that commodity production is not an isolated enclave and thus needs the rest of the economy's resources. Once we sum the restrictions from restricted and unrestricted households, government, and firms, we get the total restriction of the economy:

$$\underbrace{\frac{S_t B_{t+1}^*}{\Phi R_t^*} - S_t B_t^*}_{Foreign\ Debt} \geq \underbrace{\underbrace{P_t C_t + P_t I_t + P_t G_t}_{Domestic} + \underbrace{S_t M_t}_{Imports}}_{Expenditure} - \underbrace{P_t Y_t}_{Output}. \tag{21}$$

We measure real GDP using the definition of national accounts –that is, at constant prices, assuming $P_t = 1.0$:

$$GDP_t = Y_t - M_t. \tag{22}$$

Finally, the model is completed with the definition of the sticky-price equilibrium, which we estimate and simulate in the next section. It is expressed in real terms using P_t and P_t^*, which are the domestic and external price level, respectively.

Definition 1 (**Sticky-price equilibrium with subsidies**)**.** A sticky-price equilibrium is a set of prices in real terms with subsidies $T_t^{S,o}$,$T_t^{S,r}$, and $T_t^{S,i}$, and: :

$$\left\{ \frac{W_t}{P_t}, E_t, Q_t^T, P_t^{CM}, \frac{Z_t}{P_t}, \tilde{R}_t, \frac{R_t^* P_t^*}{P_{t+1}^*}, \frac{P_t^X}{P_t^*} \right\}_{t=0}^{\infty},$$

such that a fraction $(1-\lambda_c)\theta_W$ of households maximizes utility, a fraction θ_D of intermediate-good producers maximizes profits in the domestic market, a fraction θ_X of noncommodity exporters maximizes profits in foreign markets, all capital producers maximize profits, markets clear, and the current account restriction is fulfilled. Agents who cannot optimize at a specific point in time use either a simple rule for consumption (equation (5)) for a fraction λ_c of restricted households or Phillips curves to update wages and prices (or both), and they then make work and production decisions, respectively.

In this definition of equilibrium, agents take as given the technological constraint, social component of utility function, habit, external activity, domestic and external financial frictions (including the country risk premium), government expenditure, subsidies, initial debt, initial capital, and all shocks, which we define in section 2.1 .

1.7 Numerical solution of the model, price and wage dispersion, and welfare measurement

Since the model simulates drastic changes in some variables (see section 2.1), it is not desirable to linearize the model to find a solution. Therefore, the model is solved simultaneously using the standard Newton's method with sparse matrices (Heer and Maussner (2009)) and values for the parameters explained in the online appendix for Australia, Canada, Chile, Colombia, Mexico, and New Zealand. For the application of this method, we take the current steady state of each economy as our initial values[2]. However, the model solution for each country presents important challenges that are worth mentioning. Given the magnitude of the shocks, the simulations do not always converge directly using the above method, and in those particular cases, we use the homotopy –or divide-and-conquer– technique to simulate the model.

How accurate are the welfare results in this context? Under the nonlinear solution technique, which is based on consecutive linear approximations, the welfare effects of price and wage dispersion should be negligible in the simulations. Despite this important weakness of

[2]The steady state and calibration are explained in detail in the online appendix, and the programs are available on request via email.

the solution method, the welfare measurement error will ultimately depend on how severe the dispersion may be in practice. In this regard, our measurements indicate that by making separate approximations up to the third and fourth order for price and wage dispersion, measured by $\left(\frac{P(j)_{t+k}}{P_{t+k}}\right)^{-\varepsilon_D}$ and $\left(\frac{W(j)_{t+k}}{W_{t+k}}\right)^{-\varepsilon_W}$, given the sample average values of parameters ε_D and ε_W, both quantities would be close to one —1.0001 in the cases of the maximum change in prices and wages— so the effect of dispersion would be negligible. Therefore, the simulations were made without considering these elements.

2 Results

2.1 Shock definition

The challenge of analyzing severe external disturbances is to recognize that they are generally not isolated phenomena and, in some circumstances, last several periods longer than normal fluctuations. Indeed, the crises facing open economies are complex events in which several external variables simultaneously record sharp movements. For open economies, changes in the dominant economies –namely, the United States, Europe, and China– translate into simultaneous changes in both real variables (terms of trade and growth) and financial variables (risk premium, capital flow, and interest rates). For instance, Fernández, Schmitt-Grohé and Uribe (2020) find that world shocks that affect commodity prices and the world interest rate explain more than half of the variance of output growth, on average, across countries between 1960 and 2018.

Most likely, common factors are triggered that end up changing the balances in various markets. For example, the financial decisions of foreign investors that trigger capital flows may derive from a combination of changes affecting external growth, commodity prices, the federal funding rate, and other variables. It is difficult to think of these elements working separately, especially when financial integration falls sharply. In fact, in normal times, the synchronization of the business cycle across countries may be weakened by access to credit, as observed by Kalemli-Ozcan, Papaioannou and Peydró (2013). However, in generalized crises such as the Great Recession of 2008 and the COVID pandemic, in which the financial markets would have been paralyzed without the intervention of the government and the central bank, international synchronization reappears and intensifies for any open economy.

To address this last point, we defined a composite shock that encompasses the difficulties faced by open economies in a crisis triggered by external factors and that lasts four quarters, contrary to standard simulations using shocks that last one quarter and then quickly disappear. In other words, we are interested in fluctuations that are an intermediate between high frequency cyclical fluctuations and super-cycles. These are negative shocks whose effects can extend over a number of quarters, which is why they are defined as severe and the government intervenes, but not decades as in the case of commodity super-cycles. Examples of shocks with these characteristics include the international financial crisis of 2008 and the COVID crisis presented in table 1.

In concrete terms, instead of looking for correlations between variables or developing a complete model for the world in these circumstances, we use the average values of the 2008 international financial crisis and the COVID pandemic, considering only the external effects and leaving aside the internal effects. The simulations are not intended to replicate these particular crises, but to isolate the external elements that directly affect open economies. The shocks considered in the simulations are averages of table 1 and occur only once, i.e., once they occur the risk disappears completely, and they follow trajectories perfectly known by the economic agents. The variables that change exogenously and jointly are the following: the external activity GDP_t^* in equation (13), the commodity price P_t^{CM} in equation (15), the risk premium Φ_t in equation (19), and the external interest rate R_t^* in equation (3).

Table 1: Compound Shocks for Severe Crisis in Open Economies

	Australia		Canada		Chile	
	COVID	IFC 2008	COVID	IFC 2008	COVID	IFC 2008
UIP shocks	6.2	9.05	2.23	5.36	4.38	9.34
Quarterly foreign GDP growth	−0.7	0.11	–0.94	–0.19	–0.58	0.27
Federal funds rate	–0.3	–0.46	–0.32	–0.46	–0.32	–0.46
Commodity price	–9.9	–12.71	–33.05	–42.85	–2.87	–32.98

	Colombia		Mexico		New Zealand	
	COVID	IFC 2008	COVID	IFC 2008	COVID	IFC 2008
UIP shocks	3.31	4.23	2.95	3.27	5.37	11.16
Quarterly foreign GDP growth	–0.75	–0.02	–0.90	–0.15	–0.75	0.13
Federal funds rate	–0.32	–0.46	–0.32	–0.46	–0.32	–0.46
Commodity price	–33.05	–42.85	–33.05	–42.85	–4.07	–23.12

Source: Three-month or 90-day rates: FRED and Central Bank of Chile; CPI, real effective exchange rate, WTI oil price, copper price, iron ore price, and coal price: FRED; Trade weights: BIS; and ANZ Commodity price index: ANZ.

Notes: For the COVID crisis, the calculation compares the first two quarters of 2019 and 2020, in percentage terms. For the 2008 international financial crisis (IFC), it compares the first quarter of 2007 and 2009, because the crisis materialized in these countries mainly in 2009. UIP shocks are the errors of the uncovered interest rate parity. External GDP growth for each country is the weighted average of the GDP growth of China, Japan, Europe, and the United States. The commodity price corresponds to oil for Canada, Colombia, and Mexico; copper for Chile; coal and iron ore for Australia; and the ANZ Commodity Price Index for New Zealand.

2.2 Policy definitions

We consider four policy cases. The first case is without any policy since prices and wages are fully flexible, optimizing consumers internalize the effect of their consumption decisions on debt accumulation, and thus on the country risk premium, and there are no financially constrained households. This alternative corresponds to the Pareto equilibrium constrained by transactions in the international financial market and serves as a benchmark for the other cases.

In the second case, we assume the Taylor rule of the model. In this alternative; prices and wages are rigid, optimizing households do not internalize the effect of their consumption decisions on external debt accumulation, and restricted households are included.

In the third case we add to the previous case an expansionary monetary policy, in the form of a shock that reduces the interest rate arbitrarily in equation (18). The Taylor rule must still be satisfied to guarantee the uniqueness of the equilibrium; recall that the Newton method approximates the nonlinear solution with a series of linear approximations.

The fourth case again uses the second case as a basis, but this time an expansionary fiscal policy is incorporated instead of monetary policy, i.e., there is a fiscal shock that arbitrarily increases fiscal spending in equation (16). This simulation, in addition to maintaining the Taylor rule, includes a passive fiscal rule that considers indebtedness as described above. In this sense, the simulations presented below always consider stability in terms of inflation and public indebtedness in the medium and long term.

Finally, the magnitudes of active monetary and fiscal policies were arbitrarily calibrated considering the magnitude of the compound external shock of table 1.

2.3 Simulations with different utility functions

The first simulation is with the selfish separable utility function, this is a case widely used in the literature, especially in closed economies, while the second is with the GHH function with a social component. The results are presented in figures 1 and 2, respectively, and the welfare effects are summarized in table 2, where, for the sake of comparison, we also include the purely selfish GHH case (achieved with $\theta^S_{GHH\_2} = 0$ in equation for θ page 5, paragraph 3). The policy cases of section 2.2 are represented in each of the graphs by the following colors: magenta for no policy, blue for Taylor rule only, red for expansionary monetary policy, and green for expansionary fiscal policy.

The first result from these two simulations is that the compound external shock causes strong fluctuations in the economies due to the price rigidities, restricted households, and the externalities of financial frictions. Most macroeconomic variables fluctuate more than in the case where prices were fully flexible and external financial frictions were properly internalized, although in all cases the response is a real depreciation.

The second result is that despite the large fluctuations, expansionary macroeconomic stabilization policies, whether fiscal or monetary, paradoxically reduce welfare in the case of separable preferences. According to table 2, a better option than these expansionary policies is to follow a passive Taylor rule, although constrained households lose, they lose less than in the more expansionary cases.

As explained in proposition 1, the excessive consumption smoothing and the negative effect of labor end up burying the good intentions of an expansionary stabilization strategy if we try to measure welfare with the selfish separable preferences. Indeed, the big difference between figures 1 and 2 is that the consumption of optimizing agents fluctuates radically less in the former than in the latter, whereas fluctuations in labor are equivalent for both types of preferences. In other words, in the case of separable preferences, expansionary policies, rather than being a solution, become an additional problem, because they introduce even more fluctuation than is already produced by for all distortions considered.

This last result is related to what is known in the literature by the divine coincidence (Galí (2015)) that optimal monetary policy coincides with responding to price and wage inflation. This reflects the assumption of the selfish preferences, any shock leaves agents in a suboptimal situation and it is natural to prescribe central banks to respond strongly to price and wage inflation to return to steady state rather than adding new shocks to the economy.

The third result is about the effect of reusing government expenditure as a subsidy to compensate for the crowding-out effect, column E in table 2, in the selfish separable utility function. In this simulation, we chose arbitrary values for $\kappa_1 = 0.195$, $\kappa_2 = 0.03$, and $\kappa_3 = 0172$, which are included in the first-order conditions of private agents (as we will see below, these values were selected so that the case of the GHH utility function with a social component approximates the Pareto constrained equilibrium). Due to the specific stimulus to the constrained household, expansionary fiscal spending policy can produce positive welfare changes. However, with respect to the case without reusing fiscal spending, column D, the welfare of optimizing households worsens. This result is again explained because the recovery that would be triggered by subsidies to mitigate the crowding-out effect produces excess labor in these families.

Could the latter result be reversed if we replace the selfish separable utility function with a purely selfish GHH function? Table 2 indicates that the use of this function reverses some results. Since in this function the marginal disutility of labor is lower than in the separable case, expansionary policies (without reusing fiscal spending as a subsidy) have better welfare outcomes than the Taylor rule (compare columns B with C and D) for optimizing households. While subsidies substantially improve the welfare of constrained households, this comes at a cost: it worsens the welfare of optimizing households for the same reason as in the selfish separable case: the recovery produces too much work for these households despite the lower disutility of working.

The fourth result is about the effect of including recovery valuation in the GHH preferences. Figure 2 indicates that in the case where fiscal spending is reused as a subsidy there is a genuine recovery especially in the consumption of both types of households, the real depreciation is somewhat lower (recall that the external shock depreciates the exchange rate, but fiscal policy reduces that depreciation by the crowding-out effect), although there is decidedly more inflation than in the separable case. In terms of welfare, the results are like the case where the GHH utility function is purely selfish, see table 2.

However, there is one case where it is substantially different. Indeed, column E of table 2 indicates that optimizing households still have a welfare gain. Achieving for the first time that both households are better off with expansionary fiscal policy, and moreover, similar to the results obtained in the Pareto constrained equilibrium.

