Fiscal and monetary policy interaction: a simulation based analysis of a two-country New Keynesian DSGE model with heterogeneous households

Marcos Valli and Fabia A. de Carvalho
April, 2010
Fiscal and monetary policy interaction: a simulation based analysis of a two-country New Keynesian DSGE model with heterogeneous households*

Marcos Valli**

Fabia A. de Carvalho***

Abstract

This paper models a fiscal policy that pursues primary balance targets to stabilize the debt-to-GDP ratio in an open and heterogeneous economy where firms combine public and private capital to produce their goods. The model extends the European NAWM presented in Coenen et. al. (2008) and Christoffel et. al. (2008) by broadening the scope for fiscal policy implementation and allowing for heterogeneity in labor skills. The domestic economy is also assumed to follow a forward looking Taylor-rule consistent with an inflation targeting regime. We correct the NAWM specification of the final-goods price indices, the recursive representation of the wage setting rule, and the wage distortion index. We calibrate the model for Brazil to analyze some implications of monetary and fiscal policy interaction and explore some of the implications of fiscal policy in this class of DSGE models.

Keywords: DSGE, fiscal policy, monetary policy, government investment, primary surplus, heterogeneous agents, market frictions

JEL Classification: E32; E62; E63

* We are thankful to Mario Mesquita, Luís G. Umeno, and an anonymous referee for important comments and suggestions, and to the participants of the 2009 Conference on Computing in Economics and Finance, of the FGV-EPGE and National Treasury Seminars, and of Banca d’Italia’s 2010 Seminar on Fiscal Policy.

** Executive Office of Special Studies, Central Bank of Brazil. Email: marcos.valli@bcb.gov.br (Corresponding author)

*** Executive Office of Special Studies, Central Bank of Brazil. Email: fabia.carvalho@bcb.gov.br
1. Introduction

DSGE models are now part of the core set of tools used by major central banks to assess the widespread effects of policy making. Building mostly on the recent New Keynesian literature (Monacelli, 2005, Galí and Monacelli, 2008, Smets and Wouters, 2003, Adolfson et. al., 2007, among others), these models have been further enriched in several aspects by the inclusion of alternative pricing assumptions, imperfect competition in distinct economic sectors, international financial linkages, and financial frictions. However, as Ratto et. al. (2009) argue, “so far, not much work has been devoted towards exploring the role of fiscal policy in the (DSGE) New-Keynesian model”.  

DSGE models are a promising tool to understand the outcome of interactions between fiscal and monetary policies. The recent trend in modeling the fiscal sector in New Keynesian DSGE models is to include non-Ricardian agents and activist fiscal policies (Gunter and Coenen, 2005, Mourougane and Vogel, 2008, and Ratto et. al., 2009) mostly to assess the effects of shocks to government consumption on the aggregate economy, as well as the distributional effects of fiscal policies. However, the practice of fiscal policy usually goes beyond the decisions on consumption expenditures. The government often intervenes in the economy through public investment with important externalities upon private investment.

Ratto et. al. (2009) are a recent attempt to account for the strategic role of public investment in policy decisions in a DSGE setup. They introduce a rule for public investment that responds to the business cycle and assume that public capital interferes in the productivity of private firms, but does not belong to factor decisions.

---

1 Rato, Roeger and Veld (p.p. 222). The italics are ours.
In this paper, we depart from the assumption that public investment is a type of externality. We assume that firms can rent capital services from a competitive market of private and public capital goods. The optimal composition of capital services will depend on the elasticity of substitution between both types of capital goods and on a parameter that captures the economy’s “dependence” on public infrastructure. Households and the government have different investment agenda, and are faced with distinct efficiency in the transformation of investment to capital goods.

The reasoning for introducing public capital goods in this manner can be rationalized as follows. In our model, intermediate goods firms are the entities that actually use public capital. In the real world, there are both (mixed-capita) firms and government agencies utilizing capital owned by the government. By letting public capital enter firms’ decisions, we believe we are approximating our model to the reality of a mixed-capital economy. The production technology distinguishes between the quality of each type of capital, and as such, the demand for public capital reacts to deviations of its rental rate to the calibrated value, which we assume to be subsidized in the steady state. In the real world, the government makes decisions on investment, and the efficiency with which such investment is transformed into capital goods can differ from the efficiency of the private sector’s investment. In our model we empowered our government to decide on its public investment.

Our model builds on ECB’s New Area Wide Model (NAWM) presented in Coenen et. al. (2008) and Christoffel et. al. (2008), hereinafter referred to as CMS and CCW respectively. However, there are important distinctions. First, we change the fiscal set-up. In the ECB NAWM, government consumption and transfers follow autoregressive rules. In our model, we introduce a fiscal policy rule that tracks primary surplus targets, that responds to deviations on the debt-to-GDP ratio and that also
portrays an anti-cyclic response to economic conditions. In addition, we let fiscal transfers to be biased in favor of one of the household groups, and also introduce government investment through an autoregressive rule that also pursues an investment target. With a rule for the primary surplus, for government transfers and for public investment, government consumption thus becomes endogenous. This framework better approximates the theoretical setting of these models to the current practice of fiscal policy in a number of countries, including Brazil.

Second, we augment the labor market by introducing heterogeneity in labor skills. In Brazil, labor contracts are not usually flexible as to adjustments in daily hours worked. The most usual contracts set an 8-hour workday. Therefore, it seems reasonable to allow for the possibility that members of different social classes in average earn different wages for the same amount of hours worked.

Third, we correct some equations shown in CMS and CCW. The first refers to the specification of consumer and investment price indices, which we correct to guarantee that the producers of final consumption and investment goods operate under perfect competition. These modifications yield a representation of the economy’s resource constraint that also differs from the one presented in CMS and CCW. We also correct the recursive representation of the wage setting rule and the wage distortion index.

Fourth, we introduce a deterministic spread between the interest rates of domestically and internationally traded bonds to account for the risk premium that can be significant in emerging economies.

Finally, monetary policy in the domestic economy is modeled with a forward looking rule to better approximate the conduct of policy to an inflation targeting framework.
We calibrate the structural parameters of our model for the Brazilian economy and the rest of the world (USA+EURO), leaving the monetary and fiscal policy rules of the rest of the world as specified in CMS and CCW. We assess the impulse responses to arbitrary magnitudes of the shocks and analyze the implications of the interaction between fiscal and monetary policies. In particular, we assess the macroeconomic and distributional effects of shocks to government investment, primary surplus, transfers, and monetary policy, and analyze the effects of concomitant shocks to the fiscal and monetary policy rules. We proceed with a sensitivity analysis of the impact of varying degrees of rigor in the implementation of the fiscal rule, of fiscal commitment to a sustainable path of the public debt, and of the commitment of the monetary policy to the inflation target.

The adopted calibration of fiscal and monetary policy rules lies in a region of monetary activeness and fiscal passiveness. However, the model also shows stable equilibria under alternative calibrations where, in contrast, monetary policy is passive and fiscal policy is active. Apart from the specifications where the fiscal rule has a mute response to the public debt, active fiscal policies bring about strong cyclicality in the impulse responses.

One of the important contributions of this paper is to show that an expansionist shock to the primary surplus is not equivalent to a shock to government consumption, as the former attains with a mix of cuts in both government consumption and investment. We also show that each one of the fiscal shocks -- primary surplus, government investment and government transfers -- has a distinct impact on the model dynamics.

Under the calibrated model, a shock that reduces the primary surplus has very short lived expansionist effects on output growth. A government investment shock, on the other hand, initially depresses output growth, since compliance with the fiscal rule
requires government consumption to reduce. However, the government investment shock enables output growth expansion still within the first year after the shock. The inflationary effects of the shocks to the primary surplus and to government investment are mild, yet relatively long-lived. Shocks to government transfers have very short lived effects on economic growth. With the fiscal rule in place, an increase in government transfers induces some reduction in government consumption, which presses down production. Under our calibration, the distributional effects of all fiscal shocks end up being small, contrary to the findings of CMS and CCW likely due to the specification we adopted for labor heterogeneity.

We also experiment with different specifications of monetary and fiscal policy rules, and show that they have important effects on the models’ dynamic responses and predicted moments.

Higher commitment to the stabilization of the public debt strengthens the contractionist impact of the monetary shock. The volatility of consumer price inflation increases, as does the correlation between inflation and output growth. Strongly (and negatively) correlated policy shocks also dampen the contractionist effect of the monetary policy shock.

We find a degree of fiscal rigor that jointly minimizes the influence of the primary surplus shock on inflation and of the monetary policy on GDP growth. As expected, a more rigorous implementation of the primary surplus rule implies lower variance of inflation and output growth, and significantly increases the influence of the monetary policy shock onto the variances of consumer price inflation and output growth.

Increasing the monetary policy commitment to the inflation target significantly reduces the volatility of inflation and its correlation with output growth. The variance of
output growth poses a mild reduction. However, a higher commitment to the inflation target results in a higher stake of the variance of inflation being explained by the fiscal shock.

The model is also simulated under alternative monetary policy rules. Augmenting the rule to include an explicit reaction to the exchange rate variability or the output growth adds sluggishness to the reversal of inflation to the steady state after a monetary policy shock. However, the initial impact of the shock onto the economic activity is milder (yet more persistent). By activating the policy shocks only, the response to the exchange rate volatility reduces the variance of inflation, output growth and the exchange rate. The monetary policy shock has a smaller effect on output variation and gains influence on the volatility of inflation.

On the other hand, a monetary policy rule that responds to output growth reduces output growth volatility, but increases the variance of consumer price inflation and the exchange rate. Under this policy rule, a shock to monetary policy loses influence over inflation variance, but also reduces its stake in the variance of output growth and the exchange rate.

The paper is organized as follows. Section 2 provides an overview of the model, focusing on the extensions proposed to the NAWM. Section 3 details the calibration strategy and the normalization to attain stationary representations of the aggregated variables. Section 4 analyses the impulse responses of the model and experiments with distinct types of policy orientation. The last section concludes the paper.
2. The model

In the model, there are two economies of different sizes that interact in both goods and financial markets. Except for monetary and fiscal policy rules, both economies are symmetric with respect to the structural equations that govern their dynamics, but the structural parameters are allowed to differ across countries.

Each economy is composed of households, firms, and the government. Households are distributed in two continuous sets that differ as to their access to capital and financial markets, and also to their labor skills. Families in the less specialized group, hereinafter referred to as group $J = [1 - \omega, 1]$ , can smooth consumption only through non-interest bearing money holdings, whilst the other group of households in group $I = [0,1 - \omega ]$, with more specialized skills, has full access to capital, and to domestic and international financial markets. The differentiation in households’ ability to smooth consumption over time, a feature adopted in CMS and CCW, allows for breaking the Ricardian Equivalence in this model. Within their groups, households supply labor in a competitive monopolistic labor market to produce intermediate goods. There are Calvo-type wage rigidities combined with hybrid wage indexation rules.

Firms are distributed in two sets. The first produces intermediate goods for both domestic and foreign markets, and operates under monopolistic competition with Calvo-type price rigidities combined with hybrid price indexation. The other set is composed of three firms, each one of them producing one single type of final good: private consumption, public consumption, or investment goods. Final goods firms are assumed to operate under perfect competition.

The government comprises a monetary authority that sets nominal interest rates and issues money, and a fiscal authority that levies taxes on most economic activities,
and endogenously adjusts its consumption expenditures to comply with its investment, distributional transfers, and primary surplus rules.

A detailed derivation of the model is available in appendix H. In the remaining of this section, we correct important equations in CMS and CCW and model a fiscal sector that is more in line with the current practice of fiscal policy in a wide number of countries. Public investment has spillover effects over private investment and affects the market for capital goods.

2.1. Wage setting

Household \( i \in I = [0,1 - \omega] \) chooses consumption \( C_{i,t} \) and labor services \( N_{i,t} \) to maximize the separable intertemporal utility with external habit formation

\[
E_i \left\{ \sum_{k=0}^{\infty} B^k \left( C_{i,t+k} - \kappa C_{1,t+k-1} \right)^{1-\sigma} - \frac{1}{1+\xi} \left( N_{i,t+k}^{1+\xi} \right) \right\}
\]

subject to the budget constraint

\[
\left( 1 + \tau^C_i + \Gamma(v_i,t) \right) P_{C,i} C_{i,t} + P_{I,i} I_{i,t} + R_t^{-1} B_{i,t+1} \nu_t + \left( (1 - \Gamma(v_i,t)) r_p R_{F,i} \right)^{-1} S_{B_{i,t+1}} + M_{i,t} + \Xi_{i,t} + \Phi_{i,t}
\]

\[
= \left( 1 - \tau^N_i - \tau^\nu_i \right) W_{i,t} N_{i,t} + \left( 1 - \tau^K_i \right) \left( u_{i,t} R_{K,H,t} - \Gamma(v_i,t) P_{I,H,t} \right) K_{i,H,t} + \tau^K_i \delta P_{I,i} K_{i,H,t}
\]

\[
+ (1 - \tau^K_i) D_{i,t} + TR_{i,t} - T_{i,t} + B_{i,t} + S_{i,t} B_{i,t} + M_{i,t-1}
\]

where \( W_{i,t} \) is the wage earned by the household for one unit of labor services, \( I_{i,H,t} \) is private investment in capital goods, \( B_{i,t+1} \) are domestic government bonds, \( M_{i,t} \) is money, \( B^F_{i,t+1} \) are foreign private bonds, \( S_{t} \) is the nominal exchange rate, \( R_{F,t} \) is the interest rate of the foreign bonds, \( r_p \) is the steady state spread between interest rates of domestically and internationally traded bonds, \( \Gamma(v_i,t) \) is an extra risk premium when the external debt deviates from the steady state, \( \Gamma(v_i,t) \) is a transaction cost on
consumption, $v_{i,t}$ is the money-velocity of consumption, $D_{i,t}$ are dividends, $K_{i,H,t}$ is the private capital stock, $u_{i,t}$ is capital utilization, $\Gamma_u(u_{i,t})$ is the cost of deviating from the steady state rate of capital utilization, $R_{K,H,t}$ is the gross rate of the return on private capital, $TR_{i,t}$ are transfers from the government, $\Xi_{i,t}$ is a lump sum rebate on the risk premium introduced in the negotiation of international bonds, and $\Phi_{i,t}$ is the stock of contingent securities negotiated within group $I$, which act as an insurance against risks on labor income. Taxes are $\tau_C^c$ (consumption), $\tau_N^N$ (labor income), $\tau_W^W$ (social security), $\tau_K^K$ (capital income), $\tau_D^D$ (dividends) and $T_{i,t}$ (lump sum, active only for the foreign economy). The parameter $\kappa$ is the external habit persistence, $\beta$ is the intertemporal discount factor, $\frac{1}{\sigma}$ is the intertemporal elasticity of consumption substitution, $\frac{1}{\varepsilon}$ is the elasticity of labor effort relative to the real wage, and $\delta$ is the depreciation of capital.

Price indices are $P_{c,t}$ and $P_{i,t}$, the prices of final consumption and investment goods, respectively. Cost functions are detailed in appendix A.

Households in group $J$ maximize a utility function analogous to (1), but constrained on their investment choices, allowed to transfer wealth from one period to another only through non-interest bearing money holdings.

Within each group, households compete in a monopolistic competitive labor market. By setting wage $W_{i,t}$, household $i$ commits to meeting any labor demand $N_{i,t}$. Wages are set à la Calvo, with a probability $(1-\zeta)$ of optimizing each period. Households that do not optimize readjust their wages based on a geometric average of realized and steady state inflation $\bar{W}_{i,t} := \left( \frac{P_{C,t-1}}{P_{C,t-2}} \right)^{x_{i,t}} \pi_c^{1-x_c} W_{i,t-1}$. Optimizing households in group $I$ choose the same wage $\bar{W}_{i,t}$, which we denote $\bar{W}_{i,t}$. 


Household $i$'s optimization with respect to the wage $\tilde{W}_{i,t}$ yields the first order condition, which is the same for every optimizing household:

$$E_t \left[ \sum_{k=0}^{\infty} (\xi_t^i \beta)^k N_{i,t+k} \left( \frac{\Lambda_{i,t+k} \left( 1 - \tau_{i,t+k}^N - \tau_{i,t+k}^W \right)}{P_{C,t+k}} \frac{\tilde{W}_{i,t}}{P_{C,t+k}} \left( \frac{P_{C,t+k-1}}{P_{C,t+k}} \right)^{\tilde{\chi}_t} \frac{1}{\pi_c^{1-\tilde{\chi}_t}} k \right) \right] - \frac{\eta_t}{\eta_t - 1} \left( N_{i,t+k} \right)^{\xi_t^i} = 0$$

(3)

where $\frac{\Lambda_{i,t+k}}{P_{C,t+k}}$ is the Lagrange multipliers for the budget constraint, and $\eta_t / (\eta_t - 1)$ is the after-tax real wage markup, in the absence of wage rigidity (when $\xi_t \to 0$), with respect to the marginal rate of substitution between consumption and leisure. The markup results from the worker’s market power to set wages.

Equation (3) can be expressed in the following recursive form, which corrects the one presented in CMS after including the multiplicative constant $(1 - \omega)^{\xi}$ on the left hand side. This constant arises from the labor demand equation.

$$(1 - \omega)^{\xi_t} \left( \tilde{W}_{i,t} \right)^{1+\eta_t \xi_t} = \frac{\eta_t \tilde{F}_{i,t}}{\eta_t - 1} \tilde{G}_{i,t}$$

(4)

where

$$\tilde{F}_{i,t} := \left( \frac{W_{i,t}}{P_{C,t}} \right)^{\eta_t \xi_t} N_{i,t}^{1+\xi_t} + \tilde{\xi}_t \beta E_t \left( \frac{\pi_{C,t+1}}{\pi_{C,t}, \pi_t^{1-x_t}} \right)^{\eta_t \left( 1+\xi_t \right)} . F_{i,t+1}$$

$$\tilde{G}_{i,t} := \Lambda_{i,t} \left( 1 - \tau_t^N - \tau_t^W \right)^{\eta_t} N_{i,t}^{1+\xi_t} + \tilde{\xi}_t \beta E_t \left( \frac{\pi_{C,t+1}}{\pi_{C,t}, \pi_t^{1-x_t}} \right)^{\eta_t^{-1}} . G_{i,t+1}$$

and $N_{i,t}^{1+\xi_t}$ is households group $I$ aggregate labor demanded by firms, and $W_{i,t}$ is household group $I$'s aggregate wage index. Superscripts in the labor variable represent demand. Subscripts represent supply.

The derivation of equation (4) is detailed in appendix B.
2.2. Production

There are two types of firms in the model: producers of tradable intermediate goods and producers of non-tradable final goods.

2.2.1 Intermediate goods firms

A continuum of firms, indexed by \( f \in [0,1] \), produce tradable intermediate goods \( Y_{f,t} \) under monopolistic competition. We depart from the set-up in CMS by introducing mixed capital as an input to the production of these goods. We assume that firms competitively rent capital services from the government, \( K^S_{G,f,t} \), and from households in group \( I, K^S_{H,f,t} \), and transform them into the total capital input \( K^S_{f,t} \) through the following CES technology:

\[
K^S_{f,t} = \left[ (1 - \omega_g)^{-\eta_g} (K^S_{H,f,t})^{\eta_g^{-1}} + (\omega_g)^{-\eta_g} (K^S_{G,f,t})^{\eta_g^{-1}} \right]^{\eta_g^{-1}}
\]

where \( \omega_g \) is the economy’s degree of dependence on government investment, and \( \eta_g \) stands for the elasticity of substitution between private and public goods, and also relates to the sensitivity of demand to the cost variation in each type of capital.

In addition to renting capital services, intermediate goods firms hire labor \( N^D_{f,t} \) from all groups of households to produce the intermediate good \( Y_t \) using the technology:

\[
Y_{f,t} = z_f (K^S_{f,t})^\alpha (z_{N_{f,t}} N^D_{f,t})^{1-\alpha} - \psi \cdot z_{n_t}
\]

where \( \psi \cdot z_{n_t} \) is a cost, which in steady state is constant relative to the output. The constant \( \psi \) is chosen to ensure zero profit in the steady state, and \( z_f \) and \( z_{n_t} \) are
respectively (temporary) neutral and (permanent) labor-augmenting productivity shocks that follow the processes:

$$\ln(z_t) = (1 - \rho_z) \ln(z) + \rho_z \ln(z_{t-1}) + \varepsilon_{z,t}$$

and

$$\frac{zn_t}{zn_{t-1}} = (1 - \rho_{zn}) y + \rho_{zn} \frac{zn_{t-1}}{zn_{t-2}} + \varepsilon_{zn,t}$$

where $z$ is the stationary level of total factor productivity, $gy$ is the steady state growth rate of labor productivity, $\rho_z$ and $\rho_{zn}$ are parameters, and $\varepsilon_{z,t}$ and $\varepsilon_{zn,t}$ are exogenous white noise processes.

In equilibrium, $K^S_{f,t} = u_{f,t} K_{f,t}$, where $K_{f,t}$ is the stock of capital used by firm $f$.

For a given total demand for capital services, the intermediate firm minimizes the total cost of private and public capital services, solving:

$$\text{min}_{K^H_{f,t}, K^G_{f,t}} \left( R^H_{K_{f,t}} K^S_{f,t} + R^G_{K_{f,t}} K^G_{f,t} \right)$$

subject to (5).

The rental rate on private capital services results from the equilibrium conditions in the private capital market. The rental rate on government capital services also results from equilibrium conditions, this time in the market for government capital goods, but, in steady state, we calibrate $\omega_g$ in order to have the rental rate of public capital goods exclusively covering expenses with capital depreciation, so as to portray the idea that public capital is usually subsidized.

First order conditions to this problem yield the average rate of return on capital and the aggregate demand functions for each type of capital goods services:

$$R^H_{K_{f,t}} = \left( (1 - \omega_g) \left( R^H_{K_{f,t}} \right)^{-\eta} + \omega_g \left( R^G_{K_{f,t}} \right)^{-\eta} \right)^{1/\eta}$$
\begin{align}
K_{G,f}^S &= \omega_f \left( \frac{R_{G,f}}{R_{K,f}} \right)^{-\eta_f} K_i^S \\
K_{H,f}^S &= (1 - \omega_f) \left( \frac{R_{H,f}}{R_{K,f}} \right)^{-\eta_f} K_i^S
\end{align}

All firms are identical since they solve the same optimization problem. The aggregate composition of capital services rented by intermediate goods firms can be restated by suppressing the subscript “f” from (5), using (10), and aggregating the different types of capital services across firms:

\begin{align}
K_i^S = \left( (1 - \omega_f)^{\frac{1}{\eta_f}} \left( K_{H,f}^S \right)^{\frac{\eta_f - 1}{\eta_f}} + \omega_f^{\frac{1}{\eta_f}} \left( K_{G,f}^S \right)^{\frac{\eta_f - 1}{\eta_f}} \right)^{\frac{\eta_f}{\eta_f - 1}}
\end{align}

We also depart from CMS by introducing differentiated labor skills in the model. We reason that individuals with a lower degree of formal education are usually more constrained on their ability to analyze more sophisticated investment possibilities. In addition, it also seems reasonable to hypothesize that individuals with a lower degree of education will also have lower level of labor skills. Therefore, we make the assumption that the group of households that is investment-constrained in our model also has lower labor skills. This modeling strategy allows for a steady state where skillful workers can earn more yet working the same amount of hours as the less skilled. In addition to the labor differentiation arising from the assumption of monopolistic competition in the labor market, the non-homogeneity that we introduce here within household groups generates important differences in the impulse-responses of the model compared to CMS, as we show in Section 4.

The labor input used by firm f in the production of intermediate goods is a composite of labor demanded to both groups of households. In addition to the population-size adjustment (\(\omega\)) that CMS add to the firm’s labor demand, we add the
parameter $v_\omega \in \left[0, \frac{1}{\omega} \right]$ to introduce a bias in favor of more skilled workers. The resulting labor composite obtains from the following transformation technology

$$N_{f,t}^D := \left(1 - v_\omega \omega \right)^{1/\eta} \left(N_{f,t}^I \right)^{-1/\eta} + (v_\omega \omega)^{1/\eta} \left(N_{f,t}^J \right)^{-1/\eta}$$  \hspace{1cm} (14)

where

$$N_{f,t}^I := \left[ \left( \frac{1}{1 - \omega} \right) \int_0^{N_{f,t}^I} d_i \right]^{\eta_i/(\eta_i - 1)}$$  \hspace{1cm} (15)

$$N_{f,t}^J := \left[ \left( \frac{1}{\omega} \right) \int_{1 - \omega}^{N_{f,t}^J} d_j \right]^{\eta_i/(\eta_i - 1)}$$  \hspace{1cm} (16)

and where $\eta$ is the price-elasticity to demand for specific labor bundles, $\eta_i$ and $\eta_j$ are the price-elasticities for specific labor varieties. The special case when $v_\omega = 1$ corresponds to the equally skilled workers assumption, as in CMS.

Taking average wages ($W_{f,t}$ and $W_{f,t}$) in both groups as given, firms choose how much to hire from both groups of households by minimizing total labor cost $W_{f,t} N_{f,t}^I + W_{f,t} N_{f,t}^J$ subject to (14). It follows from first order conditions that the aggregate wage is:

$$W_t = \left[ (1 - v_\omega \omega) W_{f,t}^{1/\eta} + v_\omega \omega W_{f,t}^{1/\eta} \right]^{1/\eta}$$  \hspace{1cm} (17)

and the aggregate demand functions for each group of households are:

$$N_{f,t}^I = (1 - v_\omega \omega) \left( \frac{W_{f,t}}{W_t} \right)^{-\eta} . N_{f,t}^D$$  \hspace{1cm} (18)

$$N_{f,t}^J = v_\omega \omega \left( \frac{W_{f,t}}{W_t} \right)^{-\eta} . N_{f,t}^D$$  \hspace{1cm} (19)
2.2.2 Final goods firms

As in CMS, there are three firms producing non-tradable final goods. One specializes in the production of private consumption goods, another in public consumption goods, and the third in investment goods. Except for the firm that produces public consumption goods, all final goods producers combine domestic and imported intermediate goods in their production. The differentiation of public consumption goods stems from the evidence that usually the greatest share of government consumption is composed of services, which are heavily based on domestic human resources.

The existence of an adjustment cost to the share of imported goods in the production of final goods invalidates the standard result that the Lagrange multiplier of the technology constraint equals the price index of final goods. In this new context, we derive below the price index of private consumption goods and investment goods to ensure that final goods firms operate under perfect competition. The pricing of public consumption goods is exactly the same as in CMS.

2.2.2.a. Private consumption goods

To produce private consumption goods $Q^C_t$, the firm purchases bundles of domestic $H^C_t$ and foreign $IM^C_t$ intermediate goods. Whenever it adjusts its imported share of inputs, the firm faces a cost, $\Gamma_{IM^C_t} (IM^C_t / Q^C_t)$, detailed in appendix A. Letting $\nu_C$ denote the bias towards domestic intermediate goods, the technology to produce private consumption goods is

$$Q^C_t = \left\{ \left[ (\nu_C)^{1/\mu_C} \right] ^{1/\mu_C} \left[ H^C_t \right] ^{-1/\mu_C} + \left[ (1-\nu_C)^{1/\mu_C} \left[ (1-\Gamma_{IM^C_t} (IM^C_t / Q^C_t))IM^C_t \right] ^{-1/\mu_C} \right] ^{\mu_C, \mu_C^{-1}} \right\}$$

(20)
where

\[
H_t^C := \left( \int (H_{f,t}^C)^{1-1/\theta} \, df \right)^{\theta/(\theta - 1)}
\]

\[
IM_t^C := \left( \int (IM_{f,t}^C)^{1-1/\theta'} \, df' \right)^{\theta'/(\theta' - 1)}
\]

The firm minimizes total input costs

\[
\min_{H_t^C, IM_t^C} P_{H,t}^c H_t^C + P_{IM,t}^C IM_t^C
\]

subject to the technology constraint (20) taking intermediate goods prices as given.

The price index that results from solving this problem is\(^2\):

\[
P_{c,t} = (\Omega_t^C)^{1-\mu_c} (\lambda_t^C)^{\mu_c}
\]

where

\[
\lambda_t^C = \left[ v_c P_{H,t}^{1-\mu_c}((1-v_c)(P_{IM,t}^{\Gamma IM C} (IM_t^C/Q_t^C))^{1-\mu_c} \right]^{1-\mu_c}
\]

\[
\Omega_t^C = \left\{ v_c \left( P_{H,t}^{1-\mu_c} \right) + (1-v_c) \left( \frac{\Gamma IM C (IM_t^C/Q_t^C)}{1-\Gamma IM C (IM_t^C/Q_t^C)} \right) \right\} \left( P_{IM,t}^{\Gamma IM C} (IM_t^C/Q_t^C) \right)^{-\mu_c}
\]

In CMS, the multiplier \(\lambda_t^C\) is assumed to be the price index for one unit of the consumption good. However, this result is not compatible with their assumption that final goods firms operate with zero profits.

Notice that only when \(\Omega_t^C = \lambda_t^C\) do we obtain \(P_{c,t} = \lambda_t^C = \Omega_t^C\). This requires \(\left( \frac{\Gamma IM C (IM_t^C/Q_t^C)}{1-\Gamma IM C (IM_t^C/Q_t^C)} \right) = 1\), a very specific case.

\(^2\) Details of the derivation of (22) are shown in appendix D.
In general, when this equality does not hold, first order conditions and equation (22) can be combined to yield the following demand equations:

\[ H_i^C = V_C \left( \frac{P_{H,i}}{\Omega_i} \right)^{1-\mu_C} \left( \frac{P_{H,i}}{P_{C,i}} \right)^{-\mu_C} Q_i^C \]  

(25)

\[ IM_i^C = (1-V_C) \left( \frac{P_{C,i}}{\Omega_i^C} \right)^{1-\mu_C} \left( \frac{P_{IM,i} / \Gamma^3 \ IM_i^C / Q_i^C}{P_{C,i}} \right)^{-\mu_C} Q_i^C \left( \frac{1-\Gamma^3 \ IM_i^C / Q_i^C}{1-\Gamma^3 \ IM_i^C / Q_i^C} \right) \]  

(26)

These demand equations are different from the ones in CMS, and, as we show in subsequent sessions, they also result in important differences in the market clearing equations. In particular, the equation for the aggregate resource constraint of the economy now resembles the usual representation of national accounts.

2.2.2.b. Investment goods

The pricing problem of investment goods is analogous to that of consumer goods. The investment goods price index, which also differs from CMS, is

\[ P_{I,j} = \left( \Omega_i^I \right)^{1-\mu_i} \left( \lambda_i^I \right)^{\mu_i} \]  

(27)

where

\[ \Omega_i^I = \left[ V_i \left( P_{H,i} \right)^{1-\mu_i} + (1-V_i) \left( \frac{\Gamma^3 \ IM_i^I / Q_i^I}{1-\Gamma^3 \ IM_i^I / Q_i^I} \right) \right] \left( \frac{1}{1-\mu_i} \right) \]  

(28)

and

\[ \lambda_i^I = \left[ V_i \left( P_{H,i} \right)^{1-\mu_i} + (1-V_i) \left( P_{IM,i} / \Gamma^3 \ IM_i^I / Q_i^I \right)^{1-\mu_i} \right] \left( \frac{1}{1-\mu_i} \right) \]  

(29)
2.3 Fiscal authorities

The domestic fiscal authority pursues a primary surplus target \((sp)\), levies taxes on consumption, labor, capital and dividends, makes biased transfers, and adjusts expenditures and budget financing accordingly.

The primary surplus \(SP_t\) is defined as:

\[
SP_t = \tau^C_t P_{C,t} C_t + (\tau^N_t + \tau^W_t + \tau^K_t + \tau^W_t) W_t, N_t^B + \\
+ \tau^K_t (R_{H,t} u_{1,t} - (u_{t,1} + \delta) P_{I,t}) K_{H,t} + \tau^D_t D_t + \\
+ u_{1,t} R_{G,t} K_{G,t} - P_{G,t} G_t - TR_t - P_{I,t} I_{G,t}
\]

where \(\tau^C_t, \tau^N_t, \tau^W_t, \tau^K_t, \tau^D_t\) are rates of taxes levied on consumption, labor income, social security from workers, social security from firms, capital and dividends. \(P_{G,t}, G_t\) stands for aggregate expenditures with government consumption, \(TR_t\) stands for government transfers, and \(P_{I,t}, I_{G,t}\) stands for aggregate expenditures with government investment.

The realization of the primary surplus is affected by deviations of the public debt and economic growth from their steady-states (\(B_y\) and \(g_y\), respectively):

\[
sp_t = \rho_{1,y} sp_{t-1} + \rho_{2,y} sp_{t-2} + \\
(1 - \rho_{1,y} - \rho_{2,y}) \left( sp + \phi_{b_y} (b_{y,t} - b_Y) \right) + \phi_{g_y} (g_{y,t-1} - g_Y) + \epsilon_{sp,t}
\]

where \(sp_t = \frac{SP_t}{P_{Y,t} Y_t}, b_{Y,t} = \frac{B_t}{P_{Y,t-1} Y_{t-1}}, g_{Y,t} = \frac{Y_t}{Y_{t-1}},\) the unindexed counterparts are steady-state ratios, and \(\epsilon_{sp,t}\) is a white noise shock to the primary surplus.

For industrialized economies, Cecchetti et. al. (2010) do not find evidence of a response of the primary balance to economic conditions. For Brazil, our empirical estimates for the primary balance rule show a significant anti-cyclic component (Table 1), which is also addressed, yet in a different manner, in Ratto et. al. (2009). Estimations of the rule with only one lag in the primary balance do not show well-behaved residuals.
In our calibrations, the foreign economy is represented by the USA and the Euro area. Therefore, for the foreign economy, we adopt CMS’s assumption that the fiscal authority does not follow a primary surplus target, and government expenditures with consumption, \( g_j = \frac{P_{G,t,j}}{P_{Y,t,j}} \left( \frac{G_t}{Y_t} \right) \), follow an autoregressive process:

\[
g_j = (1 - \rho_{g,j}) g + \rho_{g,j} g_{j,t-1} + \epsilon_{g,j}\tag{32}
\]

where \( g \) is the steady state value of government expenditures as a share of GDP and \( \epsilon_{g,j} \) is a white noise shock to government expenditures. Specifically for the foreign economy, we assume that lump sum taxes exist and follow an autoregressive process of the type:

\[
\begin{pmatrix}
T_t \\
P_{Y,t,j} Y_t
\end{pmatrix}
= \phi_{bt} \left( \frac{R_{t-1} B_{t-1}}{P_{Y,t,j} Y_t} - B_Y \right)
\] \tag{33}

where \( B_Y \) is the steady state value of government bonds.

For both economies, government transfers follow the autoregressive process:

\[
\begin{pmatrix}
TR_t \\
P_{Y,t,j} Y_t
\end{pmatrix}
= \left( 1 - \rho_{tr} \right) tr + \rho_{tr} \left( \frac{TR_t}{P_{Y,t,j} Y_t} \right) + \epsilon_{tr,j}
\] \tag{34}

where \( tr \) is the steady state value of government transfers, and \( \epsilon_{tr,j} \) represents a white noise shock to government transfers.

Total transfers are distributed to each household group according to:

\[
TR_{t,j} := \frac{1 - \omega_{v,\mu}}{1 - \omega} TR_t
\] \tag{35}

\[
TR_{t,j} := v_{\mu} TR_t
\] \tag{36}

where \( v_{\mu} \) is the bias in transfers towards group \( J \).
Government investment follows an autoregressive rule of the form

\[ i_{g,t} = (1 - \rho_ig) i_{g,t-1} + \rho_ig i_{g,t-1} + \varepsilon_{i_{g,t}} \]  

(37)

and public capital accumulation follows the rule

\[ K_{G,t+1} = (1 - \delta) K_{G,t} + \left[ 1 - \Gamma_i \left( \frac{I_{G,t}}{I_{G,t-1}} \right) \right] I_{G,t} \]  

(38)

The government budget constraint is thus

\[
\begin{align*}
\tau^t_C P_{C,t} C_t + (\tau^t_N + \tau^t_W + \tau^t_Y) W_t N_t^D \\
+ \tau^t_R \left( R_{K,t} u_{t+1} - (\Gamma_w u_{t+1} + \delta) P_{I,t} \right) K_t \\
+ \tau^t_D T_t + R^t_i B_{t+1} + M_t + u_{t+1} R_{G,t} K_{G,t} \\
- P_{G,t} G_t - TR_t - B_t - M_{t-1} - P_{I,t} I_{G,t} = 0
\end{align*}
\]

(39)

with \( T_t = 0 \) for the domestic economy, which, using the primary surplus definition, can be stated as:

\[ SP_t = (B_t - R_t^{-1} B_{t+1}) - (M_t - M_{t-1}) \]  

(39)^

This equation makes clear that, in this model, money not only has an effective role in real decisions, but also matters for the adjustment of fiscal accounts. Increased money supply can alleviate the financial burden from public debt, a feature that approximates the theoretical model to the real conduct of economic policy.

2.4. Monetary authorities

The domestic monetary authority follows a forward-looking interest rate rule that is compatible with an inflation targeting regime

\[
\begin{align*}
R^t_f &= \phi_{R_1} R^{t-1}_f + \phi_{R_2} R^{t-2}_f + (1 - \phi_{R_1} - \phi_{R_2}) \left[ R^t_f + \phi_{\Pi} \left( \frac{P_{C,t+3}}{P_{C,t+1}} - \Pi \right) \right] \\
&\quad + \phi_{g_Y} \left( g_{Y,t-1} - g_Y \right) + \varepsilon_{R,f}
\end{align*}
\]

(40)

where \( \Pi \) is the annual inflation target, \( R^4 \) is the annualized quarterly nominal equilibrium interest rate, which satisfies \( R^4 = \beta^{-4} \Pi \), \( g_Y \) is the steady state output.
growth rate, and $\epsilon_{R,t}$ is a white noise shock to the interest rate rule. Empirical evidence in Brazil suggests the presence of two lags in the policy instrument\(^3\).

For the foreign economy we adopt the representation in CMS:

$$R_t^4 = \phi_R R_{t-1}^4 + (1 - \phi_R) \left[ R_t^4 + \phi_\Pi \left( \frac{P_{C,t}}{P_{C,t-3}} - \Pi_t \right) \right] + \phi_{\epsilon_y} \left( \frac{Y_t}{Y_{t-1}} - g_Y \right) + \epsilon_{R,t} \quad (41)$$

2.5. Aggregation and market clearing

Any aggregated model variable $Z_t$ denoted in per capita terms results from the aggregation $Z_t = \int_{0}^{1} Z_{h,t} dh = (1 - \omega)Z_{I,t} + \omega Z_{J,t}$ where $Z_{I,t}$ and $Z_{J,t}$ are the respective per capita values of $Z_t$ for families $I$ and $J$. Details on the aggregation that do not substantially differ from CMS are not shown.

There are important distinctions in the aggregate relations that obtain from this model as compared to those in CMS. The first refers to the wage dispersion index, and the second to the economy’s resource constraint, which are detailed below.

2.5.1. Wage dispersion

The equilibrium conditions between supply ($N_{i,t}$) and demand ($N'_{i,t}$) for individual labor are:

$$N_{i,t} = N'_{i,t} = \int_{0}^{1} N'_{j,t} df \quad (42)$$

$$N_{j,t} = N'_{j,t} = \int_{0}^{1} N'_{j,t} df \quad (43)$$

\(^3\)See Minella and Souza-Sobrinho (2009).
Aggregating the demand of all firms for labor services yields

\[ N_{i,t} = \frac{1}{1 - \omega} \left( \frac{W_{i,t}}{W_{i,t}} \right)^{-\eta_i} N^I_t \]  

(44)

\[ N_{j,t} = \frac{1}{\omega} \left( \frac{W_{j,t}}{W_{j,t}} \right)^{-\eta_j} N^J_t \]  

(45)

which can also be represented, using the group-wise aggregated labor demand equations, as a function of total demand for labor by the intermediate firms:

\[ N_{i,t} = \frac{1 - V_{\omega,\omega}}{1 - \omega} \left( \frac{W_{i,t}}{W_{i,t}} \right)^{-\eta_i} \left( \frac{W_{j,t}}{W_{j,t}} \right)^{-\eta_j} N^D_t \]  

(46)

\[ N_{j,t} = V_{\omega,\omega} \left( \frac{W_{j,t}}{W_{j,t}} \right)^{-\eta_i} \left( \frac{W_{j,t}}{W_{j,t}} \right)^{-\eta_j} N^D_t \]  

(47)

The aggregate supply of labor from each household group, \( N_{i,t} \) and \( N_{j,t} \), relates to the labor demand as:

\[ N_{i,t} := \int_0^{1 - \omega} N_{i,t} di = \frac{\psi_{i,t}}{1 - \omega} N^I_t \]  

(48)

\[ N_{j,t} := \int_{1 - \omega}^1 N_{j,t} dj = \frac{\psi_{j,t}}{\omega} N^J_t \]  

(49)

where \( \psi_{i,t} := \int_0^{1 - \omega} \frac{1}{1 - \omega} \left( \frac{W_{i,t}}{W_{i,t}} \right)^{-\eta_i} di \) and \( \psi_{j,t} := \int_{1 - \omega}^1 \frac{1}{\omega} \left( \frac{W_{j,t}}{W_{j,t}} \right)^{-\eta_j} dj \) are the dispersion indices.
We show in appendix E that the wage dispersion indices $\psi_{t,I}$ and $\psi_{t,J}$ can be stated in a recursive formulation that differs from the working paper version of CMS as to the term of current consumer-price inflation that does not show in our equation\(^4\):

\[
\psi_{t,I} := (1 - \xi_I) \left( \frac{\tilde{W}_{t,I}}{W_{t,I}} \right)^{-\eta_I} + \xi_I \left( \frac{\pi_{C,t}^{x_{t-1}} \pi_{C}^{1-x_{t}}}{\pi_{w,t,I}} \right)^{-\eta_I} \psi_{t-1,I} \tag{50}
\]

\[
\psi_{t,J} := (1 - \xi_J) \left( \frac{\tilde{W}_{t,J}}{P_{Y,t,J}} \right) \left( \frac{W_{t,J}}{P_{Y,t,J}} \right)^{-1} + \xi_J \left( \frac{\pi_{C,j,t}^{x_{t-1}} \pi_{C}^{1-x_{t}}}{\pi_{w,t,J}} \right)^{-\eta_J} \psi_{t-1,I} \tag{51}
\]

where $\pi_{w,t,I}$ and $\pi_{w,t,J}$ stand for household $I$ and $J$ wage inflation rates.

Aggregating the labor supply from household groups $I$ and $J$, using equations (48) and (49), results in

\[
N_{S,t} := \psi_{t,I} \cdot N^I_t + \psi_{t,J} \cdot N^J_t
\]

which relates to the aggregate labor demand and the total wage dispersion index as:

\[
N_{S,t} = \psi_t \cdot N^D_t \tag{52}
\]

where total wage dispersion is $\psi_t := \left\{ (1 - \omega) \left( \frac{W_{I,t}}{W_t} \right)^{-\eta} \psi_{t,I} + \omega \left( \frac{W_{J,t}}{W_t} \right)^{-\eta} \psi_{t,J} \right\}$.

2.5.2. Aggregate resource constraint

The price indices derived in the previous sessions entail representations for the aggregate resource constraint of the economy that are importantly different from the ones presented in CMS and CCW. Aggregating household and government budget constraints, and substituting for the equations of external financing and optimality conditions of firms, we obtain the aggregate resource constraint of the economy:

\[\text{Equation A.9, WPS 747/ECB.}\]
\[ P_{Y,t}Y_t = P_{C,t}Q_t^C + P_{I,t}Q_t^I + P_{G,t}Q_t^G + S_tP_{X,t}X_t - P_{IM,t}IM_t \]  

which, using the price indices derived above, can also be restated as

\[ P_{Y,t}Y_t = P_{H,t}H_t^C + P_{H,t}H_t^I + P_{H,t}H_t^G + S_tP_{X,t}X_t \]  

Despite the fact that these representations are standard for national accounts, they differ from the respective equations derived in CMS\textsuperscript{5} and CCW, as we detail in appendix F.

3. Model Transformation and Steady State Calibration

In this section we describe the transformation of variables that render the model stationary, and detail the steady state calibration.

As we assume a technology shock that permanently shifts the productivity of labor, all real variables, with the exception of hours worked, share a common stochastic trend. Besides, as the monetary authority aims at stabilizing inflation, rather than the price level, all nominal variables share a nominal stochastic trend.

The strategy consists of three main types of transformation. Real variables are divided by aggregate output \((Y_t)\), nominal variables are divided by the price of aggregate output \((P_{Y,t})\) and the variables expressed in monetary terms are divided by \(P_{Y,t}Y_t\).

Although most transformations are straightforward, some are not trivial. Predetermined variables, such as capital, are scaled by dividing their lead values by \(Y_t\); wages, domestic bonds, and internationally traded bonds are scaled by \(P_{Y,t}Y_t\). In addition, in order to make the Lagrange multipliers compatible with the adopted scaling

\textsuperscript{5} Equation (38) in CMS.
strategy, we multiply them by $Y_t^\sigma$, resulting in $Y_t^\sigma \Lambda_{I,t}$ and $Y_t^\sigma \Lambda_{J,t}$ for households $I$ and $J$, respectively.

The permanent technology shock, $z_n$, should also be divided by the aggregate output. Re-scaling the production function for the intermediate goods results in:

$$\left(\frac{z_n}{Y_t}\right)^{-1} = z_t \left( u_{I,t} - \frac{K_t}{Y_t} \right)^{\alpha} \left( \frac{N_t^{b}}{Y_t^{b}} \right)^{-\alpha} \left( \frac{Y_t}{Y_{t-1}^{b}} \right)^{-\alpha} \left( \frac{z_n}{Y_t} \right)^{-\alpha} - \psi$$

From the above, we can conclude that $\frac{z_n}{Y_t}$ is a stationary variable whenever the ratios $\frac{K_t}{Y_t}$ and $\frac{Y_t}{Y_{t-1}}$ are both stationary.

We now turn to the steady state calibration. For the domestic economy, we calibrate the model to reproduce historical averages of the Brazilian economy during the inflation targeting regime (Table 2). For parameters that are not directly derived from the historical averages in these series, we took the agnostic stance of using the same parameters adopted in the literature for Brazil, or, in its absence, we replicated the parameters in CMS. The rest of the world is calibrated using an average of the values presented in CMS for the United States and the Euro Area.

Calibration and simulations are performed under the assumption of log-linear utility ($\sigma = 1$). The steady state calibration starts by normalizing the stationary prices of intermediate goods at 1. This normalization ensures that the steady state values of some variables are one, as is the case of final goods prices and Lagrange multipliers associated with the optimization problem of final goods firms. The steady state rate of capital utilization is also fixed at one for both economies. The remaining steady state ratios are calibrated accordingly, as shown in Table 3.

---

6 An alternative strategy would be to calibrate the parameters to reproduce empirical moments of the endogenous series. We leave this for a companion paper with an estimated version of the model.
We calibrate the population size using LABORSTA\textsuperscript{7} data on the economically active population in the world for the year 2007. The size of household’s group $J$ in the domestic economy was set to equal the share of households in Brazil that earn less than two minimum wages according to the PNAD 2007 survey. Also according to this survey, relative wages for household group $I$ were set in our calibrations at 2.86.

The share of fixed costs in total production was set so as to guarantee zero profits in the steady state. The labor demand bias, $\nu_{\omega}$, was calibrated to ensure that households’ groups $I$ and $J$ work the same amount of hours. For the stationary labor productivity growth rate, we set 2% for Brazil and the rest of the world using data on GDP growth from the World Bank for the period 2000-2007.

For Brazil, we calibrated the price elasticity $\mu_c = 0.33$ according to Araújo et. al. (2006). For the price elasticity $\mu_i$, we repeated the value set for $\mu_c$. The home biases $\nu_c$ and $\nu_i$ are obtained from the demand equations of imported goods using the steady state value for the supply of consumption and investment goods, and the import quantum.

The steady state primary surplus to output ratio, $sp$, was calibrated as the mean value of the primary surplus in the period 1999-2008. For the rest of the world, the value for $sp$ was obtained implicitly from the NAWM calibration. The public debt ratio $B_y$ was set to be consistent with $sp$.

Government expenditures, $g$, for both Brazil and the rest of the world were set residually from the aggregate resource constraint. Government transfers, $tr$, for both Brazil and the rest of the world, were obtained so that household budget constraints close.

\textsuperscript{7} http://laborsta.ilo.org/
With the exception of consumption taxes, $\tau^C$, which were calibrated following Siqueira et al. (2001), Brazilian tax rates were calibrated based on the current tax law. The lump-sum tax bias, $\nu^p$, which is active only for the foreign economy, was set to one, whilst the transfer bias, $\nu^t$, was implicitly calculated from households $I$ and $J$ budget constraints.

We calibrated the price-elasticity to demand of government investment goods, $\eta_g$, to a value that is close to 1, arbitrarily approximating it to a Cobb-Douglas technology. This enabled us to calibrate $\nu_g$ from the rental rate on government capital, which we assumed to be just enough to cover expenditures with depreciation.

The inflation target and the respective steady state nominal interest rate in the domestic economy were set according to historical Brazilian averages. The reaction coefficients in the monetary policy rule were calibrated according to Minella and Souza-Sobrinho (2009), where they show that the monetary policy in Brazil has in average shown an insignificant direct reaction to output.

The parameter $\gamma_{v,2}$ that appears in the functional form of the consumption transaction for the domestic economy was set at the same value calibrated in CMS. The parameter $\gamma_{v,1}$ follows from the equation that defines the consumption transaction cost, the calibrated values for money and consumption, and the equation that defines the money velocity. Finally, some autoregressive coefficients ($\rho_{\tau^m}, \rho_{\nu^p}, \rho_{\nu^t}$) were set at 0.9 following the NAWM calibration for $\rho_g$. For autoregressive coefficients referring to government consumption and transfers, $\rho_g$ and $\rho^t$, we used estimated coefficients obtained from isolated econometric regressions for Brazil.
4. Simulations and policy analysis

In this session, we show impulse responses for shocks to: monetary policy, primary surplus, government transfers and investment. The intention here is to understand how this model responds to shocks under the adopted calibration. We compare the model’s predictions for alternative types of primary surplus and monetary policy rules. All simulations were done using the function “stoch_simul” of DYNARE at MATLAB.

4.1. Impulse responses of the calibrated model

Figure 1 shows the impulse responses of a 1 p.p. shock to the nominal interest rate. With this calibration, the shock affects inflation and output in the expected direction, but we do not obtain a hump-shaped response. The trough in inflation and output growth occurs already in the first quarter. Inflation reverts back to the steady state in the third quarter, while the nominal interest rate remains above the steady state for about one year. Output levels return to the steady state in about 6 quarters.

Despite the fact that each policy rule responds to a different set of variables, in equilibrium the fiscal response intertwines with monetary conditions, the key linking element being the public debt. The interest rate hike puts pressure on the public debt, which rises above its steady trend and takes very long to revert to the steady state. Notwithstanding, the anti-cyclic component of the fiscal rule forces the primary surplus to initially react to the economic downturn, and the fiscal rule loosens through a reduction in the primary surplus of about 0.05 p.p. of GPD from its steady state. This reaction is enabled by an increase in government consumption that should also offset

---

8 The standard deviations of all shocks were arbitrarily set at 100bps. Their values are not meant to reflect their empirical counterpart.

9 Minella (2003) and Silveira (2008) also report impulse responses of inflation and output after a monetary policy shock that lack the “hump shapeness” that is observed in other countries.
the reduction in expenditures with government investment. In the third quarter, public
debt to GDP reaches a peak, and the output growth surpasses its stationary rate. This
development puts pressure on the fiscal rule for a rise in the primary surplus of up to
0.10 p.p. of GDP, through a reduction in government consumption and levels of
government investment below the steady state for longer than private investment.
Consequently, the debt initiates a downward path, yet still above its steady state for a
long time afterwards.

The economy decelerates in the aftermath of a monetary policy shock. Capital
utilization is below the steady state and firms pay lower nominal wages to households.
The amount of labor and consumption also drops. The impact on private investment and
the stock of capital is almost negligible. The distributional effects, although very small,
are less favorable to less specialized and more constrained households.

The dynamics of endogenous variables after the shock affects GDP composition.
Although private consumption to GDP falls in the first quarter, it immediately bounces
upwards after the second quarter mostly to replace investment and public consumption.