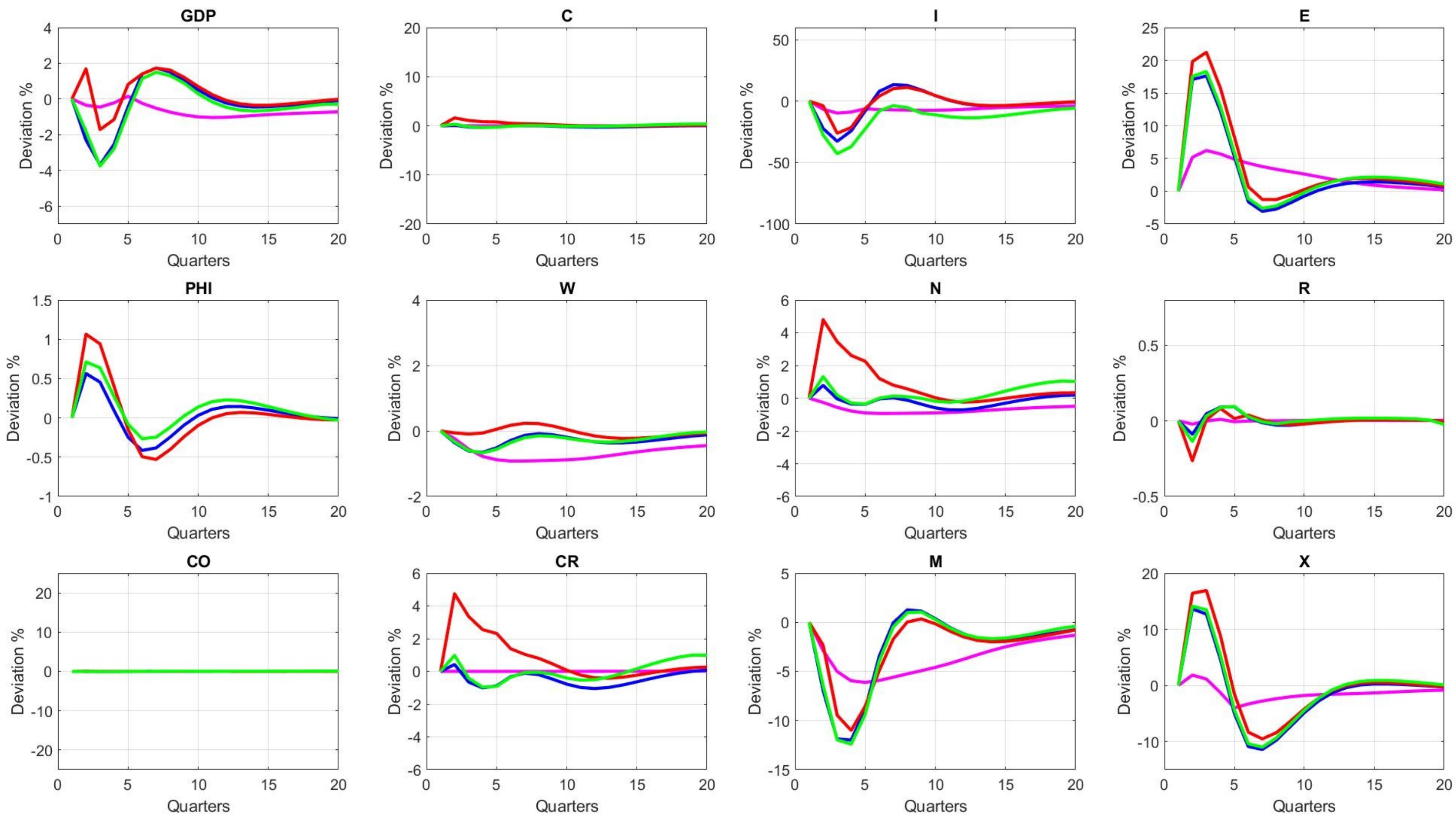
Summarizing, in the GHH preferences with a social component, the disutility of an additional unit of labor is lower, as explained in proposition 1. This means that in the face of a severe negative external shock, consumption also changes strongly, unlike the oversmoothing of this variable that occurs with separable preferences (see figures 1 and 2). In the specific case of the GHH preferences, the "social" element reinforces the general mechanism of these utility functions. It is an endogenous mechanism that pushes households to consume and work more, accelerating the recovery of the whole economy in a virtuous circle.

Table 2: Welfare

	Flexible prices, wages, and endogenous financial friction	Fixed prices, wages, and exogenous, financial friction			
	No macroeconomics policies	Taylor rule	Active monetary policy	Active fiscal policy	Active fiscal policy and with public expenditure reused as subsidy
Households	(A)	(B)	(C)	(D)	(E)
Selfish separable standar preferences					
Ricardian	14.34	3.09	-16.74	-6.79	-9.48
Restricted	14.34	-2.63	-8.33	-7.14	19.39
Selfish GHH preferences					
Ricardian	0.01	0.32	1.29	1.66	-0.23
Restricted	0.01	-2.70	-10.05	-7.96	8.19
GHH preferences with a social component					
Ricardian	0.08	0.42	1.33	1.89	0.07
Restricted	0.08	-5.50	-13.06	-13.46	0.59

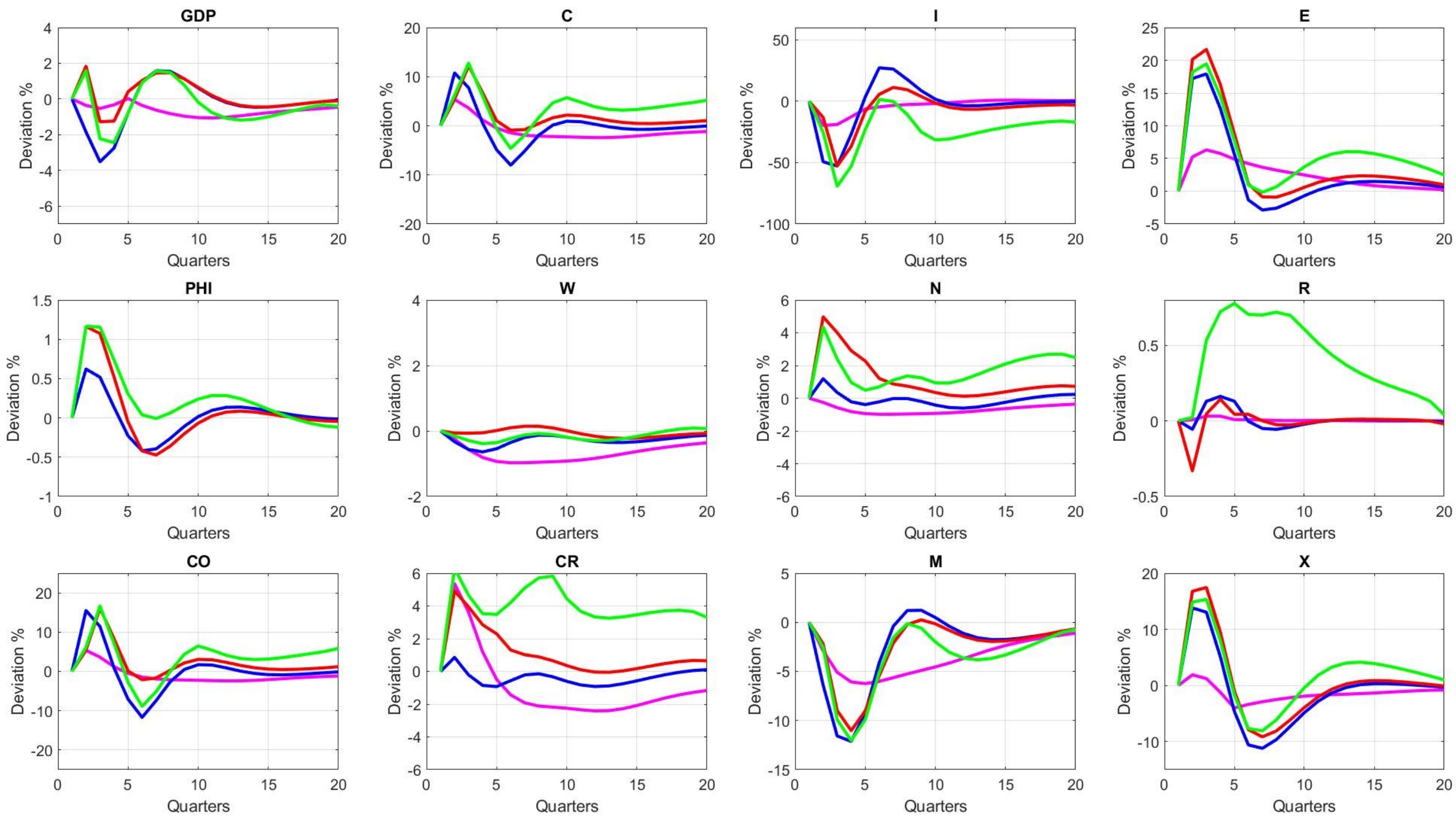
Source: Authors' calculations.

Figure 1: Effect of a severe external shock on open economies: the selfish separable utility function case



Source: Authors' calculations, based on the model presented in section 1.
Notes: Impulse responses are the average of the impulse responses of each country. C: consumption; I: private investment; E: real exchange rate; PHI: inflation rate; W: real wages; N: employment; R: real interest rate; CO: Ricardian consumption; CR: restricted consumption; X: total exports; M: total imports. Magenta: Flexible prices and optimizing consumers internalize the effect of their consumption decisions on debt accumulation. Blue: Taylor rule only. Red: Active monetary policy. Green: **Public expenditure is not reused as subsidy**.

Figure 2: Effect of a severe external shock on open economies: the GHH utility function with a social component case



Source: Authors' calculations, based on the model presented in section 1.
Notes: Impulse responses are the average of the impulse responses of each country. C: consumption; I: private investment; E: real exchange rate; PHI: inflation rate; W: real wages; N: employment; R: real interest rate; CO: Ricardian consumption; CR: restricted consumption; X: total exports; M: total imports. Magenta: Flexible prices and optimizing consumers internalize the effect of their consumption decisions on debt accumulation. Blue: Taylor rule only. Red: Active monetary policy. Green: **Public expenditure is reused as subsidy**.

2.4 The relationship between the subsidies and the social component

One of the features of table 2 is that it appears that the best combination is when the GHH utility function with a social component is combined with subsidies. In contrast, in the same table both conditions separately appear to be not sufficient to ensure that fiscal policy is superior to the other alternatives. To clarify this point, in figure 3 we show GDP growth for different cases of utility functions and subsidies, recalling that the objective of fiscal policy is to generate a genuine recovery (GDP should grow) that is valued by households.

The results in figure 3 numerically confirm the assessment that both conditions are necessary together to produce a genuine recovery that is valued by households over other alternatives. The results in figure 3 are summarized as follows: panel (A) indicates that the social component cannot be replaced by subsidies alone. Panel (B) reveals that it is also not enough to just specifically subsidize restricted households. Panel (C) shows that subsidies are vital to produce recovery, but panel (D) shows that subsidizing investment is vital. We take an additional step and formalize this important result in the following proposition:

Proposition 2. (Synchronization between the social component and subsidies). Fiscal spending reused through subsidies will produce an economic recovery if families value this recovery and vice versa.

Proof. Since the compound shock occurs only once, and it is assumed that there is no risk afterwards, the Euler equation can be written as:

$$\frac{U_t^{C,GHH\ social}}{U_{t+1}^{C,GHH\ social}} = \beta \frac{T_{t+1}^{S,o}}{T_t^{S,o}} \tilde{R}_t,$$

the effect of the subsidy is:

$$\beta \frac{T_{t+1}^{S,o}}{T_t^{S,o}} \tilde{R}_t < \beta \tilde{R}_t,$$

and we also know that the investment subsidy increases in the simulations and considering that:

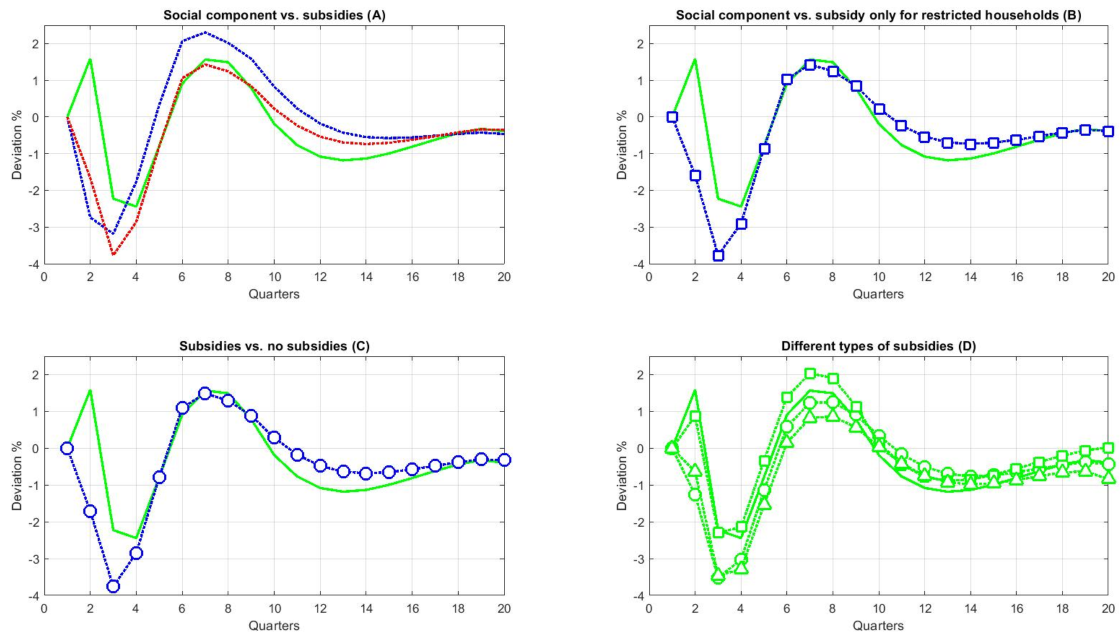
$$\frac{U_t^{C,GHH\ social}}{U_{t+1}^{C,GHH\ social}} = \left[\frac{\left(C_{t+1}^o(i) - \gamma C_t + \theta_{t+1} - \frac{\Psi N_{t+1}^o(i)^\varphi}{\varphi} \right)}{\left(C_t^o(i) - \gamma C_{t-1} + \theta_t - \frac{\Psi N_t^o(i)^\varphi}{\varphi} \right)} \right]^\sigma,$$

then, we have that the effects of $\frac{T_{t+1}^{S,o}}{T_t^{S,o}}$ and θ_t is to reduce $\frac{U_t^{C,GHH\ social}}{U_{t+1}^{C,GHH\ social}}$ below $\beta \tilde{R}_t$. □

Repeating the results of the last section (see table 2) we have that the type of monetary policy works under certain assumptions: rules with a separable and discretionary (expansionary) utility function with a purely selfish GHH utility function, changes in the interest rate put optimizing agents in a better situation. However, this policy cannot resolve the welfare fall of restricted agents, whose stabilization goes beyond the interest rate. Our results indicate that fiscal policy is useful in solving this problem, but at a cost: a dilemma arises with the smoothing of optimizing agents.