Figure 2 shows the impulse responses of a 1 p.p. reduction in the primary
surplus. The shock initially increases government consumption by about 0.4 p.p. of
GDP and raises public investment by 1% from its steady state. Such expansionist effect
initially boosts output growth to around 7% p.y., but in the second quarter, output
growth falls to levels below steady state, where it reverts to afterwards. This shock has a
smaller impact on the levels of private consumption and labor as compared to their
steady state trends. The monetary effects of the fiscal shock comprise an increase of up
to 0.2 p.p. in consumer price inflation, and, in spite of the contractionist stance of
monetary policy, inflation remains above its steady state for a prolonged period.
The shape of the responses of inflation and public debt varies according to which shock is activated. For each shock, there is a distinct transmission mechanism. When the shock comes from the monetary policy, the response of the debt is more hump-shaped as the fiscal rule reacts to economic conditions. On the other hand, when the shock stems from the fiscal sector, the response of inflation becomes more hump-shaped, as the monetary policy rule reacts to the inflationary conditions imposed by the fiscal loosening.

To account for the fact that transfers are usually an instrument used for income distribution, the shock to government transfers (Figure 3) is biased towards less specialized and more constrained households. The hike in government transfers is enabled by a reduction in government consumption and public investment. These choices of cuts in government expenditures initially result in a significant downturn in economic activity. The fall in private consumption that could follow from depressed conditions stemming from the production side of the model does not occur possibly because of the direct injection of financial resources to households by the transfers (income effect) and also because monetary policy reacts to poor economic conditions and to the drop in inflation by keeping interest rates slightly below the steady state. Net public expenditures that result from the shock to transfers are not financed through debt issuance above steady state trends. In addition, the distributional effect of the shock vanishes after about 5 quarters.

A shock to government investment (Figure 4), of about 1 p.p. of GDP, crowds out private investment, as the rental rate of public capital is cheaper in the steady state. The rise in expenditures with public investment is financed through cuts in government consumption, driving the primary surplus down to levels below the steady state, and through debt issuance. Afterwards, the rise in public debt exerts a contractionist
pressure on the fiscal rule, and the primary surplus rises after the third quarter. The initial inflationary spike results in a contractionist monetary policy reaction, and the final outcome is a drop in economic dynamism, with output below its steady state path for about 5 quarters. After the third quarter, the shock to government investment boosts output growth to above its steady state for a very prolonged time span. After the contractionist stance imposed by the fiscal and monetary adjustment unwinds, private consumption and wages rise a little above the steady state and remain there for a long time.

4.2 – Policy analysis

To understand how the interaction of fiscal and monetary policy affects the model’s predictions, we analyze impulse responses, variances and variance decompositions after policy shocks under a number of different specifications for the policy rules.

4.2.1 – Sensitivity analysis

Figure 5 shows the impulse responses of a monetary policy shock with varying degrees of fiscal commitment with the stationary path of public debt. Greater commitment to the debt-to-GDP ratio implies that the government will post a stronger reaction to events that drive the public debt as a share of GDP away from its stationary trajectory. A contractionist monetary policy\textsuperscript{10} increases interest rates and thus the service of the debt, which then triggers a reaction from the fiscal policy to stabilize the debt-to-GDP ratio. The stronger the reaction of the fiscal policy to the debt, the stronger the impact on output and inflation. The monetary policy rule then reacts to the effects

\textsuperscript{10} Notice that in the benchmark calibration of the monetary policy rule, the direct reaction of the monetary policy to output is null. As a result, the exercises shown in the subsections that follow are conditional on the adopted parameterization.
on inflation from these economic conditions, lowering interest rates. The extreme case presented in the first plot, which corresponds to the case where the fiscal response to the debt is the greatest, illustrates that the initial increase in interest rates should be promptly reversed followed by an intense expansionist reaction in the medium-run to contain the excessive contractionist impact from the fiscal feedback. This calls for some sort of coordination between fiscal and monetary policy to attain the best policy combination to reduce the volatility that arises in inflation and output when both policies are in place. The plots also show that a stronger reaction to the debt-to-GDP ratio skews the distributive effects of the monetary policy shock a little more in favor of the group of more specialized households (group I) who also have more investment alternatives.

Table 4 shows variances and variance-decomposition when only the fiscal and monetary policy shocks are active. Under varying degrees of commitment to the stationary level of the debt, an increase in the coefficient of the fiscal rule associated with the deviation of the debt from its steady state increases the volatility of consumer price inflation and the correlation between inflation and output growth. As to the volatility of the output growth, the effects are non-linear. The shock decomposition shows that the influence of the monetary shock on output growth variance attains its least value with a coefficient of 0.18, a level that also grants the least variance of output growth\(^\text{11}\). On the other hand, the greatest influence of the monetary policy shock onto inflation variance obtains with a coefficient of 0.31.

Assuming that it is desirable to have the monetary policy affecting inflation more than the fiscal shock and conversely for the case of the output growth, we sought for a standard deviation of the fiscal shock that could jointly minimize the influence of

\(^{11}\text{This could be suggestive of a region where optimal fiscal policy may lie on, but to be conclusive on this, we would need to conduct optimal policy analysis, which is beyond the scope of this paper.}\)
the primary surplus shock on inflation and of the monetary policy shock on GDP growth. For a 1 p.p. standard deviation of the monetary policy shock and for a degree of fiscal commitment that minimized the unconditional volatility of output growth, the degree of fiscal rigor in the execution of the fiscal rule that implements this outcome is 0.47. The moments and variance decomposition that result are portrayed in Table 5. In the following figures and tables, the 0.47 standard deviation of the fiscal shock is used as benchmark. Figure 6 shows the impulse responses to a combination of a contractionist monetary policy shock and expansionist fiscal policy shocks, varying the rigor with which the fiscal rule is implemented. In the short run, the fiscal policy shock nullifies the impact of the monetary policy shock on inflation, and in the medium run, it actually generates some inflation, the more so the greater the rigor in the implementation of the fiscal rule. As to the public debt, as the fiscal policy shock increases in magnitude, there is additional pressure on the debt, and its initial increase gets steeper, accompanied by a higher persistence to revert back to the steady state.

Table 6 shows the effects on the variances, co-variances and variance decompositions of different degrees of correlation between policy shocks. In this exercise we start from one of the specifications of the fiscal rule shown in Table 4, corresponding to the one (coefficient of 0.18) where output growth attains its lowest volatility and is least impacted by a monetary policy shock. When a contractionist monetary policy jointly occurs with a loosening fiscal shock, which in the table is represented in the columns of negative correlations, the unconditional volatility of inflation and output growth falls. This result was in line with what the previous discussion on Figure 6 implied. Economic stimuli from expansionist fiscal and monetary shocks add variance to both inflation and output, and also expand the correlation between these two variables.
Table 7 shows the impact of monetary policy rules that react more to deviations of expected inflation from the target. Notice that the coefficient of reaction to output growth is null under all monetary policy rules that we experiment with here. In this exercise, we used the same specification for the fiscal rule in Table 6. Under these assumptions, a more hawkish monetary policy enacts a reduction in the variances of inflation and output growth. It also reduces the correlation between these two variables. However, as monetary policy becomes more hawkish, the fiscal shock gains some power to explain the variance of consumer price inflation. When the coefficient attached to inflation targets is set at 2.44, the monetary policy shock has the smallest influence on the variance of the output growth. 12

We find an specific combination of monetary and fiscal commitment that grants the lowest volatility in output growth, bearing in mind that the benchmark monetary policy rule does not react directly to output conditions. Such combination is shown in the second column of Table 8. It increases the share of inflation variance that is attributed to the monetary policy shock, although the highest stake is still with the fiscal shock.

4.2.2 – Fiscal and monetary policy activeness

In Dynare, the model shows a unique solution for time paths of endogenous variables under two regions of policy activeness13 (Figure 7), maintaining the remaining parameters as they were originally calibrated. Under active monetary policy ($\phi_0 > 1.1$), the equilibrium is unique if the response of the fiscal rule to deviations of the public debt to its steady state ratio ($\phi_{B_r}$) remains in the positive interval of $[0.03, \infty)$, where

---

12 This result is not indicative of an optimal reaction of monetary policy to stabilize output, as it is conditioned on the fact that the calibrated monetary policy rule does not react directly to output growth, while the fiscal rule does.

the original calibrated parameter belongs, or in the interval \((-\infty, -1.21)\). In the former interval, the stronger the reaction of the fiscal rule to the debt-to-GDP ratio, the more cyclical are the responses of the output. (Figure 8).

The model also shows a unique solution (in Dynare) in regions where monetary policy is passive (5th to 8th columns of Figure 8)\(^{14}\). Again, the greater the magnitude of the reaction of the fiscal rule to the debt-to-GDP ratio, the stronger the cyclicality of the responses. However, for practically null responsiveness of the fiscal rule to the debt and of the monetary policy rule to the inflation target, the model reestablishes lower cyclicality.

4.2.3 – Alternative types of monetary policy rules

The model can also be used to analyze the effects of adopting a distinct monetary policy rule. Table 9 compares the moments and shows a variance decomposition of key endogenous variables under alternative types of monetary policy rules. If the monetary policy rule directly reacts to changes in the exchange rate\(^ {15}\), the volatility of inflation and output growth reduces. The absolute magnitude of the correlation between economic growth and inflation drastically reduces.

If the monetary policy rule reacts to the gap in output growth\(^ {16}\), the variance in output growth reduces, albeit with an increase in the variance of consumer price inflation and the exchange rate. The monetary policy shock also contributes less to the variances of inflation, output growth and the exchange rate.

\(^{14}\) Schmidt-Grohé and Uribe (2006) also obtain regions of implementable policy with Taylor coefficients lower than 1.

\(^{15}\) The coefficient of reaction to the deviation of changes in the exchange rate from its steady state was arbitrarily set at 1 in this exercise.

\(^{16}\) The coefficient of reaction to the deviation of output growth from its steady state was arbitrarily set at 0.79 in this exercise.
Impulse responses to different types of monetary rules have distinct shapes. Figure 9 shows that the introduction of an explicit reaction of the monetary policy to either output growth or to changes in the exchange rate brings about greater persistence to the drop in inflation. The initial impact on output growth is a little milder, yet the persistence is also more pronounced. Backward looking rules, on the other hand, do not substantially alter the dynamics of the main macroeconomic variables after a monetary policy shock.

5. Conclusion

In this paper we revised the work in CMS and CCW, correcting important equations relating to prices, wages and the aggregate resource constraint of the economy. In addition, in order to better approximate the modeled economy to the current practice of fiscal policy in a number of countries, including Brazil, we introduced a different modeling strategy of the fiscal sector. We let the government track a primary surplus and a debt-to-GDP target, using its instrument also as a response to economic conditions, and allowed the government to invest and the private sector to decide upon the utilization of public and private capital. We also extended the model to introduced labor specialization in order to allow for wage heterogeneity amongst households that supply the same amount of worked hours.

Under the adopted calibration, the model responses to monetary policy shocks are short-lived. The simulations show an important endogenous interaction of monetary policy conditions with fiscal policy responses, although policy rules are not directly responsive to one another. Expansionist primary surplus shocks can boost economic activity, yet with significant implications to inflation. Shocks to government investment also put pressure on inflation, and, although the immediate response of output growth is
negative, it soon reverses to a prolonged economic expansion. On the other hand, the simulations show that fiscal transfer shocks, aimed at redistributing income, negatively affect general economic conditions as consequence of the fiscal rule.

Different specifications for the policy rules significantly affect the results implied by the model. The simulations with different degrees of fiscal commitment to the stationary path of the public debt and with greater rigor in the implementation of the primary surplus rule make explicit that the strength of one policy affects the impact of the other on important variables such as output and inflation. Increasing fiscal commitment to the stationary debt-to-GDP ratio enhances the contractionist impact of a monetary policy shock upon inflation, albeit at the cost of a higher impact on output growth in the medium-run. The volatility of inflation and output growth increases, as does the correlation between them. On the other hand, a more rigorous implementation of the primary surplus rule implies, as expected, lower variance of inflation and output growth, but the correlation between them increases with the degree of rigor.

Simultaneous shocks to the primary surplus rule and to monetary policy make explicit the contrasting objectives of these policies. Primary surplus shocks dampen the contractionist effect of the monetary policy shock onto inflation and output, and also reduce the variance of inflation and output growth.

A higher commitment to the inflation target in the monetary policy rule reduces the variance of inflation and output growth, and their correlation, with the drawback that the fiscal shock gains importance in affecting the variance of inflation.

Different specifications of monetary policy rules also yield qualitatively distinct predictions. Rules that directly react to changes in the exchange rate or to the output gap reduce the variance of output growth. However, an explicit reaction to the output growth increases the variance of inflation. A monetary policy reaction to the exchange
rate holds the following outcomes: the variance of inflation and the correlation between inflation and output growth reduce, and the monetary policy shock gains a much greater stake at the variance of inflation.

Our model finds stable equilibria in regions where the fiscal policy rule is active and the Taylor principle does not hold. Impulse responses with some combinations of policy reactions in the region of fiscal-activeness show that the responses can be either well-behaved or strongly cyclical. For these cases, the model reestablishes lower cyclicality for practically null responsiveness of the fiscal rule to the debt and of the monetary policy rule to the inflation target.
APPENDIX

A. Cost functions

We describe below the functional form for each of the cost functions in the paper.

Consumption transactions cost:
\[
\Gamma_v(v_{h,t}) := \gamma_{v,1} \cdot v_{h,t} + \gamma_{v,2} \cdot v_{h,t}^{-1} - 2\sqrt{\gamma_{v,1} \cdot \gamma_{v,2}}
\]  
\[\text{(A.1)}\]

Cost on the transaction with international bonds:
\[
\Gamma_{\beta}^F(B_{I,t+1}^F) := \gamma_{\beta}^F \left( \exp \left( \frac{(1-\omega)S_{i,t-1}B_{I,t+1}^F}{P_{i,t}Y_t} \right) - \exp(B_f) \right)
\]
\[\text{(A.2)}\]

where \(B_f\) is the steady state ratio of international bonds as a share of GDP.

Cost on the utilization of capital:
\[
\Gamma_u(u_{i,t}) := \gamma_{u,1} (u_{i,t} - 1) + \gamma_{u,2} \left( u_{i,t} - 1 \right)^2
\]
\[\text{(A.3)}\]

Cost on the adjustment of the level of investment:
\[
\Gamma_{I} \left( \frac{I_{t,t}}{I_{t,t-1}} \right) := \gamma_{I} \left( \frac{I_{t,t}}{I_{t,t-1}} - g_Y \right)^2
\]
\[\text{(A.4)}\]

where \(g_Y\) is the trend growth rate of the economy.

Cost on the adjustment of the import share in the production of final consumption goods:
\[
\Gamma_{IM}^C \left( \frac{I_{t,I}^C}{Q_t^C} \right) := \gamma_{IM}^C \left( \frac{I_{t,I}^C}{Q_{t-1}^C} - 1 \right)^2
\]
\[\text{(A.5)}\]

Cost on the adjustment of the import share in the production of investment goods:
\[
\Gamma_{IM^t} \left( \frac{IM_i^t}{Q_i^t} \right) = \frac{\gamma_{IM^t}}{2} \left( \frac{IM_i^t}{IM_{i-1}^t} - 1 \right)^2
\]  
(A.6)

\[
\Gamma_{IM^t}^3 \left( \frac{IM_i^C / Q_i^C}{Q_i^C} \right) = 1 - \Gamma_{IM^t} \left( \frac{IM_i^C / Q_i^C}{Q_i^C} \right) - \Gamma_{IM^t}^2 \left( \frac{IM_i^C / Q_i^C}{Q_i^C} \right) \left( \frac{IM_i^C / Q_i^C}{Q_i^C} \right)(A.7)
\]

\[
\Gamma_{IM^t}^3 \left( \frac{IM_i^C / Q_i^C}{Q_i^C} \right) = 1 - \Gamma_{IM^t} \left( \frac{IM_i^C / Q_i^C}{Q_i^C} \right) - \Gamma_{IM^t}^2 \left( \frac{IM_i^C / Q_i^C}{Q_i^C} \right) \left( \frac{IM_i^C / Q_i^C}{Q_i^C} \right)(A.8)
\]

B. Derivation of the recursive form for wage setting

The first order condition in wage setting is

\[
E_i \left[ \sum_{k=0}^{\infty} \left( \xi_i, \beta \right)^k N_{i+t+k} \left( 1 - \tau_{i+t+k}^N - \tau_{i+t+k}^W \right) \frac{W_{i,t}}{P_{C,i+t+k}} \frac{\pi_{C,t}^I \left( 1 - \tau_{i+t+k}^I \right)^k \pi_{C,i}^{I^*} \eta_{i+k} \left( N_{i+t+k}^I \right)^\zeta} \right] = 0
\]  
(B.1)

where

\[
N_{i+t+k} = \frac{1}{1 - \omega} \left( \frac{W_{i,t} \left( P_{C,i+t+k-1} / P_{C,i+t} \right) \pi_{C,i+t+k}^{I^*} \eta_{i+k}}{W_{i,t}} \right)^{\eta_{i+k}} N_{i+t+k}^I
\]

Next, we show that the recursive formula below (B.2) is equivalent to the first order condition in (B.1):

\[
(1 - \omega)^{\eta_{i+k}} \left( \frac{W_{i,t}}{P_{C,i+t}} \right)^{\eta_{i+k}} = \frac{\eta_i}{\eta_i - 1} G_{1,t}
\]  
(B.2)

where

\[
F_{1,t} = \left( \frac{W_{i,t}}{P_{C,i+t}} \right)^{\eta_i} N_{i+t+k}^I \left( \frac{\pi_{C,i+t}^{I^*} \eta_{i+k}}{\pi_{C,i}^{I^*} \eta_{i+k}} \right) \eta_{i+k} G_{1,t+1}
\]

\[
G_{1,t} = \Lambda_{i,t} \left( 1 - \tau_{i+t+k}^N - \tau_{i+t+k}^W \right) \frac{W_{i,t}}{P_{C,i+t}} \frac{\pi_{C,i+t}^{I^*} \eta_{i+k}}{\pi_{C,i}^{I^*} \eta_{i+k}} \left( \frac{\pi_{C,i+t}^{I^*} \eta_{i+k}}{\pi_{C,i}^{I^*} \eta_{i+k}} \right) G_{1,t+1}
\]
Notice that $F_{I,t}$ can be rewritten as

$$F_{I,t} := E_t \left\{ \left( \frac{W_{I,t}}{P_{C,t|t}} \right)^{\eta_i} \right\} + \bar{\xi}_t \cdot \beta \cdot E_t \left\{ \left( \frac{\pi_{C,t+1}}{\pi_{C,t+1} \pi_{C,t}} \right)^{\eta_i} \right\} \left\{ \left( \frac{W_{I,t+1}}{P_{C,t+1}} \right)^{\eta_i} \right\} \left\{ N_{t+1}^{\eta_i} \right\}^{1+\xi}$$

and thus

$$F_{I,t} := E_t \left\{ \left( \frac{W_{I,t}}{P_{C,t|t}} \right)^{\eta_i} \right\} \left\{ N_t^{\eta_i} \right\}^{1+\xi} + \bar{\xi}_t \cdot \beta \cdot E_t \left\{ \left( \frac{\pi_{C,t+1}}{\pi_{C,t+1} \pi_{C,t}} \right)^{\eta_i} \right\} \left\{ \left( \frac{W_{I,t+1}}{P_{C,t+1}} \right)^{\eta_i} \right\} \left\{ N_{t+1}^{\eta_i} \right\}^{1+\xi}$$

Assuming the transversality conditions

$$\lim_{k \to \infty} E_t \left\{ \bar{\xi}_t \cdot \beta \cdot \left( \frac{P_{C,t+1}}{P_{C,t}} \right)^{\eta_i} \pi_{C,t+1}^{1-\eta_i} \right\} F_{I,t+k} = 0$$

$$\lim_{k \to \infty} E_t \left\{ \bar{\xi}_t \cdot \beta \cdot \left( \frac{P_{C,t+1}}{P_{C,t}} \right)^{\eta_i} \pi_{C,t+1}^{1-\eta_i} \right\} G_{I,t+k} = 0$$

we obtain

$$F_{I,t} := E_t \left\{ \sum_{k=0}^{m} \bar{\xi}_t \cdot \beta^k \left( \frac{P_{C,t+k}}{P_{C,t+k-1}} \right) \pi_{C,t+k}^{1-\eta_i} \right\} \left\{ \left( \frac{W_{I,t+k}}{P_{C,t+k}} \right)^{\eta_i} \right\} \left\{ N_{t+k}^{\eta_i} \right\}^{1+\xi}$$

$$G_{I,t} := E_t \left\{ \sum_{k=0}^{m} \bar{\xi}_t \cdot \beta^k \left( \frac{P_{C,t+k}}{P_{C,t+k-1}} \right) \pi_{C,t+k}^{1-\eta_i} \right\} \left\{ \left( \frac{W_{I,t+k}}{P_{C,t+k}} \right)^{\eta_i} \right\} \left\{ \Lambda_{I,t+k} \left( 1 - \tau_{r+k}^N - \tau_{r+k}^{\omega} \right) N_{t+k}^{\eta_i} \right\}$$

and substituting them into the recursive formula (B.2), we obtain:
which yields the first order condition

\[
E_t \left[ \sum_{k=0}^{n} \xi_t^k \beta^k \left( \frac{P_{C_{t+k}}}{P_{C_t}} \right)^{\eta_{t-k}} \Lambda_{t+k} \left( 1 - \tau_{t+k}^N - \tau_{t+k} \right) \left( \frac{\bar{W}_{t+k}}{P_{C_{t+k}}} \right)^{\eta_t} \left( \frac{N_{t+k}^I}{P_{C_{t+k}}} \right)^{1+\nu_{t+k}} \right] = 0
\]

Multiplying by the strictly positive expression \( \left( \frac{1}{1 - \omega} \right) \left( \frac{\bar{W}_{t+k}}{P_{C_{t+k}}} \right)^{1+\nu_{t+k}} \) we obtain

\[
E_t \left[ \sum_{k=0}^{n} \left( \xi_t^k \beta^k \right)^{\eta_{t-k}} \left( \frac{P_{C_{t+k}}}{P_{C_t}} \right)^{\eta_{t-k}} \left( \frac{\bar{W}_{t+k}}{P_{C_{t+k}}} \right)^{\eta_t} \left( \frac{N_{t+k}^I}{P_{C_{t+k}}} \right)^{1+\nu_{t+k}} \right] = 0
\]

After some algebraic manipulation, we obtain

\[
E_t \left[ \sum_{k=0}^{n} \left( \xi_t^k \beta^k \right)^{\eta_{t-k}} \left( \frac{P_{C_{t+k}}}{P_{C_t}} \right)^{\eta_{t-k}} \left( \frac{\bar{W}_{t+k}}{P_{C_{t+k}}} \right)^{\eta_t} \left( \frac{N_{t+k}^I}{P_{C_{t+k}}} \right)^{1+\nu_{t+k}} \right] = 0
\]

which yields the first order condition

\[
E_t \left[ \sum_{k=0}^{n} \left( \xi_t^k \beta^k \right)^{\eta_{t-k}} \left( \frac{P_{C_{t+k}}}{P_{C_t}} \right)^{\eta_{t-k}} \left( \frac{\bar{W}_{t+k}}{P_{C_{t+k}}} \right)^{\eta_t} \left( \frac{N_{t+k}^I}{P_{C_{t+k}}} \right)^{1+\nu_{t+k}} \right] = 0
\]
C. Derivation of the recursive form for the price setting rule

The first order condition for the export prices is analogous to the one for intermediate goods:

\[
E \left[ \sum_{k=0}^{\infty} (\xi_t^E)^k \Lambda_{t,i,t+k} \left( \frac{P_{H,t+k-1}}{H_{t-1}} \right)^{x_t} (\pi_H^{0,1})^{1-x_t} \beta \frac{MC_{i,t+k}}{\pi_H} \right] = 0
\]  

(C.1)

where

\[
\Lambda_{t,i,t+k} = \frac{1}{1-\beta} \int_0^{x_t} \beta^k \Lambda_{t,i,t} \frac{P_{C,i}}{P_{C,t+k}} \, di
\]

and

\[
H_{f,t+k} = \left( \frac{P_{H,t+k-1}}{P_{H,t+k}} \right)^{x_t} (\pi_H^{0,1})^{1-x_t} \theta^{\theta-\theta} \]

\(H_{f,t+k}\) is the total demand for intermediate goods produced by the domestic firm \(f\).