However, if the true utility function is a GHH with a social component, then it is possible to have an additional argument in favor of fiscal policy to solve the dilemma between fiscal and monetary policy at the welfare level, as summarized in proposition 2. Fiscal spending must be reused through subsidies to adjust for interest rate changes, especially in investment, arising from the crowding out effect. On the contrary, in the absence of either of these two conditions, the solution is again the use of standard policies with the dilemma they entail.

Figure 3: Effect of a Severe External Shock on GDP: different utility functions



Source: Authors' calculations, based on the model presented in section 1.
Notes: Impulse responses are the average of the impulse responses of each country.
Panel (A): The importance of the social component in the utility function is compared. The GHH utility function with a social component and all subsidies (green line), the purely selfish GHH utility function with all subsidies (dashed blue line), and the selfish separable utility function with all subsidies (dashed red line).
Panel (B): The importance of the social component is compared to the subsidy only for restricted households. The GHH utility function with a social component and all subsidies (green line) and the purely selfish GHH utility function with subsidy only for restricted households (dashed blue line and square markers).
Panel (C): The importance of all subsidies is compared to having no subsidies at all. The GHH utility function with a social component and all subsidies (green line) and the purely selfish utility function GHH without subsidy (dashed blue line and circle markers).
Panel (D): The relevance of different subsidies is compared. The GHH utility function with a social component and all subsidies (green line), the GHH utility function with a social component and subsidy only for restricted households (dashed green line and circle markers), the GHH utility function with a social component and with subsidy only for investment (dashed green line and square markers), and the GHH utility function with a social component and with subsidy only for optimizing households (dashed green line and triangular markers).

3 Conclusion and policy implications

In this study we quantitatively explore two apparently unrelated conditions that together could make an expansionary fiscal policy (fully financed in the future) likely to produce a genuine recovery of the economy and make this policy preferable in welfare terms compared to a discretionary or rule-based expansionary monetary policy in response to infrequent but severe external shocks. The analysis is done in a standard (nonlinear) general equilibrium model, in a flexible exchange rate context, for a set of open economies with different degrees of development, and microfounded parameters estimated previously with Bayesian econometric for the last decades.

Despite the limitations and simplifications of the modeling, we show that the following conditions i) the reuse of fiscal spending through differentiated subsidies to compensate the crowding-out effect of this policy and ii) the social valuation of the recovery in the GHH utility functions, allow us to generate with fiscal policy an endogenous recovery of the economy with more consumption that reinforces the standard mechanism of the GHH functions, achieving that different types of households obtain welfare levels comparable to the equilibrium with Pareto restrictions.

Under these conditions, a fiscal policy outperforms in welfare terms not only passive policies subject to mechanical rules linked to strict targets such as debt and inflation, but also an expansionary monetary policy in a context of a flexible exchange rate. Thus, if these conditions are present, it would be preferable to temporarily postpone specific targets such as inflation or public debt to produce a faster recovery in case of infrequent but severe shocks, although these targets should remain present in the long run to ensure stability, as assumed in all the simulations of this study.

Appendix Parameters utilized by the medium-size model

The model was estimated using six open economies with different characteristics: namely, Australia, Canada, Chile, Colombia, Mexico, and New Zealand. The sample in each case depends on data availability, as explained in the online appendix. The estimates were made with Bayesian econometrics, defining priors for each of the parameters that determine the model dynamics based on a first-order approximation of the model, with 10^6 simulations to achieve appropriate convergence in all cases. The rest of the parameters—associated with the nonstochastic steady state—were calibrated (see the online appendix for details).

All the estimated parameters and the visual criteria for checking the convergence of the estimated model for each country are reported in the online appendix. With regard to the latter, most of the parameter values are within the ranges found in the literature.

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Table Appendix: Parameters

Parameters	Australia	Canada	Chile	Colombia	Mexico	New Zealand
γ	0.48	0.40	0.26	0.33	0.31	0.53
σ	1.99	2.00	1.99	2.00	2.00	2.12
λ_C	0.16	0.36	0.41	0.35	0.35	0.21
Ω_Q	0.19	0.40	0.12	0.17	0.37	0.38
ϕ_{RP01}	0.07	0.09	0.27	0.20	0.10	0.09
ϕ_{RP02}	0.05	0.07	0.17	0.13	0.09	0.04
θ_W	0.78	0.62	0.84	0.75	0.76	0.69
δ_W	0.39	0.38	0.63	0.41	0.48	0.49
φ	1.98	1.99	2.00	2.00	2.00	2.00
η^{MU}	0.28	0.03	0.03	0.10	0.19	0.06
Ω_M	0.57	0.41	0.48	0.43	0.50	0.50
Ω_N	0.61	0.42	0.76	0.61	0.63	0.76
θ_D	0.74	0.72	0.75	0.73	0.76	0.75
δ_D	0.60	0.41	0.44	0.46	0.49	0.49
$\mathcal{AC}$	0.27	0.28	0.31	0.32	0.26	0.20
Ω_R	0.70	0.83	0.89	0.74	0.79	0.87
ψ_π	1.88	1.88	1.99	1.97	1.99	1.90
ψ_Y	1.07	0.75	0.84	0.79	0.55	1.23
ψ_{01}	0.08	0.06	0.09	0.09	0.09	0.09
ψ_{02}	0.10	0.14	0.11	0.09	0.10	0.10
$\phi_{X^{CM}}$	0.20	0.93	0.05	0.03	0.47	0.56
$\Omega_{X^{CM}}$	0.14	1.00	0.88	0.32	0.57	0.39
Ω_X	0.53	0.73	0.71	0.49	0.57	0.57
θ_B	-0.01	-0.06	-0.01	-0.04	-0.02	0.00

Source: Authors' calculations, see for more details online appendix.
Note: The estimations were performed with the model that has the separable utility function. On the one hand, the decision in favor of using this function is that the comparison between the simulations must be with the same parameters so that one of the utility functions must be chosen. On the other hand, and remembering that the model has multiple elements that increase the excess smoothing of the separable functions, the estimated parameter values are very standard values in the literature, which allows us to concentrate on the elements highlighted by the study and not on particular values of the parameters.

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Online Appendix of When Economic Recovery is Valued: a Case for Expansionary Fiscal Policy in Open Economies

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Abstract

In this appendix we present: i) the calculation of the steady state; ii) data and countries considered for the estimations; iii) log-linearized model; and iv) estimation results: parameters and stability of the estimations.

JEL Codes: D91, F31; F32; F37; F41; F44, F47.

Keywords: The GHH preferences, government spending, crowding-out effect, open economies, exchange rate, and Bayesian econometrics.

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Appendix A.1 Data, Observed Variables, and Shocks

The model was estimated for the following countries: Australia, Canada, Colombia, Chile, Mexico, and New Zealand. The length of the sample in each country—which depends on data availability—is as follows: Australia: 1994Q2–2017Q4; Canada: 1997Q2–2017Q4; Colombia: 2005Q2–2017Q4; Chile: 1997Q2–2017Q4; Mexico: 2007Q2–2017Q4; and New Zealand: 1994Q2–2017Q4. The data are from the Organization for Economic Cooperation and Development, the Bank for International Settlements, the Federal Reserve Economic Database (FRED), and the respective central banks of each country.

The following observed variables are considered in the estimation of the model: real gross domestic product (GDP), private consumption expenditure (C), general government consumption expenditure (G), gross fixed capital formation (I), exports of goods and services (X), imports of goods and services (M), CPI inflation rate (Π), nominal interest rate (R), real exchange rate (E), employment (N), wage rate (W), commodity prices (P^{CM}), U.S. CPI inflation rate (Π^*), effective federal funds rate (R^*), and U.S. real gross domestic product (GDP^*)[1].

There are 19 shocks and 15 observed variables. Since an excess of shocks can cause the shocks to be correlated (Pagan and Robinson (2020)), we reduced the number to 16 and calibrate three of them to achieve the estimates. The selection criterion was to leave the structural shocks that are traditionally used in this type of model (productivity, preferences, international liquidity premium, cost-push, fiscal policy, monetary policy, investment, domestic exports, commodity prices, foreign GDP, foreign inflation, and external interest rate) and measurement shocks in variables that the model has trouble explaining (employment and wages) or are fundamental for explaining the article's hypothesis (exports and imports). The calibrated shocks correspond to variables that are assumed to have high measurement certainty (GDP, consumption, and investment). Table A.1.1 indicates the calibration of the standard deviations of the group of this variables, which is based on the statistical information available by country.

The measurement equations were expressed as follows:

$$V\_OBS_{j,t} = \alpha_j + \widehat{v}_{j,t} - \widehat{v}_{j,t-1} + \epsilon_{j,t},\ \epsilon_{j,t} \sim N\left(0, \sigma_j^2\right) \tag{A1.1}$$

$$V\_OBS_{i,t} = \alpha_i + \widehat{v}_{i,t} - \widehat{v}_{i,t-1}, \tag{A1.2}$$

where $\hat{v}_t = ln(V) - ln(\overline{V})$ when the variables are measured in levels ($\overline{V}$ is the steady-state

[1] The programs and the database are available on request from the authors by e-mail.

value; $\hat{v}_t$ is simply the rate if the variable is originally measured in this way).

The observed variables that were estimated with an equation of type (A1.1) are GDP, C, I, X, M, N, and W. Therefore, the set of parameters α_i are: $\{\alpha_{GDP}, \alpha_N, \alpha_W\}$. We restrict the model so that the variables GDP, C, I, X, and M have the same long-term growth rate, α_{GDP}, ie, balance growth path. The standard deviations are grouped in the following set: $\{\sigma^2_{GDP}, \sigma^2_C, \sigma^2_I, \sigma^2_X, \sigma^2_M, \sigma^2_N, \sigma^2_W\}$.

The observed variables that were estimated with an equation of type (A1.2) are G, Π, R, E, P^{CM}, Π^*, R^*, and GDP^*. Therefore, the set of parameters α_j are:

$$\{\alpha_G, \alpha_\Pi, \alpha_R, \alpha_E, \alpha_{P^{CM}}, \alpha_{\Pi^*}, \alpha_{R^*}, \alpha_{GDP^*}\}.$$

Table A.1.1: Calibrated Standard Deviations for GDP, Consumption, and Investment.

	Australia	Canada	Chile	Colombia	Mexico	Nueva Zelanda
σ_{GDP}	0.53	0.63	1.03	0.93	1.19	0.87
σ_C	0.53	0.44	0.11	0.65	1.30	0.81
σ_I	2.91	1.97	3.95	3.16	2.58	4.01

Notes: GDP: gross domestic output; C: private consumption expenditure; and I: gross fixed capital formation.

Appendix A.2 Steady State and Calibrated Parameters

The steady state is the solution of the model without uncertainty and assuming flexible prices. Throughout the section, an overbar indicates steady-state values.

National account variables

The methodology consists of obtaining information from the sample so that the stationary state depends on three structural parameters: β, δ, and α_1 (see Table A.2.2).