Consider the recursive formula below:

\[
\tilde{P}_{H,t} = \frac{\theta}{\theta - 1} \frac{F_{H,t}}{G_{H,t}}
\]

(C.2)

where

\[
F_{H,t} := MC_{i,t} H_t + \xi_t \beta E_t \left\{ \frac{\Lambda_{t,i,t+1}}{\Lambda_{t,i,t}} \left( \frac{\pi_{H,t+1}^{0,1}}{\pi_{H,t}^{0,1}} \right)^{1-x_t} \right\}^{\theta-1}
\]

\[
G_{H,t} := P_{H,t} H_t + \xi_t \beta E_t \left\{ \frac{\Lambda_{t,i,t+1}^*}{\Lambda_{t,i,t}} \left( \frac{\pi_{H,t+1}^{0,1}}{\pi_{H,t}^{0,1}} \right)^{1-x_t} \right\}^{\theta-1}
\]

We will show that, when \(\Lambda_{t,i,t+k}^* = \frac{\Lambda_{t,i,t+k}}{P_{C,i,t+k}}\), the recursive formula in (C.2) is equivalent to the first order condition in (C.1). Solving \(F_{H,t}\) recursively, we obtain:
Assuming the transversality conditions below:

\[
F_{H,t} := M_{t,H} + \xi_{H} \beta E_{t} \left\{ \sum_{k=1}^{\infty} \left( \frac{\mathcal{N}_{t,H,k} \mathcal{N}_{t,H,k+1} }{\mathcal{N}_{t,H,k-1} \mathcal{N}_{t,H,k}} \right)^{\theta} \mathcal{M}_{t,1,H,k} \right\}
\]

and

\[
F_{H,t} := E_{t} \left\{ \sum_{k=0}^{\infty} \left( \frac{\mathcal{N}_{t,H,k+1} }{\mathcal{N}_{t,H,k}} \right)^{\theta} \mathcal{M}_{t,1,H,k+1} \right\}
\]

we obtain

\[
F_{H,t} := E_{t} \left\{ \sum_{k=0}^{\infty} \xi_{H} \beta \mathcal{N}_{t,H,k} \mathcal{N}_{t,H,k+1} \left( \frac{P_{H,t+1} / P_{H,t}}{P_{H,t+1} / P_{H,t}} \right)^{\theta} \mathcal{M}_{t,1,H,k} \right\}
\]

As \( \frac{\mathcal{G}_{H,t}}{P_{H,t}} = \frac{\theta}{\theta-1} \cdot F_{H,t} \), then
Multiplying both sides by $0 = \pi^H_{1} \lambda_{1,k} \left( \frac{p_{H,1+k}}{p_{H,1}} \right)^{\theta-1} \left( \frac{p_{H,1+k}}{p_{H,1}} \right)^{(1-\theta)\lambda_{1,k}} H_{1+k}$

$$E_{i} \left\{ \sum_{k=0}^{\infty} \beta^k \lambda_{1,k} \left( \frac{p_{H,1+k}}{p_{H,1}} \right)^{(1-\theta)\lambda_{1,k}} \left( \frac{p_{H,1+k}}{p_{H,1}} \right)^{\theta-1} \left( \frac{p_{H,1+k}}{p_{H,1}} \right)^{(1-\theta)\lambda_{1,k}} \right\} H_{1+k} = 0$$

Multiplying both sides by $\left( \frac{p_{H,1+k}}{p_{H,1}} \right)^{-\theta} \neq 0$, we obtain

$$E_{i} \left\{ \sum_{k=0}^{\infty} \beta^k \lambda_{1,k} \left( \frac{p_{H,1+k}}{p_{H,1}} \right)^{\theta-1} \left( \frac{p_{H,1+k}}{p_{H,1}} \right)^{(1-\theta)\lambda_{1,k}} \right\} H_{1+k} = 0$$

To obtain the equivalence of the recursive form to the first order condition, we need to have

$$\beta^k \lambda_{1,k} = \lambda_{1,k} \left( \frac{p_{C,1+k}}{p_{C,1}} \right)$$

In particular, when consumption decisions are the same across households within group $I$, we have:

$$\lambda_{1,k} = \frac{\lambda_{1,k}}{p_{C,1+k}}$$
D. Derivation of the price indices for final goods

The consumption price index that results from solving the problem in (39) is not the one CMS obtain. The corresponding Lagrange problem is

\[
\min P_{H,i} H^C_t + P_{IM,i} IM^C_t + \lambda^C_t \left\{ (v_c)^{1/\mu_c} \left[ H^C_t \right]^{-1/\mu_c} + (1-v_c)^{1/\mu_c} \left[ (1-\Gamma_{IM}^C (IM^C_t/Q^C_t))IM^C_t \right]^{-1/\mu_c} \right\} \\
\]

and the first order conditions associated with the choice of \( H^C_t \) yields:

\[
H^C_t = v_c \left( \frac{P_{H,i}}{\lambda^C_t} \right)^{-\mu_c} Q^C_t
\]

which is the demand for intermediate domestic goods for the production of consumption goods. Multiplying this by \( P_{H,i} \) yields nominal costs with intermediate domestic goods

\[
P_{H,i} H^C_t = v_c \left( \frac{P_{H,i}}{\lambda^C_t} \right)^{-\mu_c} \lambda^C_t Q^C_t
\]

The first order condition to the Lagrangean problem associated with the choice \( \lambda^C_t \) is

\[
IM^C_t = (1-v_c) \left[ P_{IM,i} / \Gamma^3_{IM} (IM^C_t/Q^C_t) \right]^{-\mu_c} \left( \lambda^C_t Q^C_t \right) \left[ (1-\Gamma_{IM}^C (IM^C_t/Q^C_t)) \right]
\]

where \( \Gamma^3_{IM} \) is detailed in appendix A.

Multiplying (D.4) by \( P_{IM,i} \) yields the nominal cost to use imported intermediate goods

\[
P_{IM,i} IM^C_t = (1-v_c) \left[ P_{IM,i} / \Gamma^3_{IM} (IM^C_t/Q^C_t) \right]^{-\mu_c} \left( \lambda^C_t Q^C_t \right) \left[ (1-\Gamma_{IM}^C (IM^C_t/Q^C_t)) \right]
\]

The first order condition to the Lagrangean problem associated with the choice of the Lagrange multiplier \( \lambda^C_t \) is
\[ \lambda^C_i = \left[ v_c P_{H,i}^{1-\mu_c} + (1-v_c) \left( \frac{P_{M,i}}{\Gamma^3 IM^C} \left( IM^C_i / Q^C_i \right) \right)^{1-\mu_c} \right]^{1-\mu_c} \] (D.6)

In CMS, this multiplier is assumed to be the price index for one unit of the consumption good. However, this result is not compatible with their assumption that final goods firms operate with zero profits, as we show next.

To see that \( \lambda^C_i \) is not a price index in this context, first notice that the nominal cost of inputs to the final goods firm can be expressed as

\[
P_{H,i}^C + P_{M,i} IM^C_i
\]

\[
= \left\{ v_c \left( \frac{P_{H,i}}{\lambda^C_i} \right)^{1-\mu_c} + (1-v_c) \left( \frac{P_{M,i}}{\Gamma^3 IM^C} \left( IM^C_i / Q^C_i \right) \right)^{1-\mu_c} \right\} \lambda^C_i Q^C_i
\]

Substituting \( \lambda^C_i \) in the expression above, using (45), results in the optimal cost being a function of prices and the proportion of imports to total production, \( IM^C_i / Q^C_i \):

\[
P_{H,i}^C + P_{M,i} IM^C_i
\]

\[
= \left\{ v_c \left( P_{H,i} \right)^{-\mu_c} + (1-v_c) \left( P_{M,i} / \Gamma^3 IM^C \left( IM^C_i / Q^C_i \right) \right)^{-\mu_c} \right\}^{-\mu_c} \frac{\Gamma^3 IM^C \left( IM^C_i / Q^C_i \right)}{1-\Gamma^3 IM^C \left( IM^C_i / Q^C_i \right) \lambda^C_i Q^C_i}
\]

\[
\times \left\{ v_c \left( P_{H,i} \right)^{-\mu_c} + (1-v_c) \left( P_{M,i} / \Gamma^3 IM^C \left( IM^C_i / Q^C_i \right) \right)^{-\mu_c} \right\}^{-\mu_c} \frac{\Gamma^3 IM^C \left( IM^C_i / Q^C_i \right)}{1-\Gamma^3 IM^C \left( IM^C_i / Q^C_i \right) \lambda^C_i Q^C_i}
\]

If final goods firms yield zero profits, we can define the corresponding price index for one unit of final good as \( P_{C,i} = \frac{P_{H,i}^C + P_{M,i} IM^C_i}{Q^C_i} \). Defining the variable \( \Omega^C_i \) as

\[ \Omega^C_i = \left\{ v_c \left( P_{H,i} \right)^{-\mu_c} + (1-v_c) \left( \frac{\Gamma^3 IM^C \left( IM^C_i / Q^C_i \right)}{1-\Gamma^3 IM^C \left( IM^C_i / Q^C_i \right) \lambda^C_i Q^C_i} \right)^{1-\mu_c} \right\}^{-\mu_c} \] (D.8)

we obtain from (D.5) – (D.7) that the correct price index in this framework is
\[ P_{c,t} = (\Omega_t^c)^{-\mu_c} (\bar{\mathcal{X}}_t^c)^{\mu_c} \]  

(D.9)

Only when \( \Omega_t^c = \mathcal{X}_t^c \) do we obtain \( P_{c,t} = \bar{\mathcal{X}}_t^c = \Omega_t^c \). This requires

\[
\left( \frac{\Gamma^{IM}_t^c(IM_t^c/Q_t^c)}{1-\Gamma^{IM}_t^c(IM_t^c/Q_t^c)} \right) = 1, \text{ a very specific case.}
\]

In general, when this equality does not hold, the demand equations, as a function of the price index (using equations (D.2), (D.4) and (D.9)), should be

\[
H_t^c = V_c \left( \frac{P_{H,t}}{\Omega_t^c} \right)^{-\mu_c} \left( \frac{P_{H,t}}{P_{C,t}} \right)^{-\mu_c} Q_t^c 
\]

(D.10)

\[
IM_t^c = (1-V_c) \left( \frac{P_{C,t}}{\Omega_t^c} \right)^{-\mu_c} \left( \frac{P_{IM,t}^{IM_c^c}(IM_t^c/Q_t^c)}{P_{C,t}} \right)^{-\mu_c} \frac{Q_t^c}{1-\Gamma^{IM}_t^c(IM_t^c/Q_t^c)} 
\]

(D.11)

E. Derivation of the wage distortion index

Consider the set \( H = [0,1] \) representing the households in the economy. This set is divided into two disjoint groups, \( I \) and \( J \), i.e., \( H = I \cup J \), where \( \omega \in [0,1] \) represents the relative amount of members of group \( J \) over the total amount of households in \( H \).

Therefore, \( \omega = \int_J dh \) and \( 1-\omega = \int_I dh \).

At every time \( t \) a (Calvo) lottery occurs to decide which households will re-optimize their wage decisions. We can thus fix the set

\( V_t = \{ h \in H : h \text{ does not optimize her wage at time } t \} \), and its complementary set of optimizing households \( V_t^c \). Should each household \( i \in I \) have a probability \( \xi_i \in [0,1] \) of not optimizing, we obtain \( \xi_i, (1-\omega) = \int_{h \in V_t} dh \) and \( (1-\xi_i), (1-\omega) = \int_{h \in V_t^c} dh \), for every \( t \).

Assume that each household \( i \in I \) sets its wage \( W_{i,t} \) according to this lottery, where \( \bar{W}_{i,t} \) is the optimized wage and \( \bar{W}_{i,t} \) is the non-optimized wage. In particular, the
model implies that all households that optimize do so identically and choose the same optimal wage \( \tilde{W}_{i,t} \).

Furthermore, assume that when a household does not optimize, it readjusts its wage using a geometric average of past inflation and the inflation target. In other words,

\[
\tilde{W}_{i,t} = \tilde{W}_{i,t} \quad \text{and} \quad \bar{W}_{i,t} = \pi_{c,t-1} \pi_{c}^{1-\pi_{c}} W_{i,t-1}, \quad \text{where} \quad \pi_{c} \in [0,1] \quad \text{is a constant weight.}
\]

Consider the wage dispersion index defined as

\[
\psi_{t} := \frac{1}{1-\omega} \int \left( \frac{W_{i,t}}{W_{i,t}} \right)^{-\eta_{t}} di.
\]

To obtain a recursive representation of this index, we shall assume that the following equality holds

\[
\frac{1}{\bar{\xi}_{t} (1-\omega)} \int_{1-\omega} \left( \frac{W_{i,t}}{W_{i,t}} \right)^{-\eta_{t}} di = \frac{1}{1-\omega} \int \left( \frac{W_{i,t-1}}{W_{i,t-1}} \right)^{-\eta_{t}} di
\]

In words, we assume that the wage dispersion, at time \( t-1 \), of households in group \( I \) who do not optimize at time \( t \) (left-hand side) is equal to the wage dispersion of all members of group \( I \) at time \( t-1 \) (right-hand side). This is a very important and stringent assumption, which is implicit in the “Calvo scheme”.

Substitution of the equations above into the wage dispersion equation yields

\[
\begin{align*}
\psi_{t} &= \frac{1}{1-\omega} \int \left( \frac{W_{i,t}}{W_{i,t}} \right)^{-\eta_{t}} di = \\
&= \frac{1}{1-\omega} \int_{1-\omega} \left( \frac{\tilde{W}_{i,t}}{W_{i,t}} \right)^{-\eta_{t}} di + \frac{1}{1-\omega} \int \left( \frac{\bar{W}_{i,t}}{W_{i,t}} \right)^{-\eta_{t}} di = \\
&= \frac{1}{1-\omega} \int_{1-\omega} \left( \frac{\tilde{W}_{i,t}}{W_{i,t}} \right)^{-\eta_{t}} di + \frac{1}{1-\omega} \int \left( \frac{\pi_{c,t-1} \pi_{c}^{1-\pi_{c}} W_{i,t-1}}{W_{i,t}} \right)^{-\eta_{t}} di = \\
&= \left( 1-\tilde{\xi}_{t} \right) \left( \frac{\tilde{W}_{i,t}}{W_{i,t}} \right)^{-\eta_{t}} + \frac{\pi_{c,t-1} \pi_{c}^{1-\pi_{c}}}{\pi_{W,t}} \frac{1}{\omega} \int \left( \frac{W_{i,t-1}}{W_{i,t-1}} \right)^{-\eta_{t}} di = \\
&= \left( 1-\tilde{\xi}_{t} \right) \left( \frac{\tilde{W}_{i,t}}{W_{i,t}} \right)^{-\eta_{t}} + \frac{\pi_{c,t-1} \pi_{c}^{1-\pi_{c}}}{\pi_{W,t}} \frac{1}{\omega} \int \left( \frac{W_{i,t-1}}{W_{i,t-1}} \right)^{-\eta_{t}} di.
\end{align*}
\]
This result can be restated recursively as:

\[ \psi_{I,t} = (1 - \xi_t) \left( \frac{\tilde{W}_{I,t}}{W_{I,t}} \right)^{-\eta_t} + \xi_t \left( \frac{\pi_{I,t}^{\xi_t} \pi_{C,t}^{1 - \xi_t}}{\pi_{W,t}} \right)^{-\eta_t} \psi_{I,t-1} \]

Analogous reasoning can be applied to obtain the corresponding recursive representation of the wage dispersion index for households in group \( J \).

**F. Derivation of the aggregate resource constraint**

To obtain the aggregate resource constraint of the economy, we use households and government budget constraints. Aggregating households’ budget constraints into the budget constraint for group \( I \) and \( J \), we obtain:

\[ P_{c,t} C_t + t \omega \Gamma_{C_t} (v_{J,t}) \] \[ + \omega \Gamma_{C_t} (v_{I,t}) \] \[ + P_{c,t} I_t \] \[ + \tau_t \] \[ + \tau_t \] \[ + \tau_t \] \[ + \tau_t \] \[ = W_t N_t + u_t R_K - (B - R_{t+1} B_{t+1}) \]

We can rewrite the government budget constraint as:

\[ P_{g,t} G_t - \tau_t W_t N_t = \tau_t P_{c,t} C_t + (\tau_t + \tau_t) W_t N_t \]

and plug it into households aggregate constraint, to obtain the economy’s aggregate budget constraint

\[ P_{c,t} \left[ C_t + (1 - \omega) \Gamma_{C_t} (v_{J,t}) \right] + \omega \Gamma_{C_t} (v_{I,t}) \left[ C_t + (1 - \omega) \Gamma_{C_t} (v_{I,t}) \right] + \left[ P_{c,t} I_t + \Gamma_{C_t} (u_{J,t}) \right] \]

Substitution of supply and demand equilibrium conditions in final goods markets into the equation above yields
\[ P_{t+1}^G + P_{t+1}^I + P_{G_t}^t = (1 + \tau^W_t) W_t N^D_t + u_{t+1} R_{t+1} K_t + D_t \]

Aggregating firms’ first order conditions results in

\[ u_{t+1} R_{t+1} K_t = \alpha_M C_t (Y_t + \psi) \]  

(F.5)

\[ (1 + \tau^W_t) W_t N^D_t = (1 - \alpha_M) M C_t (Y_t + \psi) \]  

(F.6)

Plugging (F.5) and (F.6) into the equilibrium condition

\[ D_t + M C_t (Y_t + \psi) = P_{Y,t} Y_t \]  

yields

\[ (1 + \tau^W_t) W_t N^D_t + u_{t+1} R_{t+1} M C_t (Y_t + \psi) + D_t = P_{Y,t} Y_t \]  

(F.7)

The equation above, coupled with the trade balance financing equation

\[ S_t \left[ B_t^F - \left(1 - \Gamma_{t+1} B_t^F \right) R_{t+1} \right] = P_{t+1} M - S_t P_{X,t} X_t \]  

results in the economy’s resource constraint

\[ P_{Y,t} Y_t = P_{C,t} Q_t^C + P_{I,t} Q_t^I + P_{G,t} Q_t^G + S_t P_{X,t} X_t - P_{t+1} M \]  

(F.8)

Consider the demand for domestic and intermediate goods to produce final consumption goods. Multiplying the first by \( P_{H,t} \) and the latter by \( P_{t+1} M / \Gamma_{t+1}^t \), and adding them up yields

\[ P_{H,t} H_t^C + P_{t+1} M t = \left\{ \begin{array}{c}
\nu C \left( \frac{P_{H,t}}{P_{C,t}} \right)^{1/\mu_c} \\
(1 - \nu C) \left( \frac{\Gamma_{t+1}^t}{1 - \Gamma_{t+1}^t} \right) \left( \frac{P_{t+1} M / \Gamma_{t+1}^t}{P_{C,t}} \right)^{1/\mu_c} \\
\end{array} \right\} \]

\[ \times \left( \frac{P_{C,t}}{\Omega_{C,t}} \right)^{1-\mu_c} P_{C,t} Q_t^C \]  

(F.9)
\[
P_{H,t}^C H_t^C + P_{IM,t}^C IM_t^C = \left\{ v_c \left( p_{H,t}^C \right)^{-\mu_C} + \left( 1 - v_c \right) \left( \frac{\Gamma_{IM_t^C}^3}{1 - \Gamma_{IM_t^C}} \right) \left( p_{IM,t}^C / \Gamma_{IM_t^C}^3 \right)^{-\mu_C} \right\} \times \frac{1}{\Omega_{C,t}^{-\mu_C}} P_{C,t} Q_t^C
\]

From the definition of \( \Omega_{C,t} \) we obtain:

\[
P_{H,t}^C H_t^C + P_{IM,t}^C IM_t^C = \left\{ v_c \left( p_{H,t}^C \right)^{-\mu_C} + \left( 1 - v_c \right) \left( \frac{\Gamma_{IM_t^C}^3}{1 - \Gamma_{IM_t^C}} \right) \left( p_{IM,t}^C / \Gamma_{IM_t^C}^3 \right)^{-\mu_C} \right\} \times \frac{1}{\Omega_{C,t}^{-\mu_C}} P_{C,t} Q_t^C
\]

and thus

\[
P_{C,t} Q_t^C = P_{H,t}^C H_t^C + P_{IM,t}^C IM_t^C
\]

We can obtain a similar expression for the expenditures with investment goods.

Considering the equations below and the price indices

\[
H_t^I = v_t \left( \frac{p_{H,t}^I}{\Omega_{I,t}^j} \right)^{-\mu_I} \left( \frac{p_{H,t}}{p_{I,t}} \right)^{-\mu_I} Q_t^I
\]

\[
IM_t^I = (1 - v_t) \left( \frac{p_{IM,t}^I}{\Omega_{I,t}^j} \right)^{-\mu_I} \left( \frac{p_{IM,t}^I / \Gamma_{IM_t^I}^3}{p_{I,t}} \right)^{-\mu_I} Q_t^I
\]

we obtain

\[
P_{I,t} Q_t^I = P_{H,t}^I H_t^I + P_{IM,t}^I IM_t^I
\]

For government final goods, we obtain \( P_{G,t} Q_t^G = P_{H,t}^G H_t^G \). Substituting these results into the aggregate budget constraint of the economy yields the resource constraint of the economy

\[
P_{I,t} Y_t = P_{H,t}^C H_t^C + P_{IM,t}^C IM_t^C + P_{H,t}^I H_t^I + P_{IM,t}^I IM_t^I + P_{H,t}^G H_t^G + S_t P_{X,t} X_t - P_{IM,t} IM_t
\]
As aggregate demand for domestic and imported intermediate goods are

\[ H_i := H_i^C + H_i^I + H_i^G \]

\[ IM_i := IM_i^C + IM_i^I \]

Substituting into (F.13) and rearranging terms yields

\[ P_{Y,t}Y_t := P_{H,t}H_t + S_tP_{X,t}X_t \]  (F.14)

Market clearing requires

\[ P_{Y,t}Y_t = P_{H,t}H_t^C + P_{H,t}H_t^I + P_{H,t}H_t^G + S_tP_{X,t}X_t \]  (F.15)

G. Model Derivation

We describe below the domestic economy. The foreign economy is modeled symmetrically, except for some distinct parameters and the modeling of the fiscal and monetary policy rules.

G.1 Households

G.1.1. Group I

Households are distributed into two groups. Every period each individual \( i \in I = [0,1-\omega] \) in group I chooses consumption of a final private good \( C_{i,t} \) and wage \( W_{i,t} \) for its labor services \( N_{i,t} \) to maximize the intertemporal utility function

\[ E_t \left\{ \sum_{k=0}^{\infty} \beta^k \left[ 1 - \sigma \left( C_{i,t+k} - \kappa C_{I,t+k+1} \right) \right]^{-\sigma} \right\} - \frac{1}{1-\sigma} \left( N_{i,t+k+1}^{-\sigma} \right) \]  (G.1)

where \( \kappa \) is an external habit persistence parameter, \( \beta \) is the intertemporal discount factor, \( \gamma \) is the intertemporal elasticity of consumption substitution, and \( \gamma \) is the elasticity of labor effort relative to the real wage.

Group I has access to complete financial markets, and allocates its total income in consumption, investment \( I_{i,t} \) in capital goods, domestic government bonds \( B_{i,t+1} \), money \( M_{i,t} \), and foreign private bonds \( B_{i,t+1}^F \). Transactions with foreign bonds are
subject to a risk premium $\Gamma^{r}_{B} (B_{t}^{F})$, where $B_{t}^{F} := \frac{1}{1-\omega} \int_{0}^{\tau} B_{i}^{F} di$. Consumption expenditures are taxed at the rate $\tau^{c}_t$ and are also subject to a transaction cost $\Gamma_{v}(v_{t,i})$. Cost functions are detailed in Appendix B.

Labor services, capital rents, and profits $D_{t,i}$ are also taxed. Households own the private capital stock $K_{i,H,t}$ and decide on firms’ capital utilization $u_{t,i}$, subject to a cost $\Gamma_{u}(u_{t,i})$, earning a gross rate of return $R_{K,H,t}$. Households also receive transfers $TR_{t,i}$ from the government and, only in the case of the foreign economy, pay a lump sum tax $T_{t,i}$. The intertemporal budget constraint is

$$\left(1 + \tau^{c}_t + \Gamma_{v}(v_{t,i})\right)P_{C,i}C_{i,t} + P_{t,i}I_{i,H,t} + R^{x}_{i}B_{i,t+1}^{F} + \left(\left(1 - \Gamma^{r}_{B} (B_{t}^{F})\right) r_{D} \right) S_{t} B_{t+1}^{F} + M_{t,i} + \xi_{t,i} + \Phi_{t,i}$$

$$= \left(1 - \tau^{v}_t - \tau^{e}_t\right)W_{t}N_{t,i} + \left(1 - \tau^{x}_t\right) u_{t,i} R_{K,H,t} - \Gamma_{v}(u_{t,i})P_{t,i}K_{i,H,t}^{x} + \tau^{e}_t \delta P_{t,i}K_{i,H,t}$$

$$+ \left(1 - \tau^{0}_t\right) D_{t,i} + TR_{t,i} - T_{t,i} + B_{t,i} + S_{t} B_{t}^{F} + M_{t,i-1}$$

where $v_{t,i}$ is consumption velocity, with $v_{t,i} := \frac{\left(A + \tau^{c}_t\right) P_{C,i}C_{i,t}}{M_{t,i}}$, $\xi_{t,i}$ is a lump sum rebate on the risk premium and the intermediation cost introduced in the negotiation of international bonds, and $\Phi_{t,i}$ is the stock of contingent securities negotiated within group $I$, which act as an insurance against risks on labor income.

We assume that private capital $K_{i,H,t+1}$ accumulated by each household follows the transition rule:

$$K_{i,H,t+1} = (1 - \delta) K_{i,H,t} + \left(1 - \Gamma_{t} \left(\frac{I_{i,H,t}}{I_{i,H,t-1}}\right)\right) I_{i,H,t}$$

Setting $\Lambda_{C,i,t} = P_{C,i}$ and $\Lambda_{I,i,t} = Q_{i,t}$ respectively as the Lagrange multipliers for the budget constraint and the capital accumulation function, maximization of the utility function with respect to $C_{i,t}$, $I_{t,i}$, $K_{i,H,t+1}$, $u_{t,i}$, $B_{t,i}$, $B_{t+1}^{F}$, and $M_{t,i}$ yield the following first order conditions:

$$\Lambda_{C,i,t} = \frac{\left(C_{i,t} - \kappa C_{i,t-1}\right)^{\sigma}}{1 + \tau^{c}_t + \Gamma_{v}(v_{i,t}) + \Gamma_{v}(v_{i,t})v_{i,t}}$$

$$\Lambda_{I,i,t} = \frac{\left(I_{i,t} - \kappa I_{i,t-1}\right)^{\sigma}}{1 + \tau^{c}_t + \Gamma_{v}(v_{i,t}) + \Gamma_{v}(v_{i,t})v_{i,t}}$$

$57$
Within each group, households compete in a monopolistic competitive labor market. By setting wage \( W_{i,t} \), household \( i \) commits to meeting any labor demand \( N_{i,t} \). Wages are set à la Calvo, with a probability \( (1 - \xi_i) \) of optimizing each period. Households that do not optimize readjust their wages based on a geometric average of realized and steady state inflation \( \bar{W}_{i,t} = \left( \frac{P_{C,t-1}}{P_{C,t-2}} \right)^{\gamma_t} \pi_t^{1 - \gamma_t} W_{i,t-1} \). Every optimizing household chooses \( \bar{W}_{i,t} = \bar{W}_{i,t} \).

Household’s optimization with respect to \( \bar{W}_{i,t} \) yields the first order condition:

\[
E_t \left[ \sum_{k=0}^{\infty} (\xi_i \beta)^k N_{i,t+k} \left( \frac{\Lambda_{i,t+k} (1 - \tau_{i,t+k}^N - \tau_{i,t+k}^W) \bar{W}_{i,t}}{P_{C,t+k}} \left( \frac{P_{C,t+k-1}}{P_{C,t-1}} \right)^{\gamma_t} \pi_t^{1 - \gamma_t} \right) \right] = 0
\]  

(G.11)
where \( \eta_i/(\eta_i - 1) \) is the after-tax real wage markup, in the absence of wage rigidity (when \( \xi_i \to 0 \)), with respect to the marginal rate of substitution between consumption and leisure. The markup results from the worker’s market power to set wages. Equation (G.11) can be expressed in the following recursive form, detailed in appendix C:

\[
(1 - \omega)^{\xi_i} \left( \frac{W_{i,j}}{P_{C,j}} \right)^{1 + \eta_i, \xi_i} = \frac{\eta_i}{\eta_i - 1} \frac{F_{i,j}}{G_{i,j}}
\]

where

\[
F_{i,j} := \left( \frac{W_{i,j}}{P_{C,j}} \right)^{\eta_i} N_{i,j}^{\xi_i} + \xi_i, \beta_i, E_i \left( \frac{\pi_{C,j+1}}{\pi_{C,j}^{\xi_i}} \right)^{1 - \eta_i} F_{i,j+1}
\]

\[
G_{i,j} := \Lambda_{i,j} \left( 1 - \tau_t^M - \tau_t^W \right) \left( \frac{W_{i,j}}{P_{C,j}} \right)^{\eta_i} N_{i,j}^{\xi_i} + \xi_i, \beta_i, E_i \left( \frac{\pi_{C,j+1}}{\pi_{C,j}^{\xi_i}} \right)^{1 - \eta_i} G_{i,j+1}
\]

G.1.2. Group J

Households in group \( J \) can smooth consumption only through money holdings. Their decision is to choose consumption \( C_{j,t} \) and money \( M_{j,t} \) to maximize

\[
E_t \left\{ \sum_{k=0}^{\infty} \beta^k \left[ \frac{1}{1 - \sigma} \left( C_{j,t+k} - \kappa C_{j,t+k-1} \right) \right]^{-\sigma} - \frac{1}{1 + \xi_i} \left( N_{i,t+k}^{1 + \xi_i} \right) \right\}
\]

subject to the budget constraint

\[
\left( 1 + \tau_t^C + \Gamma_t(v_{j,t}) \right) P_{C,j} C_{j,t} + M_{j,t} = \left( 1 - \tau_t^N - \tau_t^W \right) W_{j,t} N_{j,t} + \Gamma_t J_{j,t} - T_{j,t} + M_{j,t-1} + \phi_{j,t}
\]

First order conditions yield:

\[
\Lambda_{j,t} = \left( C_{j,t} - \kappa C_{j,t-1} \right)^{-\sigma} \left( 1 + \tau_t^C + \Gamma_t(v_{j,t}) + \Gamma_t(v_{j,t}) \right)
\]

and

\[
\beta E_t \left[ \frac{\Lambda_{j,t+1}}{\Lambda_{j,t}} \frac{P_{C,j}}{P_{C,j+1}} \right] = 1 - \Gamma_t(v_{j,t}) \left( \frac{v_{j,t}^2}{1 + \tau_t^C} \right)
\]
where $\Lambda_{j,t}/P_{c,t}$ is the Lagrange multiplier associated with the budget constraint.

Household $j$ sets wages in a way that is symmetric to household $i$, differing only as to the probability of being chosen to maximize $(1-\xi_j)$, which is group-specific.

G.2 Firms

There are two types of firms in the model: producers of tradable intermediate groups and producers of non-tradable final goods. Firms producing intermediate goods are indexed by $f \in [0,1]$. All of final goods producers, except for the one producing public consumption goods, combine domestic and foreign intermediate goods in the production.

G.2.1 Intermediate goods firms

A continuum of firms, indexed by $f \in [0,1]$, produce tradable intermediate goods $Y_{f,t}$ under monopolistic competition. The production inputs are capital services $K_{f,t}$ rented from both the government and households in group $I$ and labor services $N_{f,t}$ rented from households in both $I$ and $J$ groups. The production technology is

$$Y_{f,t} = z_{t,f}(K_{f,t}^{s}n_{t,f}^{d})^{-\alpha} - \psi zn_t$$

where $\psi$ is a fixed cost chosen to ensure zero profit in the steady state, and $z_t$ and $zn_t$ are respectively temporary and permanent shocks that follow the process:

$$\ln(z_t) = (1 - \rho_{z}).\ln(z) + \rho_{z}.\ln(z_{t-1}) + \varepsilon_{z,t}$$

and

$$\frac{zn_t}{zn_{t-1}} = (1 - \rho_{zn}).gy + \rho_{zn}.\frac{zn_{t-1}}{zn_{t-2}} + \varepsilon_{zn,t}$$

where $z$ is the stationary level of total factor productivity, $gy$ is the steady state growth rate of labor productivity, $\rho_{z}$ and $\rho_{zn}$ are parameters, and $\varepsilon_{z,t}$ and $\varepsilon_{zn,t}$ are white noise shocks.

For a given level of production, firms take the cost of capital $R_{k,t}$, the average per capita wage $W_t$, and social security contribution $\tau^{w}_t$ as given to minimize $R_{k,t}K_{f,t} + (1 + \tau^{w}_t)W_tN_{f,t}$ subject to the technology in (G.18). Setting $MC_{f,t}$ as the
Lagrange multiplier associated with the technology constraint, the first order conditions to this problem are

\[ MC_{f,t} \cdot \frac{\alpha(Y_{f,t} + \varphi)}{K_{f,t}} = R_{K,t} \]  

(G.20)

\[ MC_{f,t} \cdot \frac{(1 - \alpha)(Y_{f,t} + \varphi)}{N_{f,t}} = (1 + \tau_t^w)W_t \]  

(G.21)

Conditions (G.20) and (G.21) associated with technology (G.17) imply that \( MC_{f,t} \) represents the firm’s marginal cost:

\[ MC_{f,t} = \frac{R_{K,t}K_{f,t}^S + (1 + \tau_t^w)W_tN_{f,t}}{Y_{f,t} + \varphi} \]  

(G.22)

which can also be expressed as a function of wages and capital remuneration

\[ MC_r = \frac{1}{z_\alpha(1-\alpha)^{\gamma-\alpha}} \left( R_{K,t} \right)^\gamma \left( 1 + \tau_t^w \right)^{\gamma-\alpha} \]  

(G.23)

which in turn implies that the marginal cost is equal across firms, i.e., \( MC_{f,t} = MC_r \).

We assume that private \( K^H_{f,t} \) and public \( K^G_{f,t} \) capital goods transform into usable capital through the following CES technology:

\[ K_{f,t} = \left[ (1 - \omega_g)^{-\eta_g} \left( K^H_{f,t} \right)^{\eta_{g-1}} + (\omega_g)^{-\eta_g} \left( K^G_{f,t} \right)^{\eta_{g-1}} \right]^{-\eta_g} \]  

(G.24)

where \( \omega_g \) represents the economy’s degree of dependence on government investment, and \( \eta_g \) stands for the elasticity of substitution between private and public goods, and also relates to the sensitivity of demand to the cost variation in each type of capital.

For a given total demand for capital, the intermediate firm minimizes total cost of private and public capital, solving:

\[ \min_{K^H_{f,t}, K^G_{f,t}} R^H_{K,t} K^H_{f,t} + R^G_{K,t} K^G_{f,t} \]  

(G.25)

subject to the technology constraint (G.24).

First order conditions to this problem yield

\[ K^H_{f,t} = \left( 1 - \omega_g \left( \frac{R^H_{K,t}}{R_{K,t}} \right)^{-\eta_g} \right) K_{f,t} \]  

(G.26)
\[ K_{G,f,s}^G = \omega_s \left( \frac{R_{K,f,s}^G}{R_{K,s}} \right)^{-\eta_s} K_{f,s} \]  

which can be combined to yield the average rate of return on capital

\[ R_{K,f,s} = \left( 1 - \omega_s \right) \left( R_{K,f,s}^H \right)^{-\eta_s} + \omega_s \left( R_{K,s}^G \right)^{-\eta_s} \]

Aggregating the distinct types of capital across firms, using (G.28), yields aggregate physical capital rented to intermediate goods firms:

\[ K_f = \left( 1 - \omega_s \right)^{\eta_s} \left( K_f^H \right)^{-\eta_s} \left( R_{K,s}^G \right)^{-\eta_s} \]

and the aggregate demand functions for each type of capital good are:

\[ K_f^G = \omega_s \left( \frac{R_{K,f,s}^G}{R_{K,s}} \right)^{-\eta_s} K_f \]

\[ K_f^H = \left( 1 - \omega_s \right) \left( \frac{R_{K,f,s}^H}{R_{K,s}} \right)^{-\eta_s} K_f \]

Labor demanded by firm \( f \) from both types of households is aggregated with a CES technology

\[ N_{f,s} = \left( 1 - v_s \omega \right) N_{f,s}^I \left( N_{f,s}^I \right)^{-1/\eta_I} + (v_s \omega)^{1/\eta_I} \left( N_{f,s}^I \right)^{-1/\eta_I} \]

where

\[ N_{f,s}^I = \left[ 1 - (1 - \omega) \int_0^{1/\eta_I} \left( N_{f,s}^I \right)^{-1/\eta_I} \right]^{\eta_I / (\eta_I - 1)} \]

\[ N_{f,s}^J = \left[ \frac{1}{\omega} \int_{v_s}^{1} \left( N_{f,s}^J \right)^{-1/\eta_J} \right]^{\eta_J / (\eta_J - 1)} \]

where \( \eta_I \) is the elasticity of substitution between labor from households in group \( I \) and \( J \), \( \eta_I \) is the inverse-elasticity of substitution between members of group \( I \), and \( \eta_J \) is the inverse-elasticity of substitution between members of group \( J \).

Taking average wages (\( W_{I,s} \) and \( W_{J,s} \)) in both groups as given, firms choose how much to hire from both groups of households by minimizing total labor cost \( W_{I,s} N_{f,s}^I + W_{J,s} N_{f,s}^J \) subject to (G.32). It follows from first order conditions that
\[ N_{f,s}^i = (1 - v_\omega \omega) \left( \frac{W_{f,s}}{W_t} \right)^{-\eta} . N_{f,s} \]  
\[ N_{f,s}^j = v_\omega \omega \left( \frac{W_{f,s}}{W_t} \right)^{-\eta} . N_{f,s} \]  
where the aggregate wage is:
\[ W_t = \left( (1 - v_\omega \omega) W_{f,s}^{1-\eta} + v_\omega \omega W_{f,s}^{1-\eta} \right)^{\frac{1}{1-\eta}} \]  

For a given total demand for labor, conditions (G.35) and (G.36) imply that the demand for labor from each group of households is increasing in the size of the group.

Aggregating labor demand across firms, and using \( N_i^D = \int_0^1 N_{f,s} df \), yields the following aggregate demand functions for each group of households:
\[ N_i^I = (1 - v_\omega \omega) \left( \frac{W_{f,s}}{W_t} \right)^{-\eta} . N_i^D \]  
\[ N_i^J = v_\omega \omega \left( \frac{W_{f,s}}{W_t} \right)^{-\eta} . N_i^D \]

The firm demands labor \( N_{f,s}^i \) and \( N_{f,s}^j \) from each individual in groups \( I \) and \( J \) taking individual wages \( W_{i,s} \) and \( W_{j,s} \) as given to minimize the average cost
\[ \int_0^{1-\omega} W_{i,s}^i N_{f,s}^i \, di + \int_{1-\omega}^1 W_{j,s}^j N_{f,s}^j \, dj \]  
subject to aggregation constraints (G.38) and (G.39). First order conditions yield:
\[ N_{f,s}^i = \frac{1}{1 - \omega} \left( \frac{W_{f,s}}{W_{f,s}} \right)^{\eta_i} . N_{f,s} \]  
\[ N_{f,s}^j = \frac{1}{\omega} \left( \frac{W_{f,s}}{W_{f,s}} \right)^{\eta_j} . N_{f,s} \]
where wages for each group of households are
\[ W_{f,s} = \left[ \frac{1}{1 - \omega} \int_0^{1-\omega} W_{f,s}^{1-\eta_i} \, di \right]^{1-\eta_i} \]
Firms’ labor demand and wage setting conditions combine into aggregate wages for each household group as a function of optimal and mechanically readjusted wages:

\[
W_{\ell, j} = \left[ \frac{1}{\omega} \int_{1-\omega}^{1} W_{\ell,i}^{-\eta_j} di \right]^{-\eta_j}
\]

\[
G.43
\]

Prices are set under monopolistic competition, with Calvo-type price rigidities. We assume local currency pricing. Let \( P_{H,f,i} \) and \( P_{X,f,i} \) be the prices for goods sold by firm \( f \) in the domestic and foreign markets, with \( \xi_H \) and \( \xi_X \) denoting the probability that the firm will not optimize prices in each of these markets. Non-optimizing domestic and foreign firms mechanically adjust their prices according to the rules:

\[
\bar{P}_{H,f,i} := \left( \frac{P_{H,f,i-1}}{P_{H,f,i-2}} \right)^{\pi_H} P_{H,f,i-1}
\]

\[
G.46
\]

\[
\bar{P}_{X,f,i} := \left( \frac{P_{X,f,i-1}}{P_{X,f,i-2}} \right)^{\pi_X} P_{X,f,i-1}
\]

\[
G.47
\]

where \( \pi_H \) and \( \pi_X \) are domestic and foreign intermediate goods’ steady state inflation rates.

Optimizing firms choose the prices \( \tilde{P}_{H,f,i} \) and \( \tilde{P}_{X,f,i} \) to maximize the expected discounted sum of nominal profits:

\[
E_\ell \left[ \sum_{k=0}^{\infty} \Lambda_{\ell,i+j+k} \left( (\xi_H)^k D_{H,f,j+k} + (\xi_X)^k D_{X,f,j+k} \right) \right]
\]

\[
G.48
\]

where \( \Lambda_{\ell,i+j+k} \) is household \( \ell \)'s average discount factor, given by

\[
\Lambda_{\ell,i+j+k} = \frac{1}{1-\omega} \int_{0}^{1-\omega} \beta^i \Lambda_{i+j+k} P_{C,i+k} \Lambda_{i+t} P_{C,t+k} di
\]

\[
G.49
\]

and nominal profits, net of fixed costs, are defined as

\[
D_{H,f,i} = (P_{H,f,i} - MC_i) H_{f,i}
\]

\[
G.50
\]

\[
D_{X,f,i} = (S_{f,i} P_{X,f,i} - MC_i) X_{f,i}
\]

\[
G.51
\]
Optimization is subject to the price indexation rule, to domestic and foreign demand for firm $f$'s goods, $H_{f,i}$ and $X_{f,d}$, taking as given the marginal cost, the exchange rate and aggregate demand.

First order conditions for the pricing decisions yield

$$E_i \left[ \sum_{k=0}^{\infty} (\xi_h)^k \Lambda_{i,j,k} \left( \tilde{P}_{H,i} \left( \frac{P_{H,i,k+1}}{P_{H,i,k}} \right) \left( \pi_h \right)^{1-X_{H,k}} - \frac{\theta}{\theta - 1} MC_{i,k} \right) H_{f,i,k+1} \right] = 0 \quad \text{(G.52)}$$

and

$$E_i \left[ \sum_{k=0}^{\infty} (\xi_x)^k \Lambda_{i,j,k} \left( \tilde{P}_{X,i} \left( \frac{P_{X,i,k+1}}{P_{X,i,k}} \right) \left( \pi_x \right)^{1-X_{X,k}} - \frac{\theta}{\theta - 1} MC_{i,k} \right) X_{f,i,k+1} \right] = 0 \quad \text{(G.53)}$$

As firms are identical, they face the same optimization problem, choosing the same optimal price $\tilde{P}_{H,f,i} = \tilde{P}_{H,i}$ and $\tilde{P}_{X,f,i} = \tilde{P}_{X,i}$.

Pricing equations (G.52) and (G.53) can be restated recursively as

$$\frac{\tilde{P}_{H,i}}{P_{H,i}} = \frac{\theta}{\theta - 1} F_{H,i} \quad \text{(G.54)}$$

$$\frac{\tilde{P}_{X,i}}{P_{X,i}} = \frac{\theta}{\theta - 1} G_{X,i} \quad \text{(G.55)}$$

where

$$F_{H,i} := MC_{i,H,i} + \xi_h \beta E_i \left( \Lambda_{i,j+1} \frac{\pi_{H,i+1}}{\pi_{H,i}^{1-X_{H,i}}} \right)^{\theta} F_{H,i+1}$$

$$G_{H,i} := P_{H,i,H,i} + \xi_h \beta E_i \left( \Lambda_{i,j+1} \frac{\pi_{H,i+1}}{\pi_{H,i}^{1-X_{H,i}}} \right)^{\theta - 1} G_{H,i+1}$$

$$F_{X,i} := MC_{i,X,i} + \xi_x \beta E_i \left( \Lambda_{i,j+1} \frac{\pi_{X,i+1}}{\pi_{X,i}^{1-X_{X,i}}} \right)^{\theta} F_{X,i+1}$$

$$G_{X,i} := S_{i,X,i} X_{i} + \xi_x \beta E_i \left( \Lambda_{i,j+1} \frac{\pi_{X,i+1}}{\pi_{X,i}^{1-X_{X,i}}} \right)^{\theta - 1} G_{X,i+1}$$

The terms $\theta/(1-\theta)$ and $\theta^*/(1-\theta^*)$ denote the domestic and export price markups over nominal marginal costs, in the absence of price rigidities, where $\theta$ is the elasticity of substitution between domestic intermediate goods and $\theta^*$ is the analogue for export goods.
Aggregating over firms, domestic and export intermediate goods prices are

\[
P_{H,j} = \left[ (1 - \xi_H)(\bar{P}_{H,j})^{1-\theta} + \xi_H(\bar{P}_{H,j})^{\theta} \right]^{1/(1-\theta)} \quad (G.56)
\]

\[
P_{X,j} = \left[ (1 - \xi_X)(\bar{P}_{X,j})^{1-\theta} + \xi_X(\bar{P}_{X,j})^{\theta} \right]^{1/(1-\theta)} \quad (G.57)
\]

G.2.2 Final goods firms

Each one of three firms produces a distinct non-tradable final good for investment, and for private and public consumption. Except for the public consumption good, the production of final goods combines both foreign and domestic intermediate goods using a CES-type technology.

G.2.2.a. Private consumption goods

To produce private consumption goods, \( Q^C_i \), the firm purchases bundles of domestic \( H^C_i \) and foreign \( IM^C_i \) intermediate goods. To adjust its imported share of inputs, the firm faces a cost \( \Gamma_{IM_i}^C (IM^C_i / Q^C_i) \), detailed in Appendix B.. Letting \( \nu_C \) denote the bias towards domestic intermediate goods, the technology to produce private consumption goods is

\[
Q^C_i = \left\{ \left( \nu_C \right)^{1/\mu_C} \left[ H^C_i \right]^{1-1/\mu_C} + \left( 1 - \nu_C \right)^{1/\mu_C} \left[ (1 - \Gamma_{IM_i}^C (IM^C_i / Q^C_i))IM^C_i \right]^{1-1/\mu_C} \right\}^{\mu_C/(\mu_C - 1)} \quad (G.58)
\]

where

\[
H^C_i = \int (H^C_{f,j})^{1-1/\theta} \, df \quad (G.59)
\]

\[
IM^C_i = \int (IM^C_{f,j})^{1-1/\theta} \, df^* \quad (G.59)
\]

The firm will minimize total input costs

\[
\min_{H^C_i, IM^C_i} \left( P_{H,j} H^C_i + P_{IM,j} IM^C_i \right) \quad (G.59)
\]

subject to the technology constraint (G.58) taking intermediate goods prices as given.
The corresponding Lagrange problem is

\[
\min_{H^C, IM^C, \lambda^C} P_{H^C, IM^C} + P_{IM^C} IM^C
\]

\[
+ \lambda^C \left\{ Q^C - \left[ (1 - V^C)^{\mu_C} \left[ H^C \right]^{-1/\mu_C} + (1 - \Gamma^C (IM^C / Q^C)) IM^C \right]^{1/\mu_C} \right\}
\]

and the first order conditions associated with the choice of \( H^C \) yield:

\[
H^C = V^C \left( \frac{P_{H^C}}{\lambda^C} \right)^{-\mu_C} Q^C
\]

which is the demand for intermediate domestic goods for the production of consumption goods. Multiplying this by \( P_{H^C} \) yields nominal costs with intermediate domestic goods

\[
P_{H^C} H^C = V^C \left( \frac{P_{H^C}}{\lambda^C} \right)^{-\mu_C} \lambda^C Q^C
\]

The first order condition to the Lagrangean problem associated with the choice of the Lagrange multiplier \( \lambda^C \) is

\[
\lambda^C = \left[ V^C P_{H^C}^{1-\mu_C} + (1 - V^C) \left( P_{IM^C} / \Gamma^C (IM^C / Q^C) \right)^{1-\mu_C} \right]^{1/(1-\mu_C)}
\]

To see that \( \lambda^C \) is not a price index in this context, notice that the nominal cost of inputs to the final goods firm can be expressed as
Substituting $\lambda_t^C$ in the expression above, using (G.65), results in the optimal cost being a function of prices and the proportion of imports to total production, $IM_t^C / Q_t^C$:

\[
P_{H,t}H_t^C + P_{IM,t}IM_t^C
= \left\{ V_C \left( \frac{P_{H,t}}{\lambda_t^C} \right)^{1-\mu_C} + (1-V_C) \left( \frac{P_{IM,t}}{1-\Gamma^3_{IM^C}(IM_t^C/Q_t^C)} \right)^{1-\mu_C} \right\} \lambda_t^C Q_t^C
\]

\[
= \left\{ V_C \left( P_{H,t} \right)^{1-\mu_C} + (1-V_C) \left( P_{IM,t} / \Gamma^3_{IM^C}(IM_t^C/Q_t^C) \right)^{1-\mu_C} \right\} \lambda_t^C Q_t^C
\]

\[
\times \left\{ V_C \left( P_{H,t} \right)^{1-\mu_C} + (1-V_C) \left( P_{IM,t} / \Gamma^3_{IM^C}(IM_t^C/Q_t^C) \right)^{1-\mu_C} \right\} \mu_C Q_t^C
\]

If final goods firms yield zero profits, we can define the corresponding price index for one unit of final good as $P_{C,t} = \frac{P_{H,t}H_t^C + P_{IM,t}IM_t^C}{Q_t^C}$. Defining the variable $\Omega_t^C$ as

\[
\Omega_t^C = \left\{ V_C \left( P_{H,t} \right)^{1-\mu_C} + (1-V_C) \left( P_{IM,t} / \Gamma^3_{IM^C}(IM_t^C/Q_t^C) \right) \right\} \frac{1}{1-\mu_C}
\]

we obtain from (G.64) – (G.66) that the correct price index in this framework is

\[
P_{C,t} = \left( \Omega_t^C \right)^{1-\mu_C} \lambda_t^C
\]

Notice that only when $\Omega_t^C = \lambda_t^C$ do we obtain $P_{C,t} = \lambda_t^C = \Omega_t^C$.

However, in general, the demand equations as a function of the price index (using equations (G.60), (G.62) and (G.67)) are

\[
H_t^C = V_C \left( \frac{P_{H,t}}{\Omega_t^C} \right)^{1-\mu_C} \left( \frac{P_{H,t}}{P_{C,t}} \right)^{-\mu_C} Q_t^C
\]

\[
IM_t^C = (1-V_C) \left( \frac{P_{C,t}}{\Omega_t^C} \right)^{1-\mu_C} \left( \frac{P_{IM,t} /\Gamma^3_{IM^C}(IM_t^C/Q_t^C)}{P_{C,t}} \right)^{-\mu_C} Q_t^C
\]
G.2.2.b. Investment goods

The firm producing investment goods $Q^I_t$ combines domestic $H^I_t$ and foreign $IM^I_t$ intermediate goods using the technology:

$$Q^I_t = \left\{ \left( v^I \right)^{\mu_I} \left( H^I_t \right)^{1-\mu_I} + \left( 1-v^I \right)^{\mu_I} \left[ \left( 1-\Gamma^I_{IM^I_t} \right) IM^I_t \right]^{1-\mu_I} \right\}^{\mu_I/(\mu_I-1)}$$  \hspace{1cm} (G.71)

where

$$H^I_t := \left\{ \int_0^1 (H^I_{1,t})^{1-\theta} df \right\}^{\theta/(\theta-1)}$$

$$IM^I_t := \left\{ \int_0^1 (IM^I_{1,t})^{1-\theta} df \right\}^{\theta/(\theta-1)}$$

and $\Gamma^I_{IM^I_t} \left( IM^I_t / Q^I_t \right)$ is an adjustment cost in the use of imported goods in the production of investment goods and $v^I$ stands for the bias towards domestic goods.