The solution to the steady state starts with calculating the conditions of optimality in the factor markets:

$$\alpha_1 \frac{Y_t}{K_t} = \frac{Z_t}{P_t},\ \alpha_3 \frac{Y_t}{M_t} = E_t. \tag{A2.1}$$

Unlike the short-term model, in steady state we assume constant returns to scale:

$$\frac{\overline{K}}{\overline{Y}} = \frac{\alpha_1 \beta}{1-\beta\left(1-\delta\right)},\ \alpha_3 = \frac{\overline{M}}{\overline{Y}}. \tag{A2.2}$$

Next, we deal with the aggregate restriction of the economy and GDP definition:

$$\overline{Y} = \overline{C} + \overline{I} + \overline{G} + \overline{X}^D + \overline{E}\frac{\overline{P}^{CM}}{\overline{P}^*}\overline{X}^{CM}; \tag{A2.3}$$

$$\overline{GDP} = \overline{Y} - \overline{EM}.$$

Assuming that $\overline{E} = \overline{P}^{CM} = \overline{P}^* = 1$,

$$1 = \frac{\overline{C}}{\overline{Y}} + \frac{\overline{I}}{\overline{Y}} + \frac{\overline{G}}{\overline{Y}} + \frac{\overline{X}^D}{\overline{Y}} + \frac{\overline{X}^{CM}}{\overline{Y}}, \tag{A2.4}$$

$$1 = \frac{\overline{Y}}{\overline{GDP}} - \frac{\overline{M}}{\overline{GDP}}.$$

We can obtain the ratio $\frac{\overline{Y}}{\overline{GDP}}$ by assuming, a given value for imports over GDP:

$$\frac{\overline{Y}}{\overline{GDP}} = 1 + \frac{\overline{M}}{\overline{GDP}} \Rightarrow \frac{\overline{GDP}}{\overline{Y}} = \frac{1}{1+\frac{\overline{M}}{\overline{GDP}}}. \tag{A2.5}$$

Combining equations (A1.1) and (A1.2), we get the investment-GDP ratio in function of the parameters: β, δ, and α_1 (see Table A.2.2).

$$\frac{\overline{I}}{\overline{Y}} = \delta\frac{\overline{K}}{\overline{Y}} = \frac{\delta\alpha_1\beta}{1-\beta\left(1-\delta\right)}, \tag{A2.6}$$

The above condition is achieved if the parameter ξ has a specific value that ensures that δ_t is equal to δ. Indeed, from the first-order condition of capital utilization, we have:

$$\overline{\mu} = \left(\frac{\overline{Z}}{\delta\xi\overline{Q}^T}\right)^{\frac{1}{\eta_{MU}}}. \tag{A2.7}$$

Considering that $\overline{Q}^T = 1$ and $\overline{Z} = \frac{1-\beta(1-\delta)}{\beta}$, then:

$$\overline{\mu} = 1 \Leftrightarrow \xi = \frac{1-\beta\left(1-\delta\right)}{\delta\beta}. \tag{A2.8}$$

Next,

$$\frac{\overline{I}}{\overline{GDP}} = \frac{\overline{I}}{\overline{Y}}\frac{\overline{Y}}{\overline{GDP}}. \tag{A2.9}$$

On the other side,

$$\frac{\overline{G}}{\overline{Y}} = \frac{\overline{G}}{\overline{GDP}}\frac{\overline{GDP}}{\overline{Y}},\ \frac{\overline{X}^{CM}}{\overline{Y}} = \frac{\overline{X}^{CM}}{\overline{GDP}}\frac{\overline{GDP}}{\overline{Y}}. \tag{A2.10}$$

We can then define exports as follows:

$$\overline{X} = \overline{X}^D + \overline{X}^{CM} \Rightarrow \frac{\overline{X}}{\overline{Y}} = \frac{\overline{X}^D}{\overline{Y}} + \frac{\overline{X}^{CM}}{\overline{Y}} \Rightarrow \frac{\overline{X}^D}{\overline{Y}} = \frac{\overline{X}}{\overline{Y}} - \frac{\overline{X}^{CM}}{\overline{Y}}, \tag{A2.11}$$

where:

$$\frac{\overline{X}}{\overline{Y}} = \frac{\overline{X}}{\overline{GDP}}\frac{\overline{GDP}}{\overline{Y}}. \tag{A2.12}$$

Then we can calculate the Consumption-output ratio in function of the parameters: β, δ, and α_1 (see table A.2.2):

$$\overline{C} + \overline{I} + \overline{G} = \overline{GDP} - \left(1-\beta\right)\overline{B}^*, \tag{A2.13}$$

$$\frac{\overline{C}}{\overline{Y}} + \frac{\overline{I}}{\overline{Y}} + \frac{\overline{G}}{\overline{Y}} = \frac{\overline{GDP}}{\overline{Y}} - \left(1-\beta\right)\frac{\overline{B}^*}{\overline{Y}}. \tag{A2.14}$$

Then,

$$\frac{\overline{C}}{\overline{Y}} = \frac{\overline{GDP}}{\overline{Y}} - \frac{\overline{I}}{\overline{Y}} - \frac{\overline{G}}{\overline{Y}} - (1-\beta)\frac{\overline{B}^*}{\overline{Y}}, \tag{A2.15}$$

and

$$\frac{\overline{C}}{\overline{GDP}} = \frac{\overline{C}}{\overline{Y}}\frac{\overline{Y}}{\overline{GDP}}, \; \frac{\overline{B}^*}{\overline{Y}} = \frac{\overline{B}^*}{\overline{GDP}}\frac{\overline{GDP}}{\overline{Y}}. \tag{A2.16}$$

On the one hand, investment- GDP and consumption-GDP ratios can be calculated using the information from the country sample presented in table A.2.1.

On the other hand, the parameters β, δ, and α_1 can be set as follows. We assume that the total capital of the economy, PK, is composed of domestic and imported capital. Then the following expression holds:

$$PK = \alpha_1 + \alpha_3 \Rightarrow \alpha_1 = PK - \alpha_3, \tag{A2.17}$$

and

$$\alpha_3 = \frac{\overline{M}}{\overline{Y}} = \frac{\overline{M}}{\overline{GDP}}\frac{\overline{GDP}}{\overline{Y}}. \tag{A2.18}$$

We use various values for the parameters $PK \in [0.4, 0.65]$, with intervals of 0.05, and $\delta \in [0.01, 0.03]$ (the depreciation rate), with intervals of 0.005, to get the steady-state ratios for investment and consumption. A summary of the parameters needed for this calculation is presented in table A.2.2. The accuracy in terms of errors between actual and estimated ratios is presented in table A.2.3, which indicates that the parameters in table A.2.2 are reasonable for making our estimates.

Table A.2.1: GDP Ratios in Steady State obtained from country samples

	Australia	Canada	Chile	Colombia	Mexico	Nueva Zelanda
$\frac{\overline{B}^*}{\overline{GDP}}$	0.99	1.19	0.42	0.44	0.36	0.98
$\frac{\overline{X}^{CM}}{\overline{GDP}}$	0.18	0.23	0.15	0.09	0.01	0.10
$\frac{\overline{M}}{\overline{GDP}}$	0.20	0.33	0.30	0.19	0.29	0.28
$\frac{\overline{G}}{\overline{GDP}}$	0.17	0.20	0.11	0.17	0.11	0.18
$\frac{\overline{X}}{\overline{GDP}}$	0.19	0.35	0.34	0.16	0.28	0.29

Source: Authors' calculations.
Notes: B^*: external debt; GDP: gross domestic output; X^{CM}: commodity exports; G: general government consumption expenditure; M: imports of goods and services; and X: exports of goods and services.

Table A.2.2: Calibrated Parameters to Calculate Investment-GDP and Consumption-GDP Ratios in Steady State

	Australia	Canada	Chile	Colombia	Mexico	Nueva Zelanda
$\mathcal{PK}$	0.60	0.50	0.50	0.40	0.55	0.45
α_1	0.42	0.29	0.26	0.23	0.32	0.22
α_2	0.40	0.45	0.50	0.60	0.45	0.55
α_3	0.17	0.25	0.23	0.16	0.22	0.22
δ	0.01	0.01	0.02	0.02	0.01	0.03

Sources: Authors' calculations.
Notes:PK: domestic and imported capital; α_1: capital share; α_2: labor share; α_3: import share; and δ: depreciation rate. In all countries, we assume a value for parameter β of 0.99.

Table A.2.3: Calibrated Investment-GDP and Consumption-GDP Ratios in Steady State

		Australia	Canada	Chile	Colombia	Mexico	Nueva Zelanda
$\frac{\overline{C}}{\overline{GDP}}$	Model	0.55	0.54	0.63	0.63	0.67	0.59
	Data	0.56	0.55	0.61	0.64	0.67	0.58
	Error	0.012	0.011	0.018	0.013	0.001	0.010
$\frac{\overline{I}}{\overline{GDP}}$	Model	0.25	0.23	0.24	0.18	0.20	0.21
	Data	0.26	0.22	0.23	0.20	0.20	0.22
	Error	0.007	0.018	0.016	0.021	0.001	0.002

Sources: Authors' calculations.
Notes: GDP: gross domestic output; C: private consumption expenditure; and I: gross fixed capital formation.

Indexation in the Phillips curve

In relation to the calibration of the Phillips curve of the prices of products exported from small open economies, there is a wide dispersion of estimated values for price indexing in studies between and within countries. In the cases of Europe and the United States, Smets and Wouters (2003,2007) estimate a δ_X of 0.65 for Europe and 0.2 for the United States; Galí, Gertler, and Lopez-Salido (2001) obtain estimates of 0.6 for both European and U.S. data; and Christiano, Eichenbaum, and Evans (2005) find that full dynamic indexation delivers the best-fitting value for U.S. data.

In the case of Japan, Fujiwara, Hirose and Shintani (2011) find a value of 0.3 for the parameter δ_X, but Iiboshi et al (2015) obtain much higher estimated values of 0.5–0.8. For China, Dai, Minford, and Zhou (2015) find values of 0.17–0.6 depending on the econometric technique used, while Li and Liu (2017) find values around 0.6.

The labor markup

Finally, for the calculation of the parameter ϵ_w, there is no direct information, as in the case of ϵ_D with De Loecker and Eeckhout (2018), so we need to use an approximation. This was based on two facts. First, in the steady state, wage flexibility allows demand to be equalized with labor supply:

$$\left(\frac{\epsilon_w}{\epsilon_w - 1}\right) \overline{N}^{\varphi-1}\overline{C}^{\sigma} = (1-t)\,\alpha_2 \frac{\overline{Y}}{\overline{N}}, \tag{A2.19}$$

where t is the tax wedge and $\left(\frac{\epsilon_w}{\epsilon_w-1}\right)$ is the markup that families get, after firms deduct their markup, since we assume that firms also have market power. Second, in the literature, the estimated values of parameters σ and φ are remarkably close to 2, which is also our priority for both cases. Therefore, assuming that both parameters will be close to two is a reasonable approximation, as we found in our estimates (see Appendix A.5). The above equation can then be ordered as follows, assuming that the level of technology has been set arbitrarily such that $\overline{Y} = 1.0$ in steady state:

$$\left(\frac{\epsilon_w}{\epsilon_w - 1}\right) = (1-t)\,\alpha_2 \frac{1}{\overline{N}^2\overline{C}^2}. \tag{A2.20}$$

We obtain the value of ϵ_w using the steady state value for $\overline{C}$ from above and the tax information t for 2018 from the OECD.Stat database and imposing the effective values of total hours worked over the total time for work in year $\overline{N}$ for 2018, also from the OECD. Stat database.

Appendix A.3 Log linear model, adjustments, additional shocks, and definition of some estimated and calibrated parameters

We include a demand shock in the log-linear model, $u_t^D \sim N(0, \sigma_D^2)$, in the Euler equation to improve the model fit to the data.

In relation to the wage setting in the model, the parameters θ_w and δ_w are estimated, and the parameter ϵ_w is calibrated according to information from each country explained in the previous section.

Then, to improve the empirical adjustment of the macroeconomic model –and parallel to the Euler equation for consumption– we also include a supply shock $u_t^s \sim N(0, \sigma_s^2)$ in the Phillips curve of the log-linear model. For the same reasons, we assume that there are lags in conditional demand and in the response of each demand to input prices. In the log-linear model, the lags for the conditional demand for imports and labor are measured by parameters Ω_M and Ω_N, respectively. In a similar fashion, the parameters that measure this lower response to input prices are ξ_{01} and ξ_{02} for the conditional demand for imports and labor, respectively.

As in the case of wages, the parameters θ_D and δ_D are estimated, and the parameter ϵ_D is calibrated according to information for each country, which was obtained from De Loecker and Eeckhout (2018).

Also relevant in the estimates, it is the parameters AC that measure the response of investment to Tobin's Q in real terms or Q_t^T, this parameter is the inverse of the adjustment costs. For the same reasons that we included shocks in the Euler and Phillips equations, the log-linear model includes a shock in the investment equation, $u_t^I \sim N(0, \sigma_I^2)$, where this variable is determined by Tobin's Q.

Other shocks are $\hat{u}_t^{RP}$, $\hat{u}_t^{MP}$, $\hat{u}_t^{G}$, and $\hat{u}_t^{XD}$, all with normal distributions and represent shocks to the risk premium, monetary policy, fiscal spending, and exports, respectively.

Next, the parameter η^d –the price elasticity of demand– was also calibrated based on market power information obtained from De Loecker and Eeckhout (2018), taking the average of China, the United States, Europe, and Japan.

Unlike domestic prices and wages, the Phillips curve associated with the P_t^X price is partially calibrated according to values used in the literature to model the international inflation rate. The parameters associated with this calibrated Phillips curve are δ_X, an indexation measure; θ_X, the probability that a given price can be re-optimized in any period; and ϵ_X, the elasticity of substitution between any two firms. The values are equal to 0.45, 0.75, and

3.1, respectively. The criteria for choosing these values were the following: for indexation, we averaged the value used in several works, which estimate this parameter between 0.2 and 1.0 (see previous section for details); for the probability of changing prices, we used a standard value of average price rigidity used in many models; and for the substitution elasticity, we averaged the markups for China, the United States, Europe, and Japan, as reported by De Loecker and Eeckhout (2018). However, the marginal costs –expressed in real dollar terms– and the parameters associated with economies of scale are specific to each open economy.

Finally, in the log-linear version of the model, we approximate P_t^X/P_t^* for the differences $(\pi_t^X - \pi_t^*)$, where π_t^X is an $AR(1)$ process and π_t^* corresponds to U.S. inflation.

The model is as follows:

$$\hat{c}_t^o = \frac{1}{1+\gamma}\mathbb{E}\{\hat{c}_{t+1}^o\} + \frac{\gamma}{1+\gamma}\hat{c}_{t-1}^o - \frac{1}{\sigma}\left(\frac{1-\gamma}{1+\gamma}\right)(\hat{r}_t - \mathbb{E}\{\hat{\pi}_{t+1}\}) + \hat{u}_t^D, \tag{A3.1}$$

$$\hat{c}_t^r = \hat{w}_t + \hat{n}_t, \tag{A3.2}$$

$$\hat{c}_t = (1-\lambda)\,\hat{c}_t^o + \lambda\hat{c}_t^r, \tag{A3.3}$$

$$\hat{q}_t = \Omega_Q\hat{q}_{t-1} + (1-\Omega_Q)\left(\mathbb{E}\{\hat{q}_{t+1}\} - (\hat{r}_t - \mathbb{E}\{\hat{\pi}_{t+1}\}) + \left(\hat{r}_t^* - \mathbb{E}\{\hat{\pi}_{t+1}^*\}\right) + \hat{\Phi}_t\right), \tag{A3.4}$$

$$\hat{\Phi}_t = \phi_{RP01}\left(\hat{b}_{t+1}^* - g\hat{d}p_t\right) + \phi_{RP02}\left(\mathbb{E}\{\hat{b}_{t+1}^*\} - \hat{q}_t^{TOBIN} - \mathbb{E}\{\hat{k}_{t+1}\} + \hat{q}_t - \mathbb{E}\{\hat{q}_{t+1}\}\right) + \hat{u}_t^{RP}, \tag{A3.5}$$

$$\hat{w}_t = \frac{\beta}{1+\beta}\mathbb{E}\{\hat{w}_{t+1}\} + \frac{1}{1+\beta}\hat{w}_{t-1} + \frac{\beta}{1+\beta}\mathbb{E}\{\hat{\pi}_{t+1}\} - \frac{(1+\beta\delta_W)}{1+\beta}\hat{\pi}_t - \frac{\lambda_W\mu_W}{1+\beta}$$
$$\left(\hat{w}_t - (\varphi-1)\,\hat{n}_t - \frac{\sigma}{1-\gamma}\left(\hat{c}_t^o - \gamma\hat{c}_{t-1}^o\right)\right), \tag{A3.6}$$

$$\hat{y}_t = \hat{a}_t + \alpha_1\left(\hat{k}_t + \hat{\mu}_t\right) + \alpha_2\hat{n}_t + \alpha_3\hat{m}_t, \tag{A3.7}$$

$$\hat{mc}_t^r = (\alpha_1\hat{z}_t + \alpha_2\hat{w}_t + \alpha_3\hat{q}_t), \tag{A3.8}$$

$$\hat{m}_t = \Omega_M\hat{m}_{t-1} + (1-\Omega_M)\left(\chi_{01}(\hat{z}_t - \hat{q}_t) + \hat{k}_t + \hat{\mu}_t\right), \tag{A3.9}$$

$$\hat{n}_t = \Omega_N\hat{n}_{t-1} + (1-\Omega_N)\left(\chi_{02}(\hat{z}_t - \hat{w}_t) + \hat{k}_t + \hat{\mu}_t\right), \tag{A3.10}$$

$$\hat{\pi}_t = \frac{\beta}{1+\beta\delta_D}\mathbb{E}\{\hat{\pi}_{t+1}\} + \frac{\delta_D}{1+\beta\delta_D}\hat{\pi}_{t-1} + \frac{1}{1+\beta\delta_D}\lambda_D\hat{mc}_t^r, \tag{A3.11}$$

$$\hat{q}_t^{TOBIN} = \beta\mathbb{E}\{\hat{q}_{t+1}^{TOBIN}\} + (1-(1-\delta)\beta)\,\mathbb{E}\{\hat{z}_{t+1}\} - (\hat{r}_t - \mathbb{E}\{\hat{\pi}_{t+1}\}), \tag{A3.12}$$

$$\hat{i}_t = \mathcal{AC}\hat{q}_t^{TOBIN} + \hat{k}_t + \hat{u}_t^{INV}, \tag{A3.13}$$

$$\hat{k}_{t+1} = \delta\left(\hat{i}_t - \xi\hat{\mu}_t\right) + (1-\delta)\hat{k}_t, \quad \xi = \frac{(1-(1-\delta)\beta)}{\delta\beta}, \tag{A3.14}$$

$$\hat{\mu}_t = \frac{1}{\eta_{MU}}\left(\hat{z}_t - \hat{q}_t^{TOBIN}\right), \tag{A3.15}$$

$$\hat{g}_t = \rho_G\hat{g}_{t-1} + \theta_B\left(\hat{b}^*_{t+1} - \hat{gdp}_t\right) + \hat{u}_t^G, \tag{A3.16}$$

$$\hat{r}_t = \Omega_R\hat{r}_{t-1} + (1-\Omega_R)\left(\psi_\pi\hat{\pi}_t + \psi_Y\hat{gdp}_t^{NEW} + \psi_1\hat{q}_t + \psi_2\Delta\hat{q}_t\right) + \hat{u}_t^{MP}, \tag{A3.17}$$

$$\hat{\bar{r}}_t = \hat{r}_t - \mathbb{E}\{\hat{\pi}_{t+1}\}, \tag{A3.18}$$

$$\hat{\pi}_t^X = \frac{\beta^X}{1+\beta^X\delta_D^X}\mathbb{E}\{\hat{\pi}_{t+1}^X\} + \frac{\delta_D^X}{1+\beta^X\delta_D^X}\hat{\pi}_{t-1}^X + \frac{1}{1+\beta^X\delta_D^X}\lambda_D^X\left(\hat{mc}_t^r - \hat{q}_t + \frac{1}{\eta}\left(\hat{x}_t - \hat{y}_t^*\right)\right), \tag{A3.19}$$

$$\hat{x}_t^D = \Omega_X\hat{x}_{t-1}^D + (1-\Omega_X)\left(\eta\left(\hat{\pi}_t^* - \hat{\pi}_t^X\right) + \hat{y}_t^{EXT}\right) + \hat{u}_t^{XD}, \tag{A3.20}$$

$$\frac{X_{ss}}{Y_{ss}}\hat{x}_t = \frac{X_{ss}^D}{Y_{ss}}\left(\hat{x}_t^D + \hat{q}_t + \hat{\pi}_t^X - \hat{\pi}_t^*\right) + \frac{Q_{ss}^{CO}}{Y_{ss}}\left(\hat{q}_t + \hat{p}_t^{CM} + \hat{q}_t^{CO}\right), \tag{A3.21}$$

$$\hat{q}_t^{CO} = \Omega_{QCO}\hat{q}_{t-1}^{CO} + (1-\Omega_{QCO})\,\phi_{QCO}\hat{p}_t^{CM}, \tag{A3.22}$$

$$\hat{y}_t = \frac{C_{ss}}{Y_{ss}}\hat{c}_t + \frac{X_{ss}}{Y_{ss}}\hat{x}_t + \frac{I_{ss}}{Y_{ss}}\hat{i}_t + \frac{G_{ss}}{Y_{ss}}\hat{g}_t, \tag{A3.23}$$

$$\hat{gdp}_t = \frac{Y_{ss}}{GDP_{ss}}\hat{y}_t - \frac{M_{ss}}{GDP_{ss}}\left(\hat{q}_t + \hat{m}_t\right), \tag{A3.24}$$

$$\hat{gdp}_t^{NEW} = \frac{Y_{ss}}{GDP_{ss}}\left(\frac{C_{ss}}{Y_{ss}}\hat{c}_t + \frac{I_{ss}}{Y_{ss}}\hat{i}_t + \frac{G_{ss}}{Y_{ss}}\hat{g}_t + \frac{X_{ss}^D}{Y_{ss}}\hat{x}_t^D + \frac{Q_{ss}^{CO}}{Y_{ss}}\hat{q}_t^{CO}\right) - \frac{M_{ss}}{GDP_{ss}}\hat{m}_t, \tag{A3.25}$$

$$\frac{C_{ss}}{GDP_{ss}}\hat{c}_t = g\hat{d}p_t - \frac{I_{ss}}{GDP_{ss}}\hat{i}_t - \frac{G_{ss}}{GDP_{ss}}\hat{g}_t + \frac{B^*_{ss}}{GDP_{ss}}\left(\hat{q}_t - \mathbb{E}\{\hat{q}_{t+1}\} - \left(\hat{r}^*_t - \mathbb{E}\{\hat{\pi}^*_{t+1}\}\right) + \hat{b}^*_{t+1} - \hat{\Phi}_t - R_{ss}\hat{b}^*_t\right), \tag{A3.26}$$

$$\hat{a}_t = \rho_A \hat{a}_{t-1} + \hat{\epsilon}^A_t, \tag{A3.27}$$

$$\hat{u}^D_t = \hat{\epsilon}^D_t, \tag{A3.28}$$

$$\hat{u}^{RP}_t = \rho_{RP}\hat{u}^{RP}_{t-1} + \hat{\epsilon}^{RP}_t, \tag{A3.29}$$

$$\hat{u}^S_t = \hat{\epsilon}^S_t, \tag{A3.30}$$

$$\hat{u}^G_t = \hat{\epsilon}^G_t, \tag{A3.31}$$

$$\hat{u}^{MP}_t = \hat{\epsilon}^{MP}_t, \tag{A3.32}$$

$$\hat{u}^{INV}_t = \hat{\epsilon}^{INV}_t, \tag{A3.33}$$

$$\hat{u}^{XD}_t = \hat{\epsilon}^{XD}_t, \tag{A3.34}$$

$$\hat{p}^{CM}_t = \rho_{PCM}\hat{p}^{CM}_{t-1} + \hat{\epsilon}^{PCM}_t, \tag{A3.35}$$

$$\hat{y}^*_t = \rho_{YEXT}\hat{y}^*_{t-1} + \hat{\epsilon}^{YEXT}_t, \tag{A3.36}$$

$$\hat{\pi}^*_t = \rho_{PIEXT}\hat{\pi}^*_{t-1} + \hat{\epsilon}^{PIEXT}_t, \tag{A3.37}$$

$$\hat{r}^*_t = \rho_{NREXT}\hat{r}^*_{t-1} + \hat{\epsilon}^{NREXT}_t, \tag{A3.38}$$

$$GDP\_OBS = \phi_0^{TREND} + g\hat{d}p_t^{NEW} - g\hat{d}p_{t-1}^{NEW} + \hat{\epsilon}^{GDP\_OBS}_t, \tag{A3.39}$$

$$G\_OBS = \phi_0^{TREND} + \hat{g}_t - \hat{g}_{t-1}, \tag{A3.40}$$

$$C\_OBS = \phi_0^{TREND} + \hat{c}_t - \hat{c}_{t-1} + \hat{\epsilon}_t^{C\_OBS}, \tag{A3.41}$$

$$INV\_OBS = \phi_0^{TREND} + \hat{i}_t - \hat{i}_{t-1} + \hat{\epsilon}_t^{INV\_OBS}, \tag{A3.42}$$

$$X\_OBS = \phi_0^{TREND} + \rho_X \left(\hat{x}_t - \hat{x}_{t-1}\right) + \hat{\epsilon}_t^{X\_OBS}, \tag{A3.43}$$

$$M\_OBS = \phi_0^{TREND} + \hat{m}_t - \hat{m}_{t-1} + \hat{\epsilon}_t^{M\_OBS}, \tag{A3.44}$$

$$PI\_OBS = \phi_0^{PI} + \hat{\pi}_t - \hat{\pi}_{t-1}, \tag{A3.45}$$

$$NR\_OBS = \phi_0^{NR} + \hat{r}_t - \hat{r}_{t-1}, \tag{A3.46}$$

$$Q\_OBS = \phi_0^{Q} + \hat{q}_t - \hat{q}_{t-1}, \tag{A3.47}$$

$$P\_CM\_OBS = \phi_0^{PCM} + \hat{p}_t^{CM} - \hat{p}_{t-1}^{CM}, \tag{A3.48}$$

$$EMP\_OBS = \phi_0^{EMP} + \hat{n}_t - \hat{n}_{t-1} + \hat{\epsilon}_t^{EMP\_OBS}, \tag{A3.49}$$

$$WAGE\_OBS = \phi_0^{W} + \hat{w}_t - \hat{w}_{t-1} + \hat{\epsilon}_t^{WAGE\_OBS}, \tag{A3.50}$$