The cost minimization problem for the investment goods firm is exactly analogous to the one for the consumption good. The demand for domestic and imported intermediate goods is

$$H^I_t = v^I \left( \frac{P^I_{H,t}}{\Omega_t} \right)^{1-\mu_I} \left( \frac{P^I_{H,t}}{P^I_{t,t}} \right)^{-\mu_I} Q^I_t$$  \hspace{1cm} (G.72)

$$IM^I_t = (1-v^I) \left( \frac{P^I_{t,t}}{\Omega_t} \right)^{1-\mu_I} \left( \frac{P^I_{IM^I_t} / \Gamma^I_{IM^I_t} (IM^I_t / Q^I_t)}{P^I_{t,t}} \right)^{-\mu_I} \left[ \frac{Q^I_t}{1-\Gamma^I_{IM^I_t} (IM^I_t / Q^I_t)} \right]$$  \hspace{1cm} (G.73)

and the investment goods price index is

$$P^I_{t,t} = (\Omega^I_t)^{\mu_I} \left( \lambda^I_t \right)^{\mu_I}$$  \hspace{1cm} (G.74)

where

$$\Omega^I_t = \left\{ v^I \left( P^I_{H,t} \right)^{1-\mu_I} + (1-v^I) \left[ \left( \Gamma^I_{IM^I_t} (IM^I_t / Q^I_t) \right)^{1-\mu_I} \left( P^I_{IM^I_t} / \Gamma^I_{IM^I_t} (IM^I_t / Q^I_t) \right)^{1-\mu_I} \right] \right\}^{1/(1-\mu_I)}$$  \hspace{1cm} (G.75)

and

$$\lambda^I_t = \left\{ v^I P^I_{H,t} \left[ \frac{1}{1-\mu_I} \right] + (1-v^I) \left( P^I_{IM^I_t} / \Gamma^I_{IM^I_t} (IM^I_t / Q^I_t) \right)^{1-\mu_I} \right\}^{1/(1-\mu_I)}$$  \hspace{1cm} (G.76)
G.2.2.c Public consumption goods

Public goods $Q_t^G$ are produced only from domestic intermediate goods using the technology

$$Q_t^G = H_t^G := \left( \int_0^1 (H_{f,t}^G)^{1-1/\theta} \, df \right)^{\theta/(\theta-1)} \quad (G.77)$$

The first order condition for the cost minimization problem is

$$H_t^G = Q_t^G \quad (G.78)$$

which yields the public consumption goods price index:

$$P_{G,t} = P_{H,t} \quad (G.79)$$

To build on the amount $H_t^G$ of domestic intermediate goods to produce public consumption goods, the firm demands $H_{f,t}^G$ from each of the domestic intermediate goods firms, following the cost minimization first order conditions:

$$H_{f,t}^G = \left( \frac{P_{H,f,t}}{P_{H,t}} \right)^\theta H_t^G \quad (G.80)$$

G.2.3. Aggregation

Aggregating the demand for intermediate goods from the final goods firms results in the following demands for each domestic and foreign intermediate goods’ firms:

$$H_{f,t} := H_{f,t}^C + H_{f,t}^I + H_{f,t}^G = \left( \frac{P_{H,f,t}}{P_{H,t}} \right)^\theta . H_t \quad (G.81)$$

$$IM_{f,t} := IM_{f,t}^C + IM_{f,t}^I = \left( \frac{P_{IM,f,t}}{P_{IM,t}} \right)^\theta . IM_t \quad (G.82)$$

The total demand for domestic and foreign intermediate products is:

$$H_t := H_t^C + H_t^I + H_t^G \quad (G.83)$$

$$IM_t := IM_t^C + IM_t^I \quad (G.84)$$

The demand for intermediate goods imported from foreign firm $f^*$ directly determines firm $f^*$’s exports adjusted by the countries’ sizes.
\[(1 - s)X_{i,j}^* = sIM_{i,j}^* \quad (G.85)\]

The local pricing assumption can be restated as
\[P_{IM,i,j} = P_{X,i,j}^* \quad (G.86)\]

and therefore the aggregate prices of imported goods should equal the aggregate prices of goods exported by the foreign producer
\[P_{IM,j} = \left[ \int_0^1 (P_{IM,f,j}^*)^{1-\theta} df^* \right]^{1/1-\theta} = \left[ \int_0^1 (P_{X,f,j}^*)^{1-\theta} df^* \right]^{1/1-\theta} = P_{X,j}^* \quad (G.87)\]

Demand for firm \(f\)'s goods by foreign firms determines firm \(f\)'s export quantum, adjusted by the countries’ sizes:
\[sX_{f,j} = (1 - s)IM_{f,j}^* \quad (G.88)\]

Similarly, prices of goods imported from domestic firm \(f\) by the foreign importer should equal the export price set by firm \(f\) in foreign currency:
\[P_{IM,f,j}^* = P_{X,f,j} \quad (G.89)\]

Therefore, the aggregate export price \(P_{X,j}\) should equal the aggregate import price in the foreign economy:
\[P_{X,j} = \left[ \int_0^1 (P_{X,f,j}^*)^{1-\theta} df \right]^{1/1-\theta} = \left[ \int_0^1 (P_{IM,f,j}^*)^{1-\theta} df \right]^{1/1-\theta} = P_{IM,j}^* \quad (G.90)\]

G.3. Market clearing

Any aggregated model variable \(Z_i\) denoted in per capita terms results from the aggregation
\[Z_i := \int_0 Z_{h,i} dh = (1 - \omega)Z_{I,j} + \omega Z_{J,j} \quad \text{where} \quad Z_{I,j} \text{ and } Z_{J,j} \text{ are the respective per capital values of } Z_i \text{ for families } I \text{ and } J.\]

Therefore, we define
\[M_{I,j} := \frac{1}{1 - \omega} \int_0^{1-\omega} M_i di \quad (G.91)\]
\[M_{J,j} := \frac{1}{\omega} \int_0^{1-\omega} M_j dj \quad (G.92)\]
\[ TR_{i,j} := \frac{1}{1-\omega} \int_{0}^{1-\omega} TR_{i,j} \, di \]  \hspace{1cm} (G.93)

\[ TR_{j,i} := \frac{1}{\omega} \int_{0}^{1-\omega} TR_{j,i} \, dj \]  \hspace{1cm} (G.94)

\[ T_{i,j} := \frac{1}{1-\omega} \int_{0}^{1-\omega} T_{i,j} \, di \]  \hspace{1cm} (G.95)

\[ T_{j,i} := \frac{1}{\omega} \int_{0}^{1-\omega} T_{j,i} \, dj \]  \hspace{1cm} (G.96)

\[ B_{i,j+1} := \frac{1}{1-\omega} \int_{0}^{1-\omega} B_{i,j+1} \, di \]  \hspace{1cm} (G.97)

\[ I_{i} := \frac{1}{1-\omega} \int_{0}^{1-\omega} I_{i} \, di \]  \hspace{1cm} (G.98)

\[ K_{i,j} := \frac{1}{1-\omega} \int_{0}^{1-\omega} K_{i,j} \, di \]  \hspace{1cm} (G.99)

\[ D_{i,j} := \frac{1}{1-\omega} \int_{0}^{1-\omega} D_{i,j} \, di \]  \hspace{1cm} (G.100)

and, aggregating over household groups:

\[ C_{i} := (1-\omega)C_{i,j} + \omega C_{j,i} \]  \hspace{1cm} (G.101)

\[ M_{i} := (1-\omega)M_{i,j} + \omega M_{j,i} \]  \hspace{1cm} (G.102)

\[ TR_{i} := (1-\omega)TR_{i,j} + \omega TR_{j,i} \]  \hspace{1cm} (G.103)

\[ T_{i} := (1-\omega)T_{i,j} + \omega T_{j,i} \]  \hspace{1cm} (G.104)

\[ B_{i,j+1} := (1-\omega)B_{i,j+1} \]  \hspace{1cm} (G.105)

\[ B_{i,j+1}^F := (1-\omega)B_{i,j+1}^F \]  \hspace{1cm} (G.106)

\[ I_{i} := (1-\omega)I_{i,j} \]  \hspace{1cm} (G.107)

\[ K_{i} := (1-\omega)K_{i,j} \]  \hspace{1cm} (G.108)

\[ D_{i} := (1-\omega)D_{i,j} \]  \hspace{1cm} (G.109)
The equilibrium between supply and demand for labor occurs at the individual level:

\[ N_{i,t} = N'_i = \int_0^1 N'_{j,i} df \]  

\[ N_{j,i} = N'_j = \int_0^1 N'_{j,i} df \]  

which, aggregating the demand of all firms in equations (G.40) and (G.41), yields

\[ N_{i,t} = \frac{1}{1 - \omega} \left( \frac{W_{j,i}}{W_{t,i}} \right)^{-\eta_i} N'_i \]  

\[ N_{j,t} = \frac{1}{\omega} \left( \frac{W_{j,i}}{W_{j,t}} \right)^{-\eta_j} N'_j \]  

and can also be represented, using equations (G.38) and (G.39), as a function of total demand for labor by firms:

\[ N_{i,t} = \left( \frac{W_{j,i}}{W_{j,t}} \right)^{-\eta_i} \left( \frac{W_{t,i}}{W_t} \right)^{-\eta} N'_i \]  

\[ N_{j,t} = \left( \frac{W_{j,i}}{W_{j,t}} \right)^{-\eta_j} \left( \frac{W_{j,t}}{W_t} \right)^{-\eta} N'_j \]  

Aggregate supply by each household group is defined as \( N_{i,t} \) and \( N_{j,t} \), and we define \( N_{S,t} \) as the total supply of labor. Aggregating the supply of labor using equations (G.112) and (G.113) yields

\[ N_{i,t} = \frac{1}{1 - \omega} \int_0^{1 - \omega} N_{i,t} \, di = \frac{1}{1 - \omega} \int_0^{1 - \omega} \left( \frac{W_{j,i}}{W_{t,i}} \right)^{-\eta_i} N'_i \, di; \]

\[ N_{j,t} = \frac{1}{\omega} \int_0^{1 - \omega} N_{j,t} \, dj = \frac{1}{\omega} \int_0^{1 - \omega} \left( \frac{W_{j,i}}{W_{j,t}} \right)^{-\eta_j} N'_j \, dj; \]

Therefore, the relation between aggregate supply and aggregate demand depends on wage dispersion:

\[ N_{i,t} = \frac{\psi_{i,t}}{1 - \omega} N'_i \]  

\[ N_{j,t} = \frac{\psi_{j,t}}{\omega} N'_j \]
where the wage dispersion for households $I$ and $J$ is represented by:

$$
\psi_{I,t} := (1 - \xi_I) \left( \frac{\tilde{W}_{I,t}}{W_{I,t}} \right)^{-\eta_I} + \xi_I \left( \frac{\pi^{\tau_{I,t-1}}_{C} \pi^{-\tau_{I,t}}_{C}}{\pi_{W,I,t}} \right)^{-\eta_I} \psi_{I,t-1}
$$

(G.118)

$$
\psi_{J,t} := (1 - \xi_J) \left( \frac{\tilde{W}_{J,t}}{P_{Y,t} Y_t} \left( \frac{W_{J,t}}{P_{Y,t} Y_t} \right)^{-1} \right)^{-\eta_J} + \xi_J \left( \frac{\pi^{\tau_{J,t-1}}_{C} \pi^{-\tau_{J,t}}_{C}}{\pi_{W,J,t}} \right)^{-\eta_J} \psi_{J,t-1}
$$

(G.119)

and $\pi_{W,I,t}$ and $\pi_{W,J,t}$ stand for household $I$ and $J$ wage inflation rates, detailed in appendix F.

Aggregating the demand for labor from household groups $I$ and $J$ yields:

$$
N_{S,J} := \int_0^1 N_{h,t} \, dh = \int_0^{1-\omega} N_{i,t} \, di + \int_0^1 N_{j,t} \, dj = (1 - \omega).N_{I,t} + \omega.N_{J,t} = \psi_{I,t}.N_{I,t} + \psi_{J,t}.N_{J,t}
$$

$$
N_{S,J} := \psi_{J,t}.N_{I,t}^J + \psi_{J,t}.N_{J,t}^J
$$

which results in a relation between total aggregate supply and demand that depends on the total wage dispersion index:

$$
N_{S,J} = \psi_t . N^D_t
$$

(G.120)

where total wage dispersion is $\psi_t := \left\{ (1 - \omega) \left( \frac{W_{I,t}}{W_t} \right)^{-\eta} \psi_{I,t} + \omega \left( \frac{W_{J,t}}{W_t} \right)^{-\eta} \psi_{J,t} \right\}$.

Total production of domestic intermediate firm $f$ fulfills:

$$
Y_{f,t} = H_{f,t} + X_{f,t}
$$

(G.121)

Let $Y_t$ be the total supply of intermediate goods in the domestic economy, and $X_t$ be the total demand for export goods produced in the domestic economy. We thus obtain

$$
Y_t := \int_0^1 Y_{f,t} \, df = \int_0^1 H_{f,t} \, df + \int_0^1 X_{f,t} \, df = \int_0^1 \left( \frac{P_{H,f,t}}{P_{H,t}} \right)^{-\theta} H_t \, df + \int_0^1 \left( \frac{P_{X,f,t}}{P_{X,t}} \right)^{-\theta} X_t \, df
$$

which results in

$$
Y_t = \psi_{H,t} \cdot H_t + \psi_{X,t} \cdot X_t
$$

(G.122)

where price dispersion in the domestic and export markets for intermediate goods is:

$$
\psi_{H,t} := (1 - \xi_H) \left( \frac{\tilde{P}_{H,t}}{P_{H,t}} \right)^{-\theta} + \xi_H \left( \frac{\pi^{\tau_{H,t-1}}_{C} \pi^{-\tau_{H,t}}_{C}}{\pi_{H,t}} \right)^{-\theta} \psi_{H,t-1}
$$

74
\[
\psi_{X,t} = (1 - \varepsilon \delta) \left( \frac{\tilde{P}_{X,t}}{P_{X,t}} \right)^{-\theta} + \varepsilon \delta \left( \frac{\pi^X_{t-1}}{\pi_X} \right)^{-\theta} \psi_{X,t-1}
\]

Aggregate demand for export goods fulfills

\[
sX_t = \int_0^1 sX_{f,t} df = (1 - s) \int_0^1 IM^*_t df
\]

which results in

\[
sX_t = (1 - s) IM^*_t
\]

Let \( P_{Y,t} \) denote the intermediate goods price index, which satisfies

\[
P_{Y,t} = \int_0^1 P_{H,t} H_{f,t} df + \int_0^1 S_t P_{X,f,t} X_{f,t} df = H_t \int_0^1 P_{H,t} \left( \frac{P_{H,t}}{P_{H,t}} \right)^{-\theta} df + X_t S_t \int_0^1 P_{X,f,t} \left( \frac{P_{X,f,t}}{P_{X,t}} \right)^{-\theta} df
\]

We thus obtain that

\[
P_{Y,t} = \frac{H_t}{Y_t} P_{H,t} + \frac{X_t}{Y_t} S_t P_{X,t}
\]

In the competitive market for final goods, equilibrium requires that the following relations be satisfied

\[
Q_t^C = C_t + (1 - \omega) \Gamma_y (v_{L,t}) C_{t,t} + \omega \Gamma_y (v_{L,t}) C_{t,j} = C_t + \Gamma_y
\]

\[
Q_t' = I_t + \Gamma_y (u_{L,t}) C_{t,t} K_t
\]

\[
Q_t^G = G_t
\]

where \( \Gamma_y \) is the aggregate real transaction cost, \( \Gamma_y := \int_0^1 \Gamma_y (v_{L,t}) C_{t,t} dt + \int_1^{1-\omega} \Gamma_y (v_{L,j}) C_{t,j} dt \)

In the capital market, \( u_t \) is the average capital utilization, which satisfies

\[
u_t := \frac{1}{K_t} \int_0^1 K_{f,t} df
\]

Profit distribution fulfills

\[
(1 - \omega) D_{t,t} := \int_0^1 D_{H,t} df + \int_0^1 D_{X,t} df
\]
To obtain the aggregate resource constraint of the economy, we use households and government budget constraints. Aggregating households’ budget constraints into the budget constraint for group I and J, we obtain:

\[
P_{C_{t}}(1 - \omega_1)C_t + \omega_1\gamma_t(v_{i,t})P_{C_{t}} + \omega_1\gamma_t(v_{j,t})P_{C_{t}}, C_{j,t} + P_{I,t}, I_t \\
+ \tau_{I,t}^C P_{C_{t}}(1 - \omega_1) + (\tau_{I,t}^C + \tau_{I,t}^D)W_{t}N_{t}^D + \tau_{I,t}^K[k_{t,x}, R_{K_{t}}, K_{t}, (\delta + \gamma_t(v_{i,t}))P_{t}, K_{t} \\
+ \tau_{D_{t}}^D D_{t} + T_{t} + (M_{t} - M_{t-1}) - TR_{t} - (B_{t} - B_{t-1}B_{t+1}) \\
= W_{t}N_{t}^D + u_{i,t}, R_{K_{t}}, K_{t} - \Gamma_{u}(u_{i,t},)P_{t}, K_{t} + D_{t} \\
+ S_{t}\{B_{t}^F - \left[\left(\Gamma_{y}(B_{t}^F)\right)R_{F_{t}}\right]^{-1}B_{t+1}^F\}
\]

We can rewrite the government budget constraint as:

\[
P_{G_{t}} G_{t} - \tau_{w}^W W_{t}N_{t}^D = \tau_{I,t}^C P_{C_{t}}(1 - \omega_1) + (\tau_{I,t}^C + \tau_{I,t}^D)W_{t}N_{t}^D \\
+ \tau_{I,t}^K[k_{t,x}, R_{K_{t}}, K_{t}, (\delta + \gamma_t(v_{i,t}))P_{t}, K_{t} \\
+ \tau_{D_{t}}^D D_{t} + T_{t} + (M_{t} - M_{t-1}) - TR_{t} - (B_{t} - B_{t-1}B_{t+1})
\]

and plug it into households aggregate constraint, to obtain the economy’s aggregate budget constraint

\[
P_{C_{t}}(1 - \omega_1)C_t + \omega_1\gamma_t(v_{i,t})P_{C_{t}} + \omega_1\gamma_t(v_{j,t})P_{C_{t}}, C_{j,t} + P_{I,t}, I_t \\
= \left(1 + \tau_{I,t}^W\right)W_{t}N_{t}^D + u_{i,t}, R_{K_{t}}, K_{t} + D_{t} \\
+ S_{t}\{B_{t}^F - \left[\left(\Gamma_{y}(B_{t}^F)\right)R_{F_{t}}\right]^{-1}B_{t+1}^F\}
\]

Substitution of supply and demand equilibrium conditions in final goods markets (G.125)-(G.127) into the equation above yields

\[
P_{C_{t}, Q_{t}} + P_{G_{t}, Q_{t}} + P_{G_{t}}(1 + \tau_{I,t}^W)W_{t}N_{t}^D + u_{i,t}, R_{K_{t}}, K_{t} + D_{t} \\
+ S_{t}\{B_{t}^F - \left[\left(\Gamma_{y}(B_{t}^F)\right)R_{F_{t}}\right]^{-1}B_{t+1}^F\}
\]

Aggregating (G.20) and (G.21) across firms results in

\[
u_{i,t}, R_{K_{t}}, K_{t} = \alpha MC_{t}(Y_{t} + \psi) \tag{G.134}
\]

\[
(1 + \tau_{I,t}^W)W_{t}N_{t}^D = (1 - \alpha)MC_{t}(Y_{t} + \psi) \tag{G.135}
\]

Plugging (G.134) and (G.135) into the equilibrium condition

\[
D_{t} + MC_{t}(Y_{t} + \psi) = P_{Y_{t}}Y_{t} \text{ yields}\n\]

\[
(1 + \tau_{I,t}^W)W_{t}N_{t}^D + u_{i,t}, R_{K_{t}}, K_{t}MC_{t}(Y_{t} + \psi) + D_{t} = P_{Y_{t}}Y_{t} \tag{G.135}
\]

The equation above, coupled with the trade balance financing equation

\[
S_{t}\{B_{t}^F - \left[\left(\Gamma_{y}(B_{t}^F)\right)R_{F_{t}}\right]^{-1}B_{t+1}^F\} = P_{M_{t}}IM_{t} - S_{t}P_{X_{t}}X_{t} \text{ results in the economy’s resource constraint}
\]
\[
P_{C,t} Y_t = P_{C,t} Q^C_t + P_{I,t} Q^I_t + P_{G,t} Q^G_t + S_t, P_{X,t} X_t - P_{IM,t} IM_t,
\]  

(G.134)

Consider the demand for domestic and intermediate goods to produce final consumption goods (equations (G.69) and (G.70)). Multiplying the first by \( P_{H,t} \) and the latter by \( P_{IM,t} / \Gamma^3_{IM} \), and adding them up yields

\[
P_{H,t} H^C_t + P_{IM,t} IM^C_t = \left\{ v_t \left( \frac{P_{H,t}}{P_{C,t}} \right)^{1-\mu} + (1-v_t) \left( 1 - \Gamma_{IM} \right) \left( \frac{P_{IM,t}}{\Gamma^3_{IM}} \right)^{1-\mu} \right\} \frac{1}{\Omega_{C,t}} \cdot P_{C,t} Q^C_t
\]  

(G.135)

\[
P_{H,t} H^C_t + P_{IM,t} IM^C_t = \left\{ v_t \left( \frac{P_{H,t}}{P_{C,t}} \right)^{1-\mu} + (1-v_t) \left( 1 - \Gamma_{IM} \right) \left( \frac{P_{IM,t}}{\Gamma^3_{IM}} \right)^{1-\mu} \right\} \frac{1}{\Omega_{C,t}} \cdot P_{C,t} Q^C_t
\]  

(G.136)

From the definition of \( \Omega_{C,t} \) in (G.67)

\[
\Omega_{C,t} := \left\{ v_t \left( \frac{P_{H,t}}{P_{C,t}} \right)^{1-\mu} + (1-v_t) \left( 1 - \Gamma_{IM} \right) \left( \frac{P_{IM,t}}{\Gamma^3_{IM}} \right)^{1-\mu} \right\}^{-1}
\]

we obtain:

\[
P_{H,t} H^C_t + P_{IM,t} IM^C_t = \left\{ v_t \left( \frac{P_{H,t}}{P_{C,t}} \right)^{1-\mu} + (1-v_t) \left( 1 - \Gamma_{IM} \right) \left( \frac{P_{IM,t}}{\Gamma^3_{IM}} \right)^{1-\mu} \right\} \frac{1}{\Omega_{C,t}} \cdot P_{C,t} Q^C_t
\]  

(G.137)

and thus

\[
P_{C,t} Q^C_t = P_{H,t} H^C_t + P_{IM,t} IM^C_t
\]  

(G.138)

and the consumption price index is

\[
P_{C,t} \Omega_{C,t} = \left\{ v_t \left( \frac{P_{H,t}}{P_{C,t}} \right)^{1-\mu} + (1-v_t) \left( 1 - \Gamma_{IM} \right) \left( \frac{P_{IM,t}}{\Gamma^3_{IM}} \right)^{1-\mu} \right\}^{1-\mu} \]

(G.139)

We can obtain a similar expression for the expenditures with investment goods.

Considering the equations below

\[
H^C_t = v_t \left( \frac{P_{I,t}}{\Omega_{I,t}} \right)^{1-\mu} \left( \frac{P_{H,t}}{P_{I,t}} \right)^{1-\mu} \cdot Q^C_t
\]

77
we obtain $P_{1,t} = P_{H,t} H_t^I + P_{IM,t} IM_t^I$

For government final goods, we use (G.78) and (G.79) to obtain $P_{G,t} Q_t^G = P_{H,t} H_t^G$. Substituting these results into the aggregate budget constraint of the economy yields the resource constraint of the economy

$$P_{y,t} Y_t = \begin{cases} \left( P_{H,t} H_t^C + P_{IM,t} IM_t^C + P_{H,t} H_t^I + P_{IM,t} IM_t^I + P_{H,t} H_t^G + S_t P_{X,t} X_t - P_{IM,t} IM_t \right) \end{cases}$$

As aggregate demand for domestic and imported intermediate goods are

$$H_t := H_t^C + H_t^I + H_t^G$$

$$IM_t := IM_t^C + IM_t^I$$

Substituting into (G.139) and rearranging terms yields

$$P_{Y,t} Y_t := P_{H,t} H_t + S_t P_{X,t} X_t \quad \text{ (G.140)}$$

Market clearing requires

$$P_{y,t} Y_t = P_{H,t} H_t^C + P_{H,t} H_t^I + P_{H,t} H_t^G + S_t P_{X,t} X_t \quad \text{ (G.141)}$$

International bond markets are in equilibrium when

$$s z B_{t+1}^F + (1 - s z) B_{t+1}^{F^*} = 0 \quad \text{ (G.142)}$$

and the balance of payments fulfills

$$R_{F,t} B_{t+1}^F = B_{t+1}^F + \frac{TB_t}{S_t} \quad \text{ (G.143)}$$

where the trade balance is defined as

$$TB_t := S_t P_{X,t} X_t - P_{IM,t} IM_t$$

(G.144)
Domestic terms of trade are defined as \( T_{oT,j} = \frac{P_{IM,j}}{S_j P_{X,j}} \). Contingent bonds add to zero:

\[
\int_0^{1-\omega} \Phi_{i,j} \, di = 0 \tag{G.145}
\]

and so do individual rebates:

\[
\int_0^{1-\omega} \Xi_{i,j} \, di = 0 \tag{G.145}
\]
References


Table 1: Empirical Estimate of the Primary Surplus Rule in Brazil

Dependent Variable: PRI_SUR_PIB_SA
Method: Least Squares
Sample (adjusted): 1996Q3 2009Q1
Included observations: 51 after adjustments
Convergence achieved after 1 iteration

\[
PRI\_SUR\_PIB\_SA = C(2) \times PRI\_SUR\_PIB\_SA(-1) + C(4) \times PRI\_SUR\_PIB\_SA(-2) \\
+ (1-C(2)- C(4)) \times (C(1) + C(3) \times (DLSP\_PIB\_SA(-1) - 2.1214)) \\
+ C(5) \times (PIB\_TRIM\_SA(-1)/100 - 0.004962932)
\]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C(2) → ρ₁</td>
<td>0.248161</td>
<td>0.094789</td>
<td>2.618042</td>
<td>0.0119</td>
</tr>
<tr>
<td>C(4) → ρ₂</td>
<td>0.167091</td>
<td>0.083178</td>
<td>2.008836</td>
<td>0.0504</td>
</tr>
<tr>
<td>C(1) → sp</td>
<td>0.041899</td>
<td>0.004038</td>
<td>10.37669</td>
<td>0.0000</td>
</tr>
<tr>
<td>C(3) → Φ₀</td>
<td>0.040928</td>
<td>0.012266</td>
<td>3.336770</td>
<td>0.0017</td>
</tr>
<tr>
<td>C(5) → Φᵧ</td>
<td><strong>0.269544</strong></td>
<td>0.107748</td>
<td>2.501619</td>
<td><strong>0.0160</strong></td>
</tr>
</tbody>
</table>

R-squared 0.710078
Adjusted R-squared 0.684868

Table 2: Steady State Ratios

<table>
<thead>
<tr>
<th>Ratio</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TB/P₁Y</td>
<td>0.012</td>
<td>Trade balance</td>
</tr>
<tr>
<td>X/Y</td>
<td>0.128</td>
<td>Exports</td>
</tr>
<tr>
<td>IM/Y</td>
<td>0.122</td>
<td>Imports</td>
</tr>
<tr>
<td>M/P₁Y</td>
<td>0.205</td>
<td>Money</td>
</tr>
<tr>
<td>ROG/P₁Y</td>
<td>0.000</td>
<td>Government budget</td>
</tr>
<tr>
<td>P₁Iₒ/P₁Y</td>
<td>0.019</td>
<td>Government investment</td>
</tr>
<tr>
<td>T/P₁Y</td>
<td>0.000</td>
<td>Lump-sum taxes</td>
</tr>
<tr>
<td>B/P₁Y</td>
<td>2.121</td>
<td>Public Debt</td>
</tr>
<tr>
<td>SP/P₁Y</td>
<td>0.036</td>
<td>Primary Surplus</td>
</tr>
<tr>
<td>D/P₁Y</td>
<td>0.0</td>
<td>Dividends</td>
</tr>
<tr>
<td>P₁Iᵦ/P₁Y</td>
<td>0.162</td>
<td>Private Investment</td>
</tr>
</tbody>
</table>
Table 3: Calibrated parameters and steady state variables

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Brazil</td>
<td>Rest of the World</td>
</tr>
<tr>
<td>A. Households</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$s$</td>
<td>0.00478</td>
<td>0.99522</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.98183</td>
<td>0.99756</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>1.00000</td>
<td>1.00000</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>0.23280†</td>
<td>0.60000</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>1.59000‡</td>
<td>2.00000</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.02500</td>
<td>0.02500</td>
</tr>
<tr>
<td>$\omega$</td>
<td>0.59260</td>
<td>0.25000</td>
</tr>
<tr>
<td>$\xi_i, \xi_j$</td>
<td>0.48660†</td>
<td>0.75000</td>
</tr>
<tr>
<td>$\chi_i, \chi_j$</td>
<td>0.75000</td>
<td>0.75000</td>
</tr>
<tr>
<td>B. Intermediate-good firms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.30000</td>
<td>0.30000</td>
</tr>
<tr>
<td>$\psi$</td>
<td>0.14909</td>
<td>0.41200</td>
</tr>
<tr>
<td>$\zeta$</td>
<td>1.00000</td>
<td>1.00000</td>
</tr>
<tr>
<td>$\rho_x$</td>
<td>0.89000‡</td>
<td>0.90000</td>
</tr>
<tr>
<td>$\eta$</td>
<td>6.00000</td>
<td>6.00000</td>
</tr>
<tr>
<td>$\eta_i$</td>
<td>6.00000</td>
<td>6.00000</td>
</tr>
<tr>
<td>$\eta_j$</td>
<td>6.00000</td>
<td>6.00000</td>
</tr>
<tr>
<td>$\xi_H$</td>
<td>0.90000</td>
<td>0.90000</td>
</tr>
<tr>
<td>$\xi_X$</td>
<td>0.30000</td>
<td>0.30000</td>
</tr>
<tr>
<td>$\chi_H, \chi_X$</td>
<td>0.50000</td>
<td>0.50000</td>
</tr>
<tr>
<td>$\beta_Y$</td>
<td>1.00500</td>
<td>1.00500</td>
</tr>
<tr>
<td>$\rho_{xn}$</td>
<td>0.90000</td>
<td>0.90000</td>
</tr>
<tr>
<td>$\nu_\omega$</td>
<td>0.00438</td>
<td>1.00000</td>
</tr>
</tbody>
</table>
### C. Final-good firms

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\nu_C$</td>
<td>0.87500</td>
<td>0.99650</td>
<td>Home bias in the production of consumption final goods</td>
</tr>
<tr>
<td>$\nu_I$</td>
<td>0.74999</td>
<td>1.00750</td>
<td>Home bias in the production of investment final goods</td>
</tr>
<tr>
<td>$\mu_G, \mu_I$</td>
<td>3.33000</td>
<td>1.50000</td>
<td>Price elasticity of demand for intermediate-goods</td>
</tr>
<tr>
<td>$\theta$</td>
<td>7.60000</td>
<td>6.00000</td>
<td>Price elasticity of demand for a specific intermediate-good variety</td>
</tr>
</tbody>
</table>

### D. Fiscal authority

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$B_Y$</td>
<td>2.12140</td>
<td>2.78840</td>
<td>Government debt as a share of quarterly GDP in the steady state</td>
</tr>
<tr>
<td>$\phi_{B_Y}$</td>
<td>0.0409</td>
<td>0.10000</td>
<td>Primary surplus reaction to debt-to-output in the domestic economy and sensitivity of lump-sum taxes to debt-to-output ratio in the foreign economy</td>
</tr>
<tr>
<td>$\phi_{g_Y}$</td>
<td>0.2695</td>
<td>N/A</td>
<td>Primary surplus reaction to output growth</td>
</tr>
<tr>
<td>$g$</td>
<td>0.1992</td>
<td>0.11099</td>
<td>Government consumption of public goods in the steady state</td>
</tr>
<tr>
<td>$\rho_g$</td>
<td>N/A</td>
<td>0.90000</td>
<td>Parameter governing public consumption</td>
</tr>
<tr>
<td>$tr$</td>
<td>0.1526</td>
<td>0.29231</td>
<td>Public transfers-to-GDP in steady state</td>
</tr>
<tr>
<td>$\rho_{tr}$</td>
<td>0.37717</td>
<td>0.90000</td>
<td>Parameter governing public transfers</td>
</tr>
<tr>
<td>$\tau^C$</td>
<td>0.16200</td>
<td>0.18300</td>
<td>Consumption tax rate</td>
</tr>
<tr>
<td>$\tau^D$</td>
<td>0.15000</td>
<td>0.00000</td>
<td>Dividend tax rate</td>
</tr>
<tr>
<td>$\tau^K$</td>
<td>0.15000</td>
<td>0.18400</td>
<td>Capital income tax rate</td>
</tr>
<tr>
<td>$\tau^N$</td>
<td>0.15000</td>
<td>0.14000</td>
<td>Labour income tax rate</td>
</tr>
<tr>
<td>$\tau_{wh}$</td>
<td>0.11000</td>
<td>0.11800</td>
<td>Rate of social security contributions by households</td>
</tr>
<tr>
<td>$\tau_{wf}$</td>
<td>0.20000</td>
<td>0.21900</td>
<td>Rate of social security contributions by firms</td>
</tr>
<tr>
<td>$sp$</td>
<td>0.03600</td>
<td>(0.00541)</td>
<td>Stationary primary surplus to output ratio</td>
</tr>
<tr>
<td>$\rho_{1,sp}$</td>
<td>0.2481</td>
<td>0.90000</td>
<td>Parameter of the first autoregressive term in the primary surplus rule</td>
</tr>
<tr>
<td>$\rho_{2,sp}$</td>
<td>0.1671</td>
<td>N/A</td>
<td>Parameter of the second autoregressive term in the primary surplus rule</td>
</tr>
<tr>
<td>$\nu_{tr}$</td>
<td>1.01300</td>
<td>0.42668</td>
<td>Household J transfers bias</td>
</tr>
<tr>
<td>$\nu_{tp}$</td>
<td>1.00000</td>
<td>1.00000</td>
<td>Household J lump-sum tax bias</td>
</tr>
<tr>
<td>$\nu_d$</td>
<td>0.05198</td>
<td>0.05590</td>
<td>Government investment bias</td>
</tr>
<tr>
<td>$\eta_g$</td>
<td>1.00100</td>
<td>1.00100</td>
<td>Elasticity of substitution between government and private investment goods</td>
</tr>
</tbody>
</table>
$ig$ 0.01860 0.02000  Government investment-to-output ratio target
$\rho_{ig}$ 0.90000 0.90000  Parameter governing government investment-to-output ratio

E. Monetary Authority

$\Pi$ 1.04500 1.02000  Inflation target
$\phi_{R1}$ 1.13‡ 0.95000  Degree of interest-rate inertia
$\phi_{R2}$ -0.51‡ 0.00000  Degree of interest-rate inertia
$\phi_{\Pi}$ 1.57000‡ 2.00000  Interest-rate sensitivity to inflation gap
$\phi_{gY}$ 0‡ 0.10000  Interest-rate sensitivity to output-growth gap
$R$ 1.03490 1.01240  Equilibrium nominal interest-rate
$\pi_{H}$ 1.01110 1.00500  Steady state domestic prices inflation
$\pi_{X}$ 1.00500 1.01110  Steady state export prices inflation
$\pi_{C}$ 1.01110 1.00500  Steady state consumption prices inflation

F. Adjustment and transaction costs

$\gamma_{u,1}$ 0.01545 0.47073  Parameter of transaction cost function
$\gamma_{u,2}$ 0.15000 0.15000  Parameter of transaction cost function
$\gamma_{U,1}$ 0.05271 0.03409  Parameter of capital utilization cost function
$\gamma_{U,2}$ 0.00700 0.00700  Parameter of capital utilization cost function
$\gamma_{I}$ 3.00000 3.00000  Parameter of investment adjustment cost function
$\gamma_{IM^c}$ 2.50000 2.50000  Parameter of import adjustment cost function
$\gamma_{IM^I}$ 0.00000 0.00000  Parameter of import adjustment cost function
$\gamma_{BF}$ 0.01000 0.01000  Parameter of intermediation cost function

Notes
Areosa, Areosa and Lago (2006): ‡
Minella and Souza-Sobrinho (2009): †
Table 4: Higher commitment with the stationary path of the public debt in the fiscal rule

<table>
<thead>
<tr>
<th>Moments of the shocks (in p.p.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD of the monetary policy shock(^1) = 1.00</td>
</tr>
<tr>
<td>SD of the fiscal shock = 1.00</td>
</tr>
<tr>
<td>Corr between shocks(^1) = 0.00</td>
</tr>
</tbody>
</table>

Fiscal commitment to the public debt

<table>
<thead>
<tr>
<th>Coefficient in the fiscal rule</th>
<th>0.04 (^2)</th>
<th>0.18</th>
<th>0.31</th>
<th>0.50</th>
</tr>
</thead>
</table>

Moments of endogenous variables (in p.p.)

<table>
<thead>
<tr>
<th>SD of cons. price inflation</th>
<th>0.10</th>
<th>0.20</th>
<th>0.44</th>
<th>1.04</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD of GDP growth</td>
<td>1.30</td>
<td>1.28</td>
<td>1.37</td>
<td>1.93</td>
</tr>
<tr>
<td>Corr between variables</td>
<td>4.78</td>
<td>9.68</td>
<td>29.41</td>
<td>58.85</td>
</tr>
</tbody>
</table>

Variance decomposition (%)

| ↓variance / → shock | MS\(^3\) FS\(^3\) MS FS MS FS MS FS |
|---------------------|------------------|------------------|------------------|------------------|
| Consumer price inflation | 15.63 | 84.37 | 47.98 | 52.02 | 58.48 | 41.52 | 45.16 | 54.84 |
| GDP growth           | 7.86 | 92.14 | 5.22 | 94.78 | 10.85 | 89.15 | 25.53 | 74.47 |

\(^1\) SD = standard deviation / Corr = correlation

\(^2\) calibrated value

\(^3\) MS = monetary shock / FS = fiscal shock (to the primary surplus)
Table 5: Greater rigor in implementation of the primary surplus rule

<table>
<thead>
<tr>
<th>Moments of the shocks (in p.p.)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SD of the monetary policy shock $^{/1}$ = 1.00</td>
<td></td>
</tr>
<tr>
<td>SD of the fiscal shock = <strong>0.47</strong></td>
<td></td>
</tr>
<tr>
<td>Corr between shocks $^{/1}$ = 0.00</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fiscal commitment to the public debt</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient in the fiscal rule</td>
<td>$0.04^{/2}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moments of endogenous variables (in p.p.)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SD of cons. price inflation</td>
<td>0.06</td>
</tr>
<tr>
<td>SD of GDP growth</td>
<td>0.69</td>
</tr>
<tr>
<td>Corr between variables</td>
<td>24.41</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variance decomposition (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>↓variance / → shock</td>
<td>MS $^{/3}$</td>
</tr>
<tr>
<td>Consumer price inflation</td>
<td>45.12</td>
</tr>
<tr>
<td>GDP growth</td>
<td>27.45</td>
</tr>
</tbody>
</table>

$^{/1}$ SD = standard deviation / Corr = correlation

$^{/2}$ calibrated value

$^{/3}$ MS = monetary shock / FS = fiscal shock (to the primary surplus)
Table 6: Varying the correlation between monetary and fiscal policy (primary surplus) shocks

<table>
<thead>
<tr>
<th>Moments of the shocks (in p.p.)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SD of the monetary policy shock</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD between fiscal shocks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD of cons. price inflation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD of output growth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corr between policy shocks</td>
<td>0.80</td>
<td>0.50</td>
<td>0.00</td>
<td>-0.50</td>
<td>-0.80</td>
</tr>
<tr>
<td>Fiscal commitment to the public debt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coefficient in the fiscal rule</td>
<td>0.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moments of the variables (in p.p.)</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SD of cons. price inflation</td>
<td>0.19</td>
<td>0.18</td>
<td>0.16</td>
<td>0.13</td>
<td>0.11</td>
</tr>
<tr>
<td>SD of output growth</td>
<td>0.80</td>
<td>0.75</td>
<td>0.66</td>
<td>0.55</td>
<td>0.47</td>
</tr>
<tr>
<td>Corr between variables</td>
<td>18.44</td>
<td>17.40</td>
<td>14.81</td>
<td>9.95</td>
<td>4.25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variance decomposition (%) - when the 1st shock is in monetary policy</th>
<th>MS (^1)</th>
<th>FS (^3)</th>
<th>MS</th>
<th>FS</th>
<th>MS</th>
<th>FS</th>
<th>MS</th>
<th>FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer price inflation</td>
<td>95.27</td>
<td>4.73</td>
<td>88.74</td>
<td>11.26</td>
<td>80.36</td>
<td>19.64</td>
<td>78.70</td>
<td>21.30</td>
</tr>
<tr>
<td>GDP growth</td>
<td>80.49</td>
<td>19.51</td>
<td>53.70</td>
<td>46.30</td>
<td>19.64</td>
<td>80.36</td>
<td>13.68</td>
<td>44.07</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variance decomposition (%) - when the 1st shock is in the fiscal rule</th>
<th>MS (^1)</th>
<th>FS (^3)</th>
<th>MS</th>
<th>FS</th>
<th>MS</th>
<th>FS</th>
<th>MS</th>
<th>FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer price inflation</td>
<td>80.63</td>
<td>19.37</td>
<td>53.94</td>
<td>46.06</td>
<td>19.64</td>
<td>80.74</td>
<td>12.83</td>
<td>87.17</td>
</tr>
<tr>
<td>GDP growth</td>
<td>95.23</td>
<td>4.77</td>
<td>88.68</td>
<td>11.32</td>
<td>80.36</td>
<td>19.64</td>
<td>78.90</td>
<td>21.10</td>
</tr>
</tbody>
</table>

\(^1\) SD = standard deviation / Corr = correlation
\(^2\) calibrated value
\(^3\) MS = monetary shock / FS = fiscal shock (to the primary surplus)
Table 7: Varying the monetary policy commitment to the inflation target

<table>
<thead>
<tr>
<th>Moments of the shocks (in p.p.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD of the monetary policy shock (^1) = 1.00</td>
</tr>
<tr>
<td>SD of the fiscal shock = 0.47</td>
</tr>
<tr>
<td>Corr between shocks (^1) = 0.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fiscal commitment to the public debt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient in the fiscal rule = 0.18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mon. policy commitment to the inflation target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient in the mon. policy rule = 1.20</td>
</tr>
<tr>
<td>1.57 (^2)</td>
</tr>
<tr>
<td>2.44</td>
</tr>
<tr>
<td>5.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moments of endogenous variables (in p.p.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SD of cons. price inflation = 0.82</td>
</tr>
<tr>
<td>0.16</td>
</tr>
<tr>
<td>0.07</td>
</tr>
<tr>
<td>0.04</td>
</tr>
<tr>
<td>SD of GDP growth</td>
</tr>
<tr>
<td>0.73</td>
</tr>
<tr>
<td>0.66</td>
</tr>
<tr>
<td>0.63</td>
</tr>
<tr>
<td>0.61</td>
</tr>
<tr>
<td>Corr between variables = 25.52</td>
</tr>
<tr>
<td>14.81</td>
</tr>
<tr>
<td>8.40</td>
</tr>
<tr>
<td>0.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variance decomposition (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓variance / → shock</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Consumer price inflation</td>
</tr>
<tr>
<td>93.01</td>
</tr>
<tr>
<td>6.99</td>
</tr>
<tr>
<td>80.36</td>
</tr>
<tr>
<td>19.64</td>
</tr>
<tr>
<td>64.72</td>
</tr>
<tr>
<td>35.28</td>
</tr>
<tr>
<td>64.72</td>
</tr>
<tr>
<td>35.28</td>
</tr>
<tr>
<td>60.37</td>
</tr>
<tr>
<td>39.63</td>
</tr>
<tr>
<td>GDP growth</td>
</tr>
<tr>
<td>29.57</td>
</tr>
<tr>
<td>70.43</td>
</tr>
<tr>
<td>19.64</td>
</tr>
<tr>
<td>80.36</td>
</tr>
<tr>
<td>18.13</td>
</tr>
<tr>
<td>81.87</td>
</tr>
<tr>
<td>22.08</td>
</tr>
<tr>
<td>77.92</td>
</tr>
</tbody>
</table>

/1 SD = standard deviation / Corr = correlation
/2 calibrated value
/3 MS = monetary shock / FS = fiscal shock (to the primary surplus)
Table 8: Policy rules that minimize output volatility

<table>
<thead>
<tr>
<th>Moments of the shocks (in p.p.)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SD of the monetary policy shock /1 = 1.00</td>
<td></td>
</tr>
<tr>
<td>SD of the fiscal policy shock = 1.00</td>
<td></td>
</tr>
<tr>
<td>Corr between shocks /1 = 0.00</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fiscal commitment to the public debt</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficient in the fiscal rule 0.04 /2</td>
<td>0.27</td>
</tr>
</tbody>
</table>

| Monetary policy commitment to the inflation target |       |
| Coef in the monetary policy rule 1.57 /2 | 4.50  |

<table>
<thead>
<tr>
<th>Moments of endogenous variables (in p.p.)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SD of cons. price inflation 0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>SD of output growth 1.30</td>
<td>1.17</td>
</tr>
<tr>
<td>Corr between variables 4.78</td>
<td>-15.58</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variance decomposition (%)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MS /3</td>
</tr>
<tr>
<td>Consumer price inflation</td>
<td>15.63</td>
</tr>
<tr>
<td>GDP growth</td>
<td>7.86</td>
</tr>
</tbody>
</table>

/1 SD = standard deviation / Corr = correlation

/2 calibrated value

/3 MS = monetary shock / FS = fiscal shock (to the primary surplus)
Table 9: Alternative monetary policy rules

<table>
<thead>
<tr>
<th></th>
<th>calibrated model</th>
<th>calibrated rule + reaction to the exchange rate</th>
<th>calibrated rule + reaction to the output growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moments of endogenous variables (in p.p.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SD of inflation</td>
<td>0.10</td>
<td>0.04</td>
<td>0.41</td>
</tr>
<tr>
<td>SD of GDP growth</td>
<td>1.30</td>
<td>1.27</td>
<td>0.85</td>
</tr>
<tr>
<td>SD of exchange rate variation</td>
<td>0.68</td>
<td>0.22</td>
<td>1.28</td>
</tr>
<tr>
<td>Corr between consumer price inflation and GDP growth</td>
<td>4.78</td>
<td>0.46</td>
<td>-7.51</td>
</tr>
<tr>
<td>Corr between consumer price inflation and exchange rate variation</td>
<td>48.84</td>
<td>40.25</td>
<td>46.36</td>
</tr>
<tr>
<td>Corr between GDP growth and exchange rate variation</td>
<td>8.58</td>
<td>-25.58</td>
<td>-78.61</td>
</tr>
</tbody>
</table>

Variance decomposition (%)

<table>
<thead>
<tr>
<th></th>
<th>MS /3</th>
<th>FS /3</th>
<th>MS</th>
<th>FS</th>
<th>MS</th>
<th>FS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consumer price inflation</td>
<td>15.63</td>
<td>84.37</td>
<td>97.67</td>
<td>2.33</td>
<td>10.14</td>
<td>89.86</td>
</tr>
<tr>
<td>GDP growth</td>
<td>7.86</td>
<td>92.14</td>
<td>1.75</td>
<td>98.25</td>
<td>2.80</td>
<td>97.20</td>
</tr>
<tr>
<td>Exchange rate variation</td>
<td>89.4</td>
<td>10.6</td>
<td>86.16</td>
<td>13.84</td>
<td>5.1</td>
<td>94.9</td>
</tr>
</tbody>
</table>

/1 SD = standard deviation / Corr = correlation
/2 calibrated value
/3 MS = monetary shock / FS = fiscal shock (to the primary surplus)
Figure 1: Impulse responses to a contractionist shock to monetary policy
Figure 2: Impulse responses to an expansionist shock to the primary surplus
Figure 3: Impulse responses to a shock to government transfers
Figure 4: Impulse responses to a shock to government investment
Figure 5: Fiscal commitment to the steady state level of the public debt: impulse responses of a monetary policy shock
Figure 6: Combination of policy shocks: Impulse responses to a monetary policy shock varying the rigor in the implementation of the fiscal rule
Figure 7: Regions where the model converges to a unique solution in Dynare $^{1/}$

The regions of convergence were plotted only for the interval $\phi_{By} \in (-1000,100)$ and $\phi_{d} \in (-2,10)$. The colored region continues in the area beyond the plotted limits.

The numbered dots represent the points selected to draw impulse responses in Figure 8.
Figure 8: Some plots of impulse responses to a fiscal policy shock under distinct combinations of policy parameters in the regions where the model converges to a unique solution in Dynare.\textsuperscript{17}

The numbers in each column of graphs indicate the combinations of policy reactions plotted (and equally numbered) in Figure 7.

\textsuperscript{17}
Figure 9: Impulse responses to a 1 p.p. monetary policy shock under alternative monetary policy rules
## Working Paper Series

Working Papers in PDF format can be downloaded from: http://www.bc.gov.br

<table>
<thead>
<tr>
<th>Paper Number</th>
<th>Title</th>
<th>Authors/Editors</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Implementing Inflation Targeting in Brazil</td>
<td>Joel Bogdanski, Alexandre Antonio Tombini and Sérgio Ribeiro da Costa Werlang</td>
<td>Jul/2000</td>
</tr>
<tr>
<td>2</td>
<td>Política Monetária e Supervisão do Sistema Financeiro Nacional no Banco Central do Brasil</td>
<td>Eduardo Lundberg</td>
<td>Jul/2000</td>
</tr>
<tr>
<td>6</td>
<td>Optimal Interest Rate Rules in Inflation Targeting Frameworks</td>
<td>José Alvaro Rodrigues Neto, Fabio Araújo and Maria Baltar J. Moreira</td>
<td>Jul/2000</td>
</tr>
<tr>
<td>7</td>
<td>Leading Indicators of Inflation for Brazil</td>
<td>Marcelle Chauvet</td>
<td>Sep/2000</td>
</tr>
<tr>
<td>8</td>
<td>The Correlation Matrix of the Brazilian Central Bank’s Standard Model for Interest Rate Market Risk</td>
<td>José Alvaro Rodrigues Neto</td>
<td>Sep/2000</td>
</tr>
<tr>
<td>9</td>
<td>Estimating Exchange Market Pressure and Intervention Activity</td>
<td>Emanuel-Werner Kohlscheen</td>
<td>Nov/2000</td>
</tr>
<tr>
<td>10</td>
<td>Análise do Financiamento Externo a uma Pequena Economia</td>
<td>Carlos Hamilton Vasconcelos Araújo and Renato Galvão Flôres Júnior</td>
<td>Mar/2001</td>
</tr>
<tr>
<td>12</td>
<td>A Test of Competition in Brazilian Banking</td>
<td>Márcio I. Nakane</td>
<td>Mar/2001</td>
</tr>
</tbody>
</table>
13 Modelos de Previsão de Insolvência Bancária no Brasil  
Marcio Magalhães Janot  
Mar/2001

14 Evaluating Core Inflation Measures for Brazil  
Francisco Marcos Rodrigues Figueiredo  
Mar/2001

15 Is It Worth Tracking Dollar/Real Implied Volatility?  
Sandro Canesso de Andrade and Benjamin Miranda Tabak  
Mar/2001

16 Avaliação das Projeções do Modelo Estrutural do Banco Central do Brasil para a Taxa de Variação do IPCA  
Sergio Afonso Lago Alves  
Jul/2001

17 Estimando o Produto Potencial Brasileiro: uma Abordagem de Função de Produção  
Tito Nícius Teixeira da Silva Filho  
Abr/2001

18 A Simple Model for Inflation Targeting in Brazil  
Paulo Springer de Freitas and Marcelo Kfoury Muinhos  
Apr/2001

19 Uncovered Interest Parity with Fundamentals: a Brazilian Exchange Rate Forecast Model  
Marcelo Kfoury Muinhos, Paulo Springer de Freitas and Fabio Araújo  
May/2001

20 Credit Channel without the LM Curve  
Victorio Y. T. Chu and Márcio I. Nakane  
May/2001

21 Os Impactos Econômicos da CPMF: Teoria e Evidência  
Pedro H. Albuquerque  
Jun/2001

22 Decentralized Portfolio Management  
Paulo Coutinho and Benjamin Miranda Tabak  
Jun/2001

23 Os Efeitos da CPMF sobre a Intermediação Financeira  
Sérgio Mikio Koyama e Márcio I. Nakane  
Jul/2001

24 Inflation Targeting in Brazil: Shocks, Backward-Looking Prices, and IMF Conditionality  
Joel Bogdanski, Paulo Springer de Freitas, Ilan Goldfajn and Alexandre Antonio Tombini  
Aug/2001

25 Inflation Targeting in Brazil: Reviewing Two Years of Monetary Policy 1999/00  
Pedro Fachada  
Aug/2001

26 Inflation Targeting in an Open Financially Integrated Emerging Economy: the Case of Brazil  
Marcelo Kfoury Muinhos  
Aug/2001