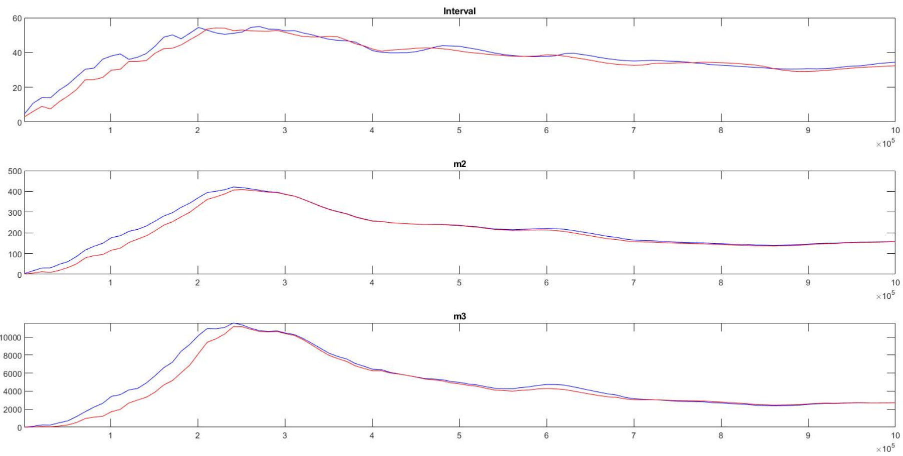
$$PI\_EXT\_OBS = \phi_0^{PIEXT} + \hat{\pi}_t^* - \hat{\pi}_{t-1}^*, \tag{A3.51}$$

$$NR\_EXT\_OBS = \phi_0^{NREXT} + \hat{r}_t^* - \hat{r}_{t-1}^*, \tag{A3.52}$$

$$Y\_EXT\_OBS = \phi_0^{TREND\_YEXT} + \hat{y}_t^* - \hat{y}_{t-1}^*. \tag{A3.53}$$

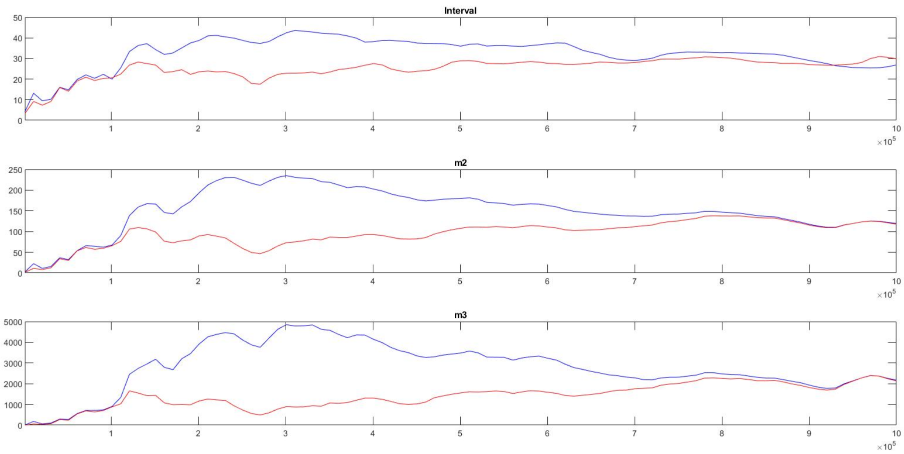
Appendix A.4 Stability of the Estimates

Figure A.4.1: Brooks-Gelman Criteria for Checking Stability of Estimates: Australia



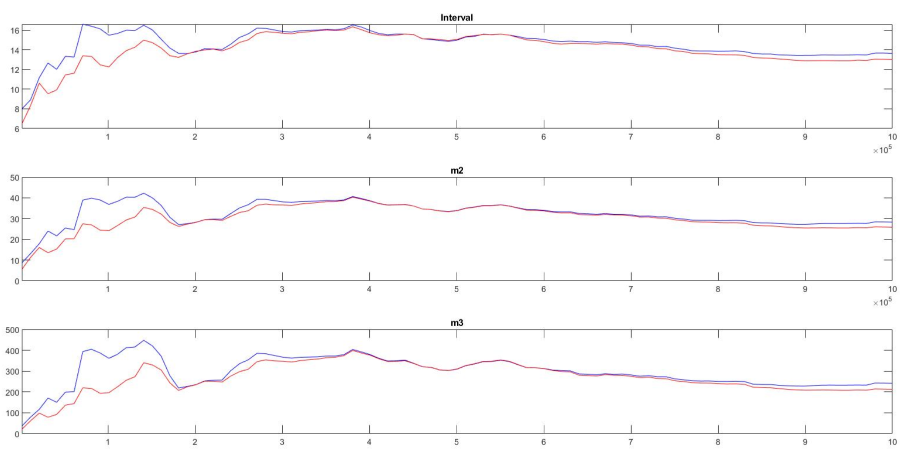
Source: Authors' calculations, based on the model presented in section 2 of the article.
Notes: The figure shows the differences of the value of the marginal likelihood with respect to the within and between mean (first graph: Interval), variance (second graph: m2), and a third moment (third graph: m3), according to the standard methodology of Brooks and Gelman (1998). The blue line corresponds to the convergence between the chains; the red line is the convergence within the chains.

Figure A.4.2: Brooks-Gelman Criteria for Checking Stability of Estimates: Canada



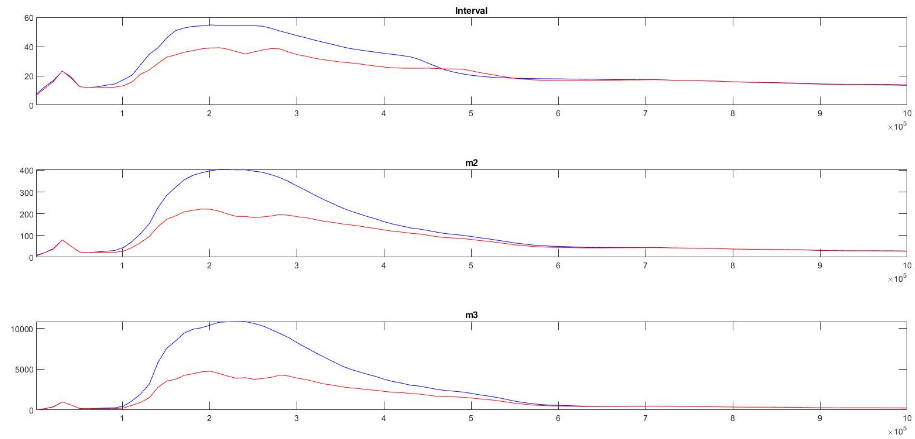
Source: Authors' calculations, based on the model presented in section 2 of the article.
Note: See figure A.4.1.

Figure A.4.3: Brooks-Gelman Criteria for Checking Stability of Estimates: Chile



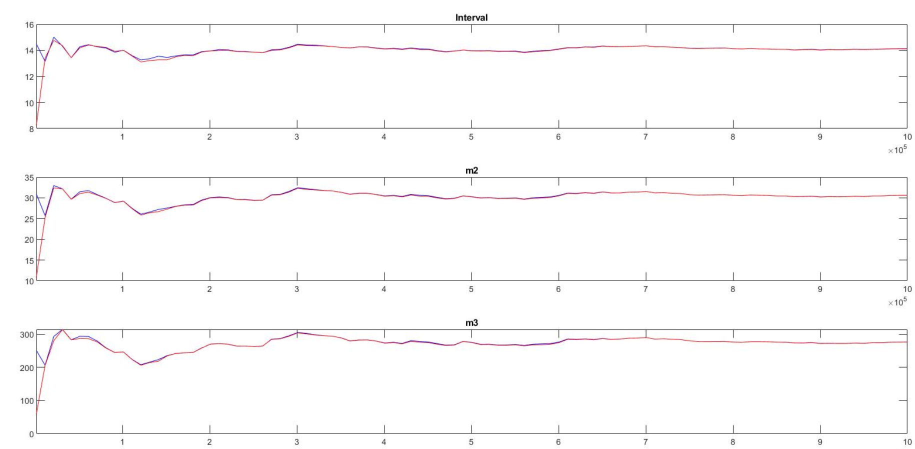
Source: Authors' calculations, based on the model presented in section 2 of the article.
Note: See figure A.4.1.

Figure A.4.4: Brooks-Gelman Criteria for Checking Stability of Estimates: Colombia



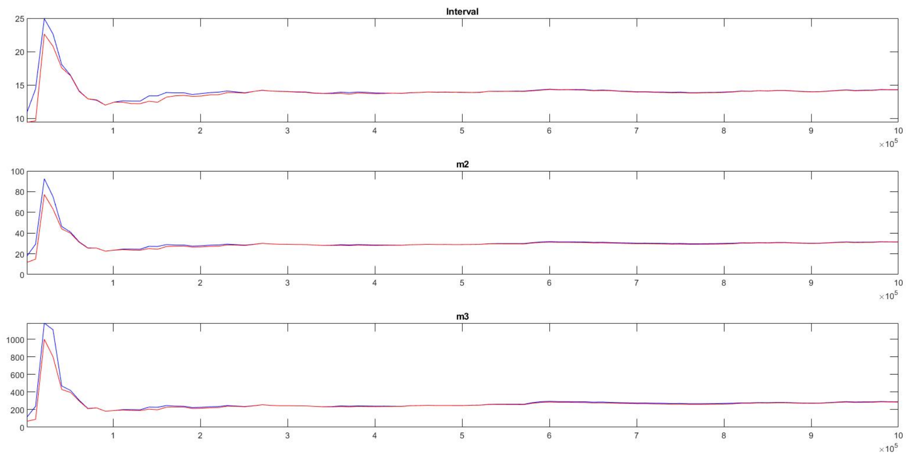
Source: Authors' calculations, based on the model presented in section 2 of the article.
Note: See figure A.4.1.

Figure A.4.5: Brooks-Gelman Criteria for Checking Stability of Estimates: Mexico



Source: Authors' calculations, based on the model presented in section 2 of the article.
Note: See figure A.4.1.

Figure A.4.6: Brooks-Gelman Criteria for Checking Stability of Estimates: New Zealand



Source: Authors' calculations, based on the model presented in section 2 of the article.
Note: See figure A.4.1.

Appendix A.5 Estimated Parameters

This appendix presents the estimates for all the model parameters and the shocks mentioned in the article by country.

Table A.5.1: Estimated Parameters: Australia

Parameters	Type[a]	Prior Mean	Posterior Mean	90% HPDI	
Structural Parameters					
γ	B	0.30	0.48	0.42	0.52
σ	G	2.00	1.99	1.98	1.99
λ_C	B	0.20	0.16	0.11	0.21
Ω_Q	U	0.30	0.19	0.10	0.29
ϕ_{RP01}	B	0.10	0.07	0.06	0.08
ϕ_{RP02}	B	0.10	0.05	0.05	0.06
θ_W	B	0.75	0.78	0.77	0.78
δ_W	B	0.45	0.39	0.35	0.41
φ	G	2.00	1.98	1.97	1.99
η^{MU}	U	0.26	0.28	0.15	0.42
Ω_M	B	0.50	0.57	0.54	0.60
Ω_N	B	0.50	0.61	0.56	0.66
θ_D	B	0.75	0.74	0.74	0.75
δ_D	B	0.45	0.60	0.54	0.66
$\mathcal{AC}$	G	0.25	0.27	0.22	0.32
Ω_R	B	0.70	0.70	0.66	0.74
ψ_π	G	2.00	1.88	1.84	1.92
ψ_Y	G	0.50	1.07	1.00	1.14
ψ_{01}	G	0.10	0.08	0.08	0.09
ψ_{02}	G	0.10	0.10	0.09	0.10
$\phi_{X^{CM}}$	U	0.50	0.20	0.09	0.31
$\Omega_{X^{CM}}$	U	0.50	0.14	0.00	0.32
Ω_X	B	0.50	0.53	0.50	0.57
θ_B	U	-0.05	-0.01	-0.01	0.00
Persistence of the Exogenous Processes					
ρ_A	B	0.50	0.94	0.92	0.95
ρ_{PCM}	B	0.50	0.87	0.85	0.88
ρ_{RP}	B	0.50	1.00	1.00	1.00
ρ_G	B	0.50	0.85	0.79	0.91
ρ_{YEXT}	B	0.50	0.94	0.93	0.95
ρ_{PIEXT}	B	0.50	0.83	0.78	0.89
ρ_{NREXT}	B	0.50	0.94	0.92	0.95

Source: Authors' calculations. *Note:*[a] U: Uniform, G: Gamma, B: Beta, N: Normal, IG: Inverse-Gamma.

Table A.5.2: Estimated Standard Deviations and Measurement Equation Parameters: Australia

PARAMETERS	TYPE[a]	PRIOR MEAN	POSTERIOR MEAN	90% HPDI	
St. Dev. Innovations					
$\hat{\epsilon}_t^A$	IG	1.00	0.98	0.81	1.14
$\hat{\epsilon}_t^D$	IG	1.00	1.76	1.50	2.03
$\hat{\epsilon}_t^{RP}$	IG	1.00	1.13	0.92	1.33
$\hat{u\epsilon}_t^G$	IG	1.00	1.16	1.02	1.30
$\hat{\epsilon}_t^{MP}$	IG	0.25	1.05	0.89	1.22
$\hat{\epsilon}_t^{PCM}$	IG	6.00	6.88	6.26	7.52
$\hat{\epsilon}_t^S$	IG	1.00	0.32	0.27	0.37
$\hat{\epsilon}_t^{INV}$	IG	3.00	2.05	1.66	2.37
$\hat{\epsilon}_t^{XD}$	IG	4.00	4.11	3.85	4.34
$\hat{\epsilon}_t^{YEXT}$	IG	1.00	0.68	0.59	0.77
$\hat{\epsilon}_t^{PIEXT}$	IG	1.00	0.68	0.60	0.77
$\hat{\epsilon}_t^{NREXT}$	IG	1.00	0.85	0.73	0.96
Measurement Equation Parameters					
ρ^X	U	1.00	0.04	0.00	0.08
ϕ_0^{TREND}	N	0.67	0.69	0.64	0.74
ϕ_0^{NR}	G	0.51	0.61	0.56	0.66
ϕ_0^{PI}	G	1.00	1.13	1.08	1.18
ϕ_0^Q	N	0.20	0.38	0.31	0.46
ϕ_0^{PCM}	N	0.12	0.12	0.08	0.15
$\phi_0^{TREND\_YEXT}$	N	0.60	0.57	0.53	0.61
ϕ_0^{PIEXT}	G	0.55	0.56	0.54	0.58
ϕ_0^{NREXT}	G	0.65	0.62	0.57	0.66
ϕ_0^{EMP}	N	0.67	0.66	0.58	0.75
ϕ_0^W	N	0.25	0.36	0.28	0.43
St. Dev. of the Measurement Equations					
$\hat{\epsilon}_t^X$	IG	4.50	3.26	3.03	3.51
$\hat{\epsilon}_t^M$	IG	4.50	3.71	3.45	3.96
$\hat{\epsilon}_t^{EMP}$	IG	2.50	1.54	1.32	1.77
$\hat{\epsilon}_t^{WAGE}$	IG	2.50	1.89	1.45	2.26

Source: Authors' calculations. *Note:*[a] U: Uniform, G: Gamma, B: Beta, N: Normal, IG: Inverse-Gamma.

Table A.5.3: Estimated Parameters: Canada

Parameters	Type[a]	Prior Mean	Posterior Mean	90% HPDI	
Structural Parameters					
γ	B	0.30	0.40	0.37	0.43
σ	G	2.00	2.00	2.00	2.01
λ_C	B	0.35	0.36	0.34	0.37
Ω_Q	U	0.20	0.40	0.39	0.40
ϕ_{RP01}	B	0.15	0.09	0.09	0.09
ϕ_{RP02}	B	0.15	0.07	0.07	0.07
θ_W	B	0.75	0.62	0.60	0.64
δ_W	B	0.45	0.38	0.34	0.42
φ	G	2.00	1.99	1.99	2.00
η^{MU}	U	0.26	0.03	0.01	0.05
Ω_M	B	0.50	0.41	0.39	0.43
Ω_N	B	0.50	0.42	0.40	0.44
θ_D	B	0.75	0.72	0.72	0.73
δ_D	B	0.45	0.41	0.39	0.44
$\mathcal{AC}$	G	0.25	0.28	0.23	0.33
Ω_R	B	0.70	0.83	0.79	0.86
ψ_π	G	2.00	1.88	1.85	1.91
ψ_Y	G	0.50	0.75	0.68	0.82
ψ_{01}	G	0.10	0.06	0.06	0.07
ψ_{02}	G	0.10	0.14	0.13	0.14
$\phi_{X^{CM}}$	U	0.50	0.93	0.86	1.00
$\Omega_{X^{CM}}$	U	0.50	1.00	1.00	1.00
Ω_X	B	0.50	0.73	0.70	0.75
θ_B	U	-0.05	-0.06	-0.06	-0.05
Persistence of the Exogenous Processes					
ρ_A	B	0.50	0.94	0.92	0.95
ρ_{PCM}	B	0.50	0.76	0.74	0.78
ρ_{RP}	B	0.50	0.55	0.54	0.56
ρ_G	B	0.50	0.95	0.94	0.95
ρ_{YEXT}	B	0.50	0.94	0.93	0.95
ρ_{PIEXT}	B	0.50	0.95	0.95	0.95
ρ_{NREXT}	B	0.50	0.76	0.74	0.79

Source: Authors' calculations. *Note:*[a] U: Uniform, G: Gamma, B: Beta, N: Normal, IG: Inverse-Gamma.

Table A.5.4: Estimated Standard Deviations and Measurement Equation Parameters: Canada

Parameters	Type[a]	Prior Mean	Posterior Mean	90% HPDI	
St. Dev. Innovations					
$\hat{\epsilon}_t^{A}$	IG	1.00	1.90	1.64	2.20
$\hat{\epsilon}_t^{D}$	IG	1.00	2.99	2.77	3.21
$\hat{\epsilon}_t^{RP}$	IG	1.00	4.25	4.01	4.50
$\hat{u\epsilon}_t^{G}$	IG	1.00	1.10	0.96	1.24
$\hat{\epsilon}_t^{MP}$	IG	0.25	0.62	0.51	0.72
$\hat{\epsilon}_t^{PCM}$	IG	6.00	18.74	18.26	19.39
$\hat{\epsilon}_t^{S}$	IG	1.00	0.57	0.36	0.76
$\hat{\epsilon}_t^{INV}$	IG	3.00	2.90	2.64	3.11
$\hat{\epsilon}_t^{XD}$	IG	4.00	5.72	5.55	5.92
$\hat{\epsilon}_t^{YEXT}$	IG	1.00	0.67	0.61	0.73
$\hat{\epsilon}_t^{PIEXT}$	IG	1.00	0.90	0.77	1.03
$\hat{\epsilon}_t^{NREXT}$	IG	1.00	1.47	1.31	1.63
Measurement Equation Parameters					
ρ^{X}	U	1.00	0.05	0.00	0.08
ϕ_0^{TREND}	N	0.67	0.90	0.85	0.97
ϕ_0^{NR}	G	0.51	0.42	0.37	0.48
ϕ_0^{PI}	G	1.00	0.59	0.54	0.65
ϕ_0^{Q}	N	0.20	0.69	0.60	0.77
ϕ_0^{PCM}	N	0.12	0.25	0.19	0.31
$\phi_0^{TREND\_YEXT}$	N	0.60	0.64	0.61	0.67
ϕ_0^{PIEXT}	G	0.55	0.29	0.26	0.31
ϕ_0^{NREXT}	G	0.65	0.49	0.47	0.51
ϕ_0^{EMP}	N	0.67	0.23	0.15	0.32
ϕ_0^{W}	N	0.25	0.36	0.32	0.40
St. Dev. of the Measurement Equations					
$\hat{\epsilon}_t^{X}$	IG	4.50	2.92	2.69	3.17
$\hat{\epsilon}_t^{M}$	IG	4.50	3.04	2.78	3.30
$\hat{\epsilon}_t^{EMP}$	IG	2.50	2.76	2.51	3.05
$\hat{\epsilon}_t^{WAGE}$	IG	2.50	1.38	1.20	1.55

Source: Authors' calculations. *Note:*[a] U: Uniform, G: Gamma, B: Beta, N: Normal, IG: Inverse-Gamma.

Table A.5.5: Estimated Parameters: Chile

Parameters	Type[a]	Prior Mean	Posterior Mean	90% HPDI	
Structural Parameters					
γ	B	0.30	0.26	0.18	0.35
σ	G	2.00	1.99	1.98	2.01
λ_C	B	0.35	0.41	0.35	0.48
Ω_Q	U	0.30	0.12	0.00	0.26
ϕ_{RP01}	B	0.35	0.27	0.19	0.37
ϕ_{RP02}	B	0.35	0.17	0.11	0.23
θ_W	B	0.75	0.84	0.79	0.89
δ_W	B	0.45	0.63	0.47	0.77
φ	G	2.00	2.00	1.98	2.01
η^{MU}	U	0.26	0.03	0.01	0.06
Ω_M	B	0.50	0.48	0.42	0.54
Ω_N	B	0.50	0.76	0.72	0.79
θ_D	B	0.75	0.75	0.73	0.76
δ_D	B	0.45	0.44	0.35	0.51
$\mathcal{AC}$	G	0.25	0.31	0.22	0.40
Ω_R	B	0.70	0.89	0.87	0.91
ψ_π	G	2.00	1.99	1.90	2.07
ψ_Y	G	0.50	0.84	0.54	1.08
ψ_{01}	G	0.10	0.09	0.08	0.10
ψ_{02}	G	0.10	0.11	0.09	0.13
$\phi_{X^{CM}}$	U	0.50	0.05	0.00	0.12
$\Omega_{X^{CM}}$	U	0.50	0.88	0.70	1.00
Ω_X	B	0.50	0.71	0.64	0.79
θ_B	U	-0.05	-0.01	-0.01	0.00
Persistence of the Exogenous Processes					
ρ_A	B	0.50	0.94	0.93	0.95
ρ_{PCM}	B	0.50	0.80	0.76	0.85
ρ_{RP}	B	0.50	0.79	0.55	1.00
ρ_G	B	0.50	0.79	0.70	0.88
ρ_{YEXT}	B	0.50	0.91	0.88	0.95
ρ_{PIEXT}	B	0.50	0.85	0.80	0.90
ρ_{NREXT}	B	0.50	0.95	0.94	0.95

Source: Authors' calculations. *Note:*[a] U: Uniform, G: Gamma, B: Beta, N: Normal, IG: Inverse-Gamma.

Table A.5.6: Estimated Standard Deviations and Measurement Equation Parameters: Chile

Parameters	Type[a]	Prior Mean	Posterior Mean	90% HPDI	
St. Dev. Innovations					
$\hat{\epsilon}_t^{A}$	IG	1.00	1.32	1.08	1.55
$\hat{\epsilon}_t^{D}$	IG	1.00	0.56	0.40	0.73
$\hat{\epsilon}_t^{RP}$	IG	1.00	4.53	3.29	5.63
$\hat{u\epsilon}_t^{G}$	IG	1.00	1.29	1.09	1.47
$\hat{\epsilon}_t^{MP}$	IG	0.25	0.38	0.24	0.51
$\hat{\epsilon}_t^{PCM}$	IG	6.00	14.30	12.30	16.45
$\hat{\epsilon}_t^{S}$	IG	1.00	0.44	0.35	0.53
$\hat{\epsilon}_t^{INV}$	IG	3.00	2.30	1.86	2.74
$\hat{\epsilon}_t^{XD}$	IG	4.00	7.77	6.13	9.29
$\hat{\epsilon}_t^{YEXT}$	IG	1.00	0.69	0.59	0.79
$\hat{\epsilon}_t^{PIEXT}$	IG	1.00	0.70	0.61	0.79
$\hat{\epsilon}_t^{NREXT}$	IG	1.00	0.69	0.59	0.78
Measurement Equation Parameters					
ρ^{X}	U	1.00	0.13	0.02	0.22
ϕ_0^{TREND}	N	0.67	0.92	0.84	1.00
ϕ_0^{NR}	G	0.51	0.84	0.79	0.88
ϕ_0^{PI}	G	1.00	1.14	1.09	1.20
ϕ_0^{Q}	N	0.20	0.39	0.30	0.48
ϕ_0^{PCM}	N	0.12	0.24	0.09	0.36
$\phi_0^{TREND\_YEXT}$	N	0.60	0.52	0.48	0.56
ϕ_0^{PIEXT}	G	0.55	0.55	0.52	0.58
ϕ_0^{NREXT}	G	0.65	0.56	0.51	0.62
ϕ_0^{EMP}	N	0.67	0.46	0.31	0.62
ϕ_0^{W}	N	0.25	0.27	0.13	0.38
St. Dev. of the Measurement Equations					
$\hat{\epsilon}_t^{X}$	IG	4.50	3.82	3.44	4.18
$\hat{\epsilon}_t^{M}$	IG	4.50	3.86	3.48	4.24
$\hat{\epsilon}_t^{EMP}$	IG	2.50	1.92	1.62	2.22
$\hat{\epsilon}_t^{WAGE}$	IG	2.50	1.31	1.15	1.47

Source: Authors' calculations. *Note:*[a] U: Uniform, G: Gamma, B: Beta, N: Normal, IG: Inverse-Gamma.

Table A.5.7: Estimated Parameters: Colombia

Parameters	Type[a]	Prior Mean	Posterior Mean	90% HPDI	
Structural Parameters					
γ	B	0.30	0.33	0.26	0.39
σ	G	2.00	2.00	1.98	2.01
λ_C	B	0.30	0.35	0.28	0.41
Ω_Q	U	0.20	0.17	0.00	0.30
ϕ_{RP01}	B	0.35	0.20	0.14	0.26
ϕ_{RP02}	B	0.35	0.13	0.10	0.16
θ_W	B	0.75	0.75	0.73	0.76
δ_W	B	0.45	0.41	0.35	0.49
φ	G	2.00	2.00	1.98	2.02
η^{MU}	U	0.26	0.10	0.01	0.22
Ω_M	B	0.50	0.43	0.37	0.50
Ω_N	B	0.50	0.61	0.50	0.70
θ_D	B	0.75	0.73	0.71	0.74
δ_D	B	0.45	0.46	0.39	0.53
$\mathcal{AC}$	G	0.25	0.32	0.23	0.40
Ω_R	B	0.70	0.74	0.69	0.79
ψ_π	G	2.00	1.97	1.90	2.05
ψ_Y	G	0.50	0.79	0.64	0.94
ψ_{01}	G	0.10	0.09	0.07	0.10
ψ_{02}	G	0.10	0.09	0.08	0.11
$\phi_{X^{CM}}$	U	0.50	0.03	0.00	0.06
$\Omega_{X^{CM}}$	U	0.50	0.32	0.00	0.63
Ω_X	B	0.50	0.49	0.43	0.56
θ_B	U	-0.05	-0.04	-0.05	-0.02
Persistence of the Exogenous Processes					
ρ_A	B	0.50	0.88	0.84	0.92
ρ_{PCM}	B	0.50	0.67	0.59	0.74
ρ_{RP}	B	0.50	0.99	0.99	1.00
ρ_G	B	0.50	0.56	0.36	0.79
ρ_{YEXT}	B	0.50	0.84	0.78	0.90
ρ_{PIEXT}	B	0.50	0.68	0.58	0.78
ρ_{NREXT}	B	0.50	0.92	0.90	0.95

Source: Authors' calculations. *Note:*[a] U: Uniform, G: Gamma, B: Beta, N: Normal, IG: Inverse-Gamma.

Table A.5.8: Estimated Standard Deviations and Measurement Equation Parameters: Colombia

Parameters	Type[a]	Prior Mean	Posterior Mean	90% HPDI	
St. Dev. Innovations					
$\hat{\epsilon}_t^{A}$	IG	1.00	1.81	1.25	2.31
$\hat{\epsilon}_t^{D}$	IG	1.00	0.55	0.39	0.71
$\hat{\epsilon}_t^{RP}$	IG	1.00	3.96	3.15	4.77
$\hat{u\epsilon}_t^{G}$	IG	1.00	2.47	1.85	3.13
$\hat{\epsilon}_t^{MP}$	IG	0.25	0.51	0.39	0.62
$\hat{\epsilon}_t^{PCM}$	IG	6.00	16.89	14.49	19.33
$\hat{\epsilon}_t^{S}$	IG	1.00	0.48	0.38	0.58
$\hat{\epsilon}_t^{INV}$	IG	3.00	2.25	1.84	2.64
$\hat{\epsilon}_t^{XD}$	IG	4.00	3.92	3.28	4.55
$\hat{\epsilon}_t^{YEXT}$	IG	1.00	0.69	0.57	0.80
$\hat{\epsilon}_t^{PIEXT}$	IG	1.00	0.84	0.70	0.99
$\hat{\epsilon}_t^{NREXT}$	IG	1.00	0.60	0.49	0.71
Measurement Equation Parameters					
ρ^{X}	U	1.00	0.10	0.03	0.16
ϕ_0^{TREND}	N	0.67	0.97	0.88	1.06
ϕ_0^{NR}	G	0.51	1.02	0.96	1.09
ϕ_0^{PI}	G	1.00	1.41	1.34	1.49
ϕ_0^{Q}	N	0.20	0.13	-0.02	0.29
ϕ_0^{PCM}	N	0.12	0.05	-0.07	0.17
$\phi_0^{TREND\_YEXT}$	N	0.60	0.40	0.35	0.45
ϕ_0^{PIEXT}	G	0.55	0.46	0.43	0.50
ϕ_0^{NREXT}	G	0.65	0.37	0.31	0.44
ϕ_0^{EMP}	N	0.67	0.62	0.47	0.77
ϕ_0^{W}	N	0.25	0.20	0.07	0.33
St. Dev. of the Measurement Equations					
$\hat{\epsilon}_t^{X}$	IG	4.50	4.09	3.66	4.48
$\hat{\epsilon}_t^{M}$	IG	4.50	4.28	3.79	4.77
$\hat{\epsilon}_t^{EMP}$	IG	2.50	2.56	2.14	2.99
$\hat{\epsilon}_t^{WAGE}$	IG	2.50	6.61	5.69	7.49

Source: Authors' calculations. *Note:*[a] U: Uniform, G: Gamma, B: Beta, N: Normal, IG: Inverse-Gamma.

Table A.5.9: Estimated Parameters: Mexico

Parameters	Type[a]	Prior Mean	Posterior Mean	90% HPDI	
Structural Parameters					
γ	B	0.30	0.31	0.22	0.40
σ	G	2.00	2.00	1.98	2.02
λ_C	B	0.35	0.35	0.27	0.42
Ω_Q	U	0.30	0.37	0.24	0.51
ϕ_{RP01}	B	0.15	0.10	0.04	0.16
ϕ_{RP02}	B	0.15	0.09	0.04	0.14
θ_W	B	0.75	0.76	0.68	0.84
δ_W	B	0.45	0.48	0.31	0.64
φ	G	2.00	2.00	1.98	2.02
η^{MU}	U	0.26	0.19	0.01	0.39
Ω_M	B	0.50	0.50	0.41	0.58
Ω_N	B	0.50	0.63	0.55	0.72
θ_D	B	0.75	0.76	0.74	0.77
δ_D	B	0.45	0.49	0.41	0.57
$\mathcal{AC}$	G	0.25	0.26	0.17	0.34
Ω_R	B	0.70	0.79	0.74	0.84
ψ_π	G	2.00	1.99	1.91	2.07
ψ_Y	G	0.50	0.55	0.39	0.71
ψ_{01}	G	0.10	0.09	0.08	0.11
ψ_{02}	G	0.10	0.10	0.08	0.11
$\phi_{X^{CM}}$	U	0.50	0.47	0.00	0.88
$\Omega_{X^{CM}}$	U	0.50	0.57	0.14	1.00
Ω_X	B	0.50	0.57	0.49	0.65
θ_B	U	-0.05	-0.02	-0.04	-0.01
Persistence of the Exogenous Processes					
ρ_A	B	0.50	0.64	0.42	0.89
ρ_{PCM}	B	0.50	0.94	0.87	1.00
ρ_{RP}	B	0.50	0.85	0.77	0.94
ρ_G	B	0.50	0.49	0.35	0.64
ρ_{YEXT}	B	0.50	0.81	0.74	0.88
ρ_{PIEXT}	B	0.50	0.56	0.43	0.69
ρ_{NREXT}	B	0.50	0.91	0.88	0.95

Source: Authors' calculations. *Note:*[a] U: Uniform, G: Gamma, B: Beta, N: Normal, IG: Inverse-Gamma.

Table A.5.10: Estimated Standard Deviations and Measurement Equation Parameters: Mexico

Parameters	Type[a]	Prior Mean	Posterior Mean	90% HPDI	
St. Dev. Innovations					
$\hat{\epsilon}_t^{A}$	IG	1.00	0.82	0.42	1.27
$\hat{\epsilon}_t^{D}$	IG	1.00	0.57	0.39	0.75
$\hat{\epsilon}_t^{RP}$	IG	1.00	2.31	1.60	3.00
$\hat{u\epsilon}_t^{G}$	IG	1.00	0.71	0.58	0.84
$\hat{\epsilon}_t^{MP}$	IG	0.25	0.47	0.34	0.59
$\hat{\epsilon}_t^{PCM}$	IG	6.00	16.91	14.02	19.81
$\hat{\epsilon}_t^{S}$	IG	1.00	0.78	0.58	0.97
$\hat{\epsilon}_t^{INV}$	IG	3.00	2.30	1.87	2.72
$\hat{\epsilon}_t^{XD}$	IG	4.00	4.08	3.32	4.85
$\hat{\epsilon}_t^{YEXT}$	IG	1.00	0.75	0.60	0.89
$\hat{\epsilon}_t^{PIEXT}$	IG	1.00	0.80	0.66	0.94
$\hat{\epsilon}_t^{NREXT}$	IG	1.00	0.49	0.39	0.59
Measurement Equation Parameters					
ρ^{X}	U	1.00	0.33	0.12	0.54
ϕ_0^{TREND}	N	0.67	0.59	0.55	0.64
ϕ_0^{NR}	G	0.51	0.99	0.96	1.03
ϕ_0^{PI}	G	1.00	1.25	1.20	1.29
ϕ_0^{Q}	N	0.20	0.07	-0.07	0.22
ϕ_0^{PCM}	N	0.12	0.11	-0.05	0.28
$\phi_0^{TREND\_YEXT}$	N	0.60	0.41	0.35	0.47
ϕ_0^{PIEXT}	G	0.55	0.41	0.37	0.44
ϕ_0^{NREXT}	G	0.65	0.28	0.22	0.34
ϕ_0^{EMP}	N	0.67	0.62	0.47	0.78
ϕ_0^{W}	N	0.25	0.25	0.09	0.42
St. Dev. of the Measurement Equations					
$\hat{\epsilon}_t^{X}$	IG	4.50	3.77	3.29	4.25
$\hat{\epsilon}_t^{M}$	IG	4.50	4.34	3.76	4.92
$\hat{\epsilon}_t^{EMP}$	IG	2.50	1.84	1.51	2.17
$\hat{\epsilon}_t^{WAGE}$	IG	2.50	5.15	4.34	5.91

Source: Authors' calculations. *Note:*[a] U: Uniform, G: Gamma, B: Beta, N: Normal, IG: Inverse-Gamma.

Table A.5.11: Estimated Parameters: New Zealand

Parameters	Type[a]	Prior Mean	Posterior Mean	90% HPDI	
Structural Parameters					
γ	B	0.30	0.53	0.41	0.64
σ	G	2.00	2.12	2.04	2.20
λ_C	B	0.20	0.21	0.15	0.30
Ω_Q	U	0.30	0.38	0.31	0.45
ϕ_{RP01}	B	0.10	0.09	0.05	0.13
ϕ_{RP02}	B	0.10	0.04	0.01	0.06
θ_W	B	0.75	0.69	0.63	0.74
δ_W	B	0.45	0.49	0.41	0.57
φ	G	2.00	2.00	1.98	2.02
η^{MU}	U	0.26	0.06	0.01	0.14
Ω_M	B	0.75	0.50	0.42	0.57
Ω_N	B	0.45	0.76	0.72	0.79
θ_D	B	0.50	0.75	0.70	0.80
δ_D	B	0.50	0.49	0.41	0.58
$\mathcal{AC}$	G	0.25	0.20	0.13	0.26
Ω_R	B	0.70	0.87	0.85	0.90
ψ_π	G	2.00	1.90	1.81	1.99
ψ_Y	G	0.50	1.23	1.07	1.42
ψ_{01}	G	0.10	0.09	0.08	0.10
ψ_{02}	G	0.10	0.10	0.08	0.12
$\phi_{X^{CM}}$	U	0.50	0.56	0.20	1.00
$\Omega_{X^{CM}}$	U	0.50	0.39	0.03	0.67
Ω_X	B	0.50	0.57	0.45	0.68
θ_B	U	-0.05	0.00	-0.01	0.00
Persistence of the Exogenous Processes					
ρ_A	B	0.50	0.89	0.84	0.95
ρ_{PCM}	B	0.50	0.74	0.68	0.80
ρ_{RP}	B	0.50	0.82	0.76	0.88
ρ_G	B	0.50	0.82	0.77	0.87
ρ_{YEXT}	B	0.50	0.93	0.92	0.95
ρ_{PIEXT}	B	0.50	0.79	0.74	0.84
ρ_{NREXT}	B	0.50	0.95	0.95	0.95

Source: Authors' calculations. *Note:*[a] U: Uniform, G: Gamma, B: Beta, N: Normal, IG: Inverse-Gamma.

Table A.5.12: Estimated Standard Deviations and Measurement Equation Parameters: New Zealand

Parameters	Type[a]	Prior Mean	Posterior Mean	90% HPDI	
St. Dev. Innovations					
$\hat{\epsilon}_t^{A}$	IG	1.00	0.75	0.57	0.95
$\hat{\epsilon}_t^{D}$	IG	1.00	0.51	0.38	0.64
$\hat{\epsilon}_t^{RP}$	IG	1.00	1.35	1.07	1.63
$\hat{u\epsilon}_t^{G}$	IG	1.00	1.32	1.15	1.47
$\hat{\epsilon}_t^{MP}$	IG	0.25	1.12	0.90	1.35
$\hat{\epsilon}_t^{PCM}$	IG	6.00	5.04	4.46	5.65
$\hat{\epsilon}_t^{S}$	IG	1.00	0.35	0.30	0.41
$\hat{\epsilon}_t^{INV}$	IG	3.00	2.21	1.87	2.57
$\hat{\epsilon}_t^{XD}$	IG	4.00	4.27	3.21	5.58
$\hat{\epsilon}_t^{YEXT}$	IG	1.00	0.67	0.58	0.75
$\hat{\epsilon}_t^{PIEXT}$	IG	1.00	0.71	0.62	0.79
$\hat{\epsilon}_t^{NREXT}$	IG	1.00	0.76	0.67	0.85
Measurement Equation Parameters					
ρ^{X}	U	1.00	0.08	0.00	0.16
ϕ_0^{TREND}	N	0.67	0.72	0.68	0.75
ϕ_0^{NR}	G	0.51	0.47	0.42	0.51
ϕ_0^{PI}	G	1.00	1.27	1.22	1.33
ϕ_0^{Q}	N	0.20	0.43	0.34	0.51
ϕ_0^{PCM}	N	0.12	0.11	0.02	0.21
$\phi_0^{TREND\_YEXT}$	N	0.60	0.58	0.54	0.62
ϕ_0^{PIEXT}	G	0.55	0.57	0.55	0.58
ϕ_0^{NREXT}	G	0.65	0.65	0.60	0.70
ϕ_0^{EMP}	N	0.67	0.63	0.47	0.78
ϕ_0^{W}	N	0.25	0.26	0.13	0.39
St. Dev. of the Measurement Equations					
$\hat{\epsilon}_t^{X}$	IG	4.50	3.15	2.84	3.46
$\hat{\epsilon}_t^{M}$	IG	4.50	4.29	3.87	4.70
$\hat{\epsilon}_t^{EMP}$	IG	2.50	1.40	1.21	1.60
$\hat{\epsilon}_t^{WAGE}$	IG	2.50	1.12	1.03	1.21

Source: Authors' calculations. *Note:*[a] U: Uniform, G: Gamma, B: Beta, N: Normal, IG: Inverse-Gamma.

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