27 Complementaridade e Fungibilidade dos Fluxos de Capitais Internacionais  
Carlos Hamilton Vasconcelos Araújo e Renato Galvão Flôres Júnior  
Set/2001
<table>
<thead>
<tr>
<th>No.</th>
<th>Título</th>
<th>Autor(a)</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>Using a Money Demand Model to Evaluate Monetary Policies in Brazil</td>
<td>Pedro H. Albuquerque and Solange Gouvêa</td>
<td>Nov/2001</td>
</tr>
<tr>
<td>30</td>
<td>Testing the Expectations Hypothesis in the Brazilian Term Structure of Interest Rates</td>
<td>Benjamin Miranda Tabak and Sandro Canesso de Andrade</td>
<td>Nov/2001</td>
</tr>
<tr>
<td>31</td>
<td>Algumas Considerações sobre a Sazonalidade no IPCA</td>
<td>Francisco Marcos R. Figueiredo e Roberta Blass Staub</td>
<td>Nov/2001</td>
</tr>
<tr>
<td>32</td>
<td>Crises Cambiais e Ataques Especulativos no Brasil</td>
<td>Mauro Costa Miranda</td>
<td>Nov/2001</td>
</tr>
<tr>
<td>35</td>
<td>Uma Definição Operacional de Estabilidade de Preços</td>
<td>Tito Nícius Teixeira da Silva Filho</td>
<td>Dez/2001</td>
</tr>
<tr>
<td>38</td>
<td>Volatilidade Implícita e Antecipação de Eventos de Stress: um Teste para o Mercado Brasileiro</td>
<td>Frederico Pechir Gomes</td>
<td>Mar/2002</td>
</tr>
<tr>
<td>40</td>
<td>Speculative Attacks on Debts, Dollarization and Optimum Currency Areas</td>
<td>Aloísio Araújo and Márcia Leon</td>
<td>Apr/2002</td>
</tr>
<tr>
<td>41</td>
<td>Mudanças de Regime no Câmbio Brasileiro</td>
<td>Carlos Hamilton V. Araújo e Getúlio B. da Silveira Filho</td>
<td>Jun/2002</td>
</tr>
<tr>
<td>42</td>
<td>Modelo Estrutural com Setor Externo: Endogenização do Prêmio de Risco e do Câmbio</td>
<td>Marcelo Kfoury Muinhos, Sérgio Afonso Lago Alves e Gil Riella</td>
<td>Jun/2002</td>
</tr>
<tr>
<td>43</td>
<td>The Effects of the Brazilian ADRs Program on Domestic Market Efficiency</td>
<td>Benjamin Miranda Tabak and Eduardo José Araújo Lima</td>
<td>Jun/2002</td>
</tr>
<tr>
<td>No.</td>
<td>Title</td>
<td>Author(s)</td>
<td>Date</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>44</td>
<td>Estrutura Competitiva, Produtividade Industrial e Liberação Comercial no Brasil</td>
<td>Pedro Cavalcanti Ferreira e Osmani Teixeira de Carvalho Guillén</td>
<td>Jun/2002</td>
</tr>
<tr>
<td>45</td>
<td>Optimal Monetary Policy, Gains from Commitment, and Inflation Persistence</td>
<td>André Minella</td>
<td>Aug/2002</td>
</tr>
<tr>
<td>46</td>
<td>The Determinants of Bank Interest Spread in Brazil</td>
<td>Tarsila Segalla Afansieff, Priscilla Maria Villa Lhacer and Márcio I. Nakane</td>
<td>Aug/2002</td>
</tr>
<tr>
<td>47</td>
<td>Indicadores Derivados de Agregados Monetários</td>
<td>Fernando de Aquino Fonseca Neto e José Albuquerque Júnior</td>
<td>Set/2002</td>
</tr>
<tr>
<td>49</td>
<td>Desenvolvimento do Sistema Financeiro e Crescimento Econômico no Brasil: Evidências de Causalidade</td>
<td>Orlando Carneiro de Matos</td>
<td>Set/2002</td>
</tr>
<tr>
<td>50</td>
<td>Macroeconomic Coordination and Inflation Targeting in a Two-Country Model</td>
<td>Eui Jung Chang, Marcelo Kfoury Muinhos and Joanílio Rodolpho Teixeira</td>
<td>Sep/2002</td>
</tr>
<tr>
<td>51</td>
<td>Credit Channel with Sovereign Credit Risk: an Empirical Test</td>
<td>Victorio Yi Tson Chu</td>
<td>Sep/2002</td>
</tr>
<tr>
<td>52</td>
<td>Generalized Hyperbolic Distributions and Brazilian Data</td>
<td>José Fajardo and Aquiles Farias</td>
<td>Sep/2002</td>
</tr>
<tr>
<td>54</td>
<td>Stock Returns and Volatility</td>
<td>Benjamin Miranda Tabak and Solange Maria Guerra</td>
<td>Nov/2002</td>
</tr>
<tr>
<td>55</td>
<td>Componentes de Curto e Longo Prazo das Taxas de Juros no Brasil</td>
<td>Carlos Hamilton Vasconcelos Araújo e Osmani Teixeira de Carvalho de Guillén</td>
<td>Nov/2002</td>
</tr>
<tr>
<td>56</td>
<td>Causality and Cointegration in Stock Markets: the Case of Latin America</td>
<td>Benjamin Miranda Tabak and Eduardo José Araújo Lima</td>
<td>Dec/2002</td>
</tr>
<tr>
<td>57</td>
<td>As Leis de Falência: uma Abordagem Econômica</td>
<td>Aloísio Araújo</td>
<td>Dez/2002</td>
</tr>
<tr>
<td>59</td>
<td>Os Preços Administrados e a Inflação no Brasil</td>
<td>Francisco Marcos R. Figueiredo e Thaís Porto Ferreira</td>
<td>Dez/2002</td>
</tr>
<tr>
<td>60</td>
<td>Delegated Portfolio Management</td>
<td>Paulo Coutinho and Benjamin Miranda Tabak</td>
<td>Dec/2002</td>
</tr>
<tr>
<td>No.</td>
<td>Título</td>
<td>Autor(es)</td>
<td>Data</td>
</tr>
<tr>
<td>-----</td>
<td>------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>61</td>
<td>O Uso de Dados de Alta Freqüência na Estimação da Volatilidade e do Valor em Risco para o Ibovespa</td>
<td>João Maurício de Souza Moreira e Eduardo Facó Lemgruber</td>
<td>Dez/2002</td>
</tr>
<tr>
<td>62</td>
<td>Taxa de Juros e Concentração Bancária no Brasil</td>
<td>Eduardo Kiyoshi Tomooka e Sérgio Mikio Koyama</td>
<td>Fev/2003</td>
</tr>
<tr>
<td>63</td>
<td>Optimal Monetary Rules: the Case of Brazil</td>
<td>Charles Lima de Almeida, Marco Aurélio Peres, Geraldo da Silva e Souza and Benjamin Miranda Tabak</td>
<td>Feb/2003</td>
</tr>
<tr>
<td>64</td>
<td>Medium-Size Macroeconomic Model for the Brazilian Economy</td>
<td>Marcelo Kfoury Muinhos and Sergio Afonso Lago Alves</td>
<td>Feb/2003</td>
</tr>
<tr>
<td>65</td>
<td>On the Information Content of Oil Future Prices</td>
<td>Benjamin Miranda Tabak</td>
<td>Feb/2003</td>
</tr>
<tr>
<td>68</td>
<td>Real Balances in the Utility Function: Evidence for Brazil</td>
<td>Leonardo Soriano de Alencar and Márcio I. Nakane</td>
<td>Feb/2003</td>
</tr>
<tr>
<td>69</td>
<td>r-filters: a Hodrick-Prescott Filter Generalization</td>
<td>Fabio Araújo, Marta Baltar Moreira Areosa and José Alvaro Rodrigues Neto</td>
<td>Feb/2003</td>
</tr>
<tr>
<td>70</td>
<td>Monetary Policy Surprises and the Brazilian Term Structure of Interest Rates</td>
<td>Benjamin Miranda Tabak</td>
<td>Feb/2003</td>
</tr>
<tr>
<td>71</td>
<td>On Shadow-Prices of Banks in Real-Time Gross Settlement Systems</td>
<td>Rodrigo Penaloza</td>
<td>Apr/2003</td>
</tr>
<tr>
<td>72</td>
<td>O Prêmio pela Maturidade na Estrutura a Termo das Taxas de Juros Brasileiras</td>
<td>Ricardo Dias de Oliveira Brito, Angelo J. Mont’Alverne Duarte and Osmaní Teixeira de C. Guillen</td>
<td>Maio/2003</td>
</tr>
<tr>
<td>74</td>
<td>Aplicação do Modelo de Black, Derman &amp; Toy à Precificação de Opções Sobre Títulos de Renda Fixa</td>
<td>Octavio Manuel Bessada Lion, Carlos Alberto Nunes Cosenza e César das Neves</td>
<td>Maio/2003</td>
</tr>
<tr>
<td>75</td>
<td>Brazil’s Financial System: Resilience to Shocks, no Currency Substitution, but Struggling to Promote Growth</td>
<td>Ilan Goldfajn, Katherine Hennings and Helio Mori</td>
<td>Jun/2003</td>
</tr>
<tr>
<td>No.</td>
<td>Title</td>
<td>Authors</td>
<td>Date</td>
</tr>
<tr>
<td>-----</td>
<td>----------------------------------------------------------------------</td>
<td>----------------------------------------------</td>
<td>--------</td>
</tr>
<tr>
<td>76</td>
<td>Inflation Targeting in Emerging Market Economies</td>
<td>Arminio Fraga, Ilan Goldfajn and André Minella</td>
<td>Jun/2003</td>
</tr>
<tr>
<td>77</td>
<td>Inflation Targeting in Brazil: Constructing Credibility under Exchange Rate Volatility</td>
<td>André Minella, Paulo Springer de Freitas, Ilan Goldfajn and Marcelo Kfoury Muinhos</td>
<td>Jul/2003</td>
</tr>
<tr>
<td>78</td>
<td>Contornando os Pressupostos de Black &amp; Scholes: Aplicação do Modelo de Precificação de Opções de Duan no Mercado Brasileiro</td>
<td>Gustavo Silva Araújo, Claudio Henrique da Silveira Barbedo, Antonio Carlos Figueiredo, Eduardo Facó Lemgruber</td>
<td>Out/2003</td>
</tr>
<tr>
<td>79</td>
<td>Inclusão do Decaimento Temporal na Metodologia</td>
<td></td>
<td>Out/2003</td>
</tr>
<tr>
<td>80</td>
<td>Diferenças e Semelhanças entre Países da América Latina: uma Análise de Markov Switching para os Ciclos Econômicos de Brasil e Argentina</td>
<td>Arnildo da Silva Correa</td>
<td>Out/2003</td>
</tr>
<tr>
<td>81</td>
<td>Bank Competition, Agency Costs and the Performance of the Monetary Policy</td>
<td>Leonardo Soriano de Alencar and Márcio I. Nakane</td>
<td>Jan/2004</td>
</tr>
<tr>
<td>83</td>
<td>Does Inflation Targeting Reduce Inflation? An Analysis for the OECD Industrial Countries</td>
<td>Thomas Y. Wu</td>
<td>May/2004</td>
</tr>
<tr>
<td>84</td>
<td>Speculative Attacks on Debts and Optimum Currency Area: a Welfare Analysis</td>
<td>Aloisio Araujo and Marcia Leon</td>
<td>May/2004</td>
</tr>
<tr>
<td>86</td>
<td>Identificação do Fator Estocástico de Descontos e Algumas Implicações sobre Testes de Modelos de Consumo</td>
<td>Fabio Araujo e João Victor Issler</td>
<td>Maio/2004</td>
</tr>
<tr>
<td>87</td>
<td>Mercado de Crédito: uma Análise Econométrica dos Volumes de Crédito Total e Habitacional no Brasil</td>
<td>Ana Carla Abrão Costa</td>
<td>Dez/2004</td>
</tr>
<tr>
<td>89</td>
<td>O Mercado de Hedge Cambial no Brasil: Reação das Instituições Financeiras a Intervenções do Banco Central</td>
<td>Fernando N. de Oliveira</td>
<td>Dez/2004</td>
</tr>
<tr>
<td>No.</td>
<td>Title</td>
<td>Authors</td>
<td>Date</td>
</tr>
<tr>
<td>-----</td>
<td>----------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>90</td>
<td>Bank Privatization and Productivity: Evidence for Brazil</td>
<td>Márcio I. Nakane and Daniela B. Weintraub</td>
<td>Dec/2004</td>
</tr>
<tr>
<td>92</td>
<td>Steady-State Analysis of an Open Economy General Equilibrium Model for Brazil</td>
<td>Mirta Noemi Sataka Bugarin, Roberto de Goes Ellery Jr., Victor Gomes Silva, Marcelo Kfoury Muinhos</td>
<td>Apr/2005</td>
</tr>
<tr>
<td>93</td>
<td>Avaliação de Modelos de Cálculo de Exigência de Capital para Risco Cambial</td>
<td>Claudio H. da S. Barbedo, Gustavo S. Araújo, João Maurício S. Moreira e Ricardo S. Maia Clemente</td>
<td>Abr/2005</td>
</tr>
<tr>
<td>95</td>
<td>Comment on Market Discipline and Monetary Policy by Carl Walsh</td>
<td>Maurício S. Bugarin and Fábia A. de Carvalho</td>
<td>Apr/2005</td>
</tr>
<tr>
<td>96</td>
<td>O que É Estratégia: uma Abordagem Multiparadigmática para a Disciplina</td>
<td>Anthero de Moraes Meirelles</td>
<td>Ago/2005</td>
</tr>
<tr>
<td>100</td>
<td>Targets and Inflation Dynamics</td>
<td>Sergio A. L. Alves and Waldyr D. Areosa</td>
<td>Oct/2005</td>
</tr>
<tr>
<td>101</td>
<td>Comparing Equilibrium Real Interest Rates: Different Approaches to Measure Brazilian Rates</td>
<td>Marcelo Kfoury Muinhos and Márcio I. Nakane</td>
<td>Mar/2006</td>
</tr>
<tr>
<td>102</td>
<td>Judicial Risk and Credit Market Performance: Micro Evidence from Brazilian Payroll Loans</td>
<td>Ana Carla A. Costa and João M. P. de Mello</td>
<td>Apr/2006</td>
</tr>
<tr>
<td>103</td>
<td>The Effect of Adverse Supply Shocks on Monetary Policy and Output</td>
<td>Maria da Glória D. S. Araújo, Mirta Bugarin, Marcelo Kfoury Muinhos and Jose Ricardo C. Silva</td>
<td>Apr/2006</td>
</tr>
</tbody>
</table>
104 Extração de Informação de Opções Cambiais no Brasil
Eui Jung Chang e Benjamin Miranda Tabak
Abr/2006

105 Representing Roommate's Preferences with Symmetric Utilities
José Alvaro Rodrigues Neto
Apr/2006

106 Testing Nonlinearities Between Brazilian Exchange Rates and Inflation Volatilities
Cristiane R. Albuquerque and Marcelo Portugal
May/2006

107 Demand for Bank Services and Market Power in Brazilian Banking
Márcio I. Nakane, Leonardo S. Alencar and Fabio Kanczuk
Jun/2006

108 O Efeito da Consignação em Folha nas Taxas de Juros dos Empréstimos Pessoais
Eduardo A. S. Rodrigues, Victorio Chu, Leonardo S. Alencar e Tony Takeda
Jun/2006

109 The Recent Brazilian Disinflation Process and Costs
Alexandre A. Tombini and Sergio A. Lago Alves
Jun/2006

110 Fatores de Risco e o Spread Bancário no Brasil
Fernando G. Bignotto e Eduardo Augusto de Souza Rodrigues
Jul/2006

111 Avaliação de Modelos de Exigência de Capital para Risco de Mercado do Cupom Cambial
Alan Cosme Rodrigues da Silva, João Maurício de Souza Moreira and Myrian Beatriz Eiras das Neves
Jul/2006

112 Interdependence and Contagion: an Analysis of Information Transmission in Latin America's Stock Markets
Angelo Marsiglia Fasolo
Jul/2006

113 Investigação da Memória de Longo Prazo da Taxa de Câmbio no Brasil
Sergio Rubens Stancato de Souza, Benjamin Miranda Tabak e Daniel O. Cajueiro
Ago/2006

114 The Inequality Channel of Monetary Transmission
Marta Areosa and Waldyr Areosa
Aug/2006

115 Myopic Loss Aversion and House-Money Effect Overseas: an Experimental Approach
José L. B. Fernandes, Juan Ignacio Peña and Benjamin M. Tabak
Sep/2006

116 Out-Of-The-Money Monte Carlo Simulation Option Pricing: the Join Use of Importance Sampling and Descriptive Sampling
Jaqueline Terra MouraMarins, Eduardo Saliby and Josète Florencio dos Santos
Sep/2006

117 An Analysis of Off-Site Supervision of Banks’ Profitability, Risk and Capital Adequacy: a Portfolio Simulation Approach Applied to Brazilian Banks
Theodore M. Barnhill, Marcos R. Souto and Benjamin M. Tabak
Sep/2006

118 Contagion, Bankruptcy and Social Welfare Analysis in a Financial Economy with Risk Regulation Constraint
Aloísio P. Araújo and José Valentim M. Vicente
Oct/2006
119 A Central de Risco de Crédito no Brasil: uma Análise de Utilidade de Informação
Ricardo Schechtman
Out/2006

120 Forecasting Interest Rates: an Application for Brazil
Eduardo J. A. Lima, Felipe Luduvice and Benjamin M. Tabak
Oct/2006

121 The Role of Consumer’s Risk Aversion on Price Rigidity
Sergio A. Lago Alves and Mirta N. S. Bugarin
Nov/2006

122 Nonlinear Mechanisms of the Exchange Rate Pass-Through: a Phillips Curve Model With Threshold for Brazil
Arnildo da Silva Correa and André Minella
Nov/2006

123 A Neoclassical Analysis of the Brazilian “Lost-Decades”
Flávia Mourão Graminho
Nov/2006

124 The Dynamic Relations between Stock Prices and Exchange Rates: Evidence for Brazil
Benjamin M. Tabak
Nov/2006

125 Herding Behavior by Equity Foreign Investors on Emerging Markets
Barbara Alemanni and José Renato Haas Ornelas
Dec/2006

126 Risk Premium: Insights over the Threshold
José L. B. Fernandes, Augusto Hasman and Juan Ignacio Peña
Dec/2006

127 Uma Investigação Baseada em Reamostragem sobre Requerimentos de Capital para Risco de Crédito no Brasil
Ricardo Schechtman
Dec/2006

128 Term Structure Movements Implicit in Option Prices
Caio Ibsen R. Almeida and José Valentim M. Vicente
Dec/2006

129 Brazil: Taming Inflation Expectations
Afonso S. Bevilaqua, Mário Mesquita and André Minella
Jan/2007

130 The Role of Banks in the Brazilian Interbank Market: Does Bank Type Matter?
Daniel O. Cajueiro and Benjamin M. Tabak
Jan/2007

131 Long-Range Dependence in Exchange Rates: the Case of the European Monetary System
Sergio Rubens Stancato de Souza, Benjamin M. Tabak and Daniel O. Cajueiro
Mar/2007

132 Credit Risk Monte Carlo Simulation Using Simplified Creditmetrics’ Model: the Joint Use of Importance Sampling and Descriptive Sampling
Jaqueline Terra Moura Marins and Eduardo Saliby
Mar/2007

133 A New Proposal for Collection and Generation of Information on Financial Institutions’ Risk: the Case of Derivatives
Gilneu F. A. Vivan and Benjamin M. Tabak
Mar/2007

134 Amostragem Descritiva no Apreçamento de Opções Européias através de Simulação Monte Carlo: o Efeito da Dimensionalidade e da Probabilidade de Exercício no Ganho de Precisão
Eduardo Saliby, Sergio Luiz Medeiros Proença de Gouvêa e Jaqueline Terra Moura Marins
Abr/2007
<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Authors</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>136</td>
<td>Identifying Volatility Risk Premium from Fixed Income Asian Options</td>
<td>Caio Ibsen R. Almeida and José Valentim M. Vicente</td>
<td>May/2007</td>
</tr>
<tr>
<td>137</td>
<td>Monetary Policy Design under Competing Models of Inflation Persistence</td>
<td>Solange Gouvea e Abhijit Sen Gupta</td>
<td>May/2007</td>
</tr>
<tr>
<td>140</td>
<td>Inflation Targeting, Credibility and Confidence Crises</td>
<td>Rafael Santos and Aloísio Araújo</td>
<td>Aug/2007</td>
</tr>
<tr>
<td>141</td>
<td>Forecasting Bonds Yields in the Brazilian Fixed income Market</td>
<td>Jose Vicente and Benjamin M. Tabak</td>
<td>Aug/2007</td>
</tr>
<tr>
<td>142</td>
<td>Crises Análise da Coerência de Medidas de Risco no Mercado Brasileiro de Ações e Desenvolvimento de uma Metodologia Híbrida para o Expected Shortfall</td>
<td>Alan Cosme Rodrigues da Silva, Eduardo Facó Lemgruber, José Alberto Rebello Baranowski and Renato da Silva Carvalho</td>
<td>Ago/2007</td>
</tr>
<tr>
<td>143</td>
<td>Price Rigidity in Brazil: Evidence from CPI Micro Data</td>
<td>Solange Gouvea</td>
<td>Sep/2007</td>
</tr>
<tr>
<td>144</td>
<td>The Effect of Bid-Ask Prices on Brazilian Options Implied Volatility: a Case Study of Telemar Call Options</td>
<td>Claudio Henrique da Silveira Barbedo and Eduardo Facó Lemgruber</td>
<td>Oct/2007</td>
</tr>
<tr>
<td>145</td>
<td>The Stability-Concentration Relationship in the Brazilian Banking System</td>
<td>Benjamin Miranda Tabak, Solange Maria Guerra, Eduardo José Araújo Lima and Eui Jung Chang</td>
<td>Oct/2007</td>
</tr>
<tr>
<td>146</td>
<td>Movimentos da Estrutura a Termo e Critérios de Minimização do Erro de Previsão em um Modelo Paramétrico Exponencial</td>
<td>Caio Almeida, Romeu Gomes, André Leite e José Vicente</td>
<td>Out/2007</td>
</tr>
<tr>
<td>148</td>
<td>Um Modelo de Fatores Latentes com Variáveis Macroeconômicas para a Curva de Cupom Cambial</td>
<td>Felipe Pinheiro, Caio Almeida e José Vicente</td>
<td>Out/2007</td>
</tr>
<tr>
<td>149</td>
<td>Joint Validation of Credit Rating PDs under Default Correlation</td>
<td>Ricardo Schechtman</td>
<td>Oct/2007</td>
</tr>
</tbody>
</table>
150 A Probabilistic Approach for Assessing the Significance of Contextual Variables in Nonparametric Frontier Models: an Application for Brazilian Banks
Roberta Blass Staub and Geraldo da Silva e Souza

Oct/2007

151 Building Confidence Intervals with Block Bootstraps for the Variance Ratio Test of Predictability
Eduardo José Araújo Lima and Benjamin Miranda Tabak

Nov/2007

152 Demand for Foreign Exchange Derivatives in Brazil: Hedge or Speculation?
Fernando N. de Oliveira and Walter Novaes

Dec/2007

153 Aplicação da Amostragem por Importância à Simulação de Opções Asiáticas Fora do Dinheiro
Jaqueline Terra Moura Marins

Dez/2007

154 Identification of Monetary Policy Shocks in the Brazilian Market for Bank Reserves
Adriana Soares Sales and Maria Tannuri-Pianto

Dec/2007

155 Does Curvature Enhance Forecasting?
Caio Almeida, Romeu Gomes, André Leite and José Vicente

Dec/2007

156 Escolha do Banco e Demanda por Empréstimos: um Modelo de Decisão em Duas Etapas Aplicado para o Brasil
Sérgio Mikio Koyama e Márcio I. Nakane

Dez/2007

157 Is the Investment-Uncertainty Link Really Elusive? The Harmful Effects of Inflation Uncertainty in Brazil
Tito Nícias Teixeira da Silva Filho

Jan/2008

158 Characterizing the Brazilian Term Structure of Interest Rates
Osmani T. Guillen and Benjamin M. Tabak

Feb/2008

159 Behavior and Effects of Equity Foreign Investors on Emerging Markets
Barbara Alemanni and José Renato Haas Ornelas

Feb/2008

160 The Incidence of Reserve Requirements in Brazil: Do Bank Stockholders Share the Burden?
Fábia A. de Carvalho and Cyntia F. Azevedo

Feb/2008

161 Evaluating Value-at-Risk Models via Quantile Regressions
Wagner P. Gaglianone, Luiz Renato Lima and Oliver Linton

Feb/2008

162 Balance Sheet Effects in Currency Crises: Evidence from Brazil
Marcio M. Janot, Márcio G. P. Garcia and Walter Novaes

Apr/2008

163 Searching for the Natural Rate of Unemployment in a Large Relative Price Shocks’ Economy: the Brazilian Case
Tito Nícias Teixeira da Silva Filho

May/2008

164 Foreign Banks’ Entry and Departure: the recent Brazilian experience (1996-2006)
Pedro Fachada

Jun/2008

165 Avaliação de Opções de Troca e Opções de Spread Européias e Americanas
Giuliano Carrozza Uzêda Iorio de Souza, Carlos Patrício Samanez e Gustavo Santos Raposo

Jul/2008
<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Authors</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>166</td>
<td>Testing Hyperinflation Theories Using the Inflation Tax Curve: a case study</td>
<td>Fernando de Holanda Barbosa and Tito Nícias Teixeira da Silva Filho</td>
<td>Jul/2008</td>
</tr>
<tr>
<td>167</td>
<td>O Poder Discriminante das Operações de Crédito das Instituições Financeiras Brasileiras</td>
<td>Clodoaldo Aparecido Annibal</td>
<td>Jul/2008</td>
</tr>
<tr>
<td>168</td>
<td>An Integrated Model for Liquidity Management and Short-Term Asset Allocation in Commercial Banks</td>
<td>Wenersamy Ramos de Alcântara</td>
<td>Jul/2008</td>
</tr>
<tr>
<td>170</td>
<td>Política de Fechamento de Bancos com Regulador Não-Beneficente: Resumo e Aplicação</td>
<td>Adriana Souza Sales</td>
<td>Jul/2008</td>
</tr>
<tr>
<td>171</td>
<td>Modelos para a Utilização das Operações de Redesconto pelos Bancos com Carteira Comercial no Brasil</td>
<td>Sérgio Mikio Koyama e Márcio Issao Nakane</td>
<td>Ago/2008</td>
</tr>
<tr>
<td>172</td>
<td>Combining Hodrick-Prescott Filtering with a Production Function Approach to Estimate Output Gap</td>
<td>Marta Areosa</td>
<td>Aug/2008</td>
</tr>
<tr>
<td>173</td>
<td>Exchange Rate Dynamics and the Relationship between the Random Walk Hypothesis and Official Interventions</td>
<td>Eduardo José Araújo Lima and Benjamin Miranda Tabak</td>
<td>Aug/2008</td>
</tr>
<tr>
<td>174</td>
<td>Foreign Exchange Market Volatility Information: an investigation of real-dollar exchange rate</td>
<td>Frederico Pechir Gomes, Marcelo Yoshio Takami and Vinicius Ratton Brandi</td>
<td>Aug/2008</td>
</tr>
<tr>
<td>176</td>
<td>Fiat Money and the Value of Binding Portfolio Constraints</td>
<td>Mário R. Páscoa, Myrian Petrassi and Juan Pablo Torres-Martínez</td>
<td>Dec/2008</td>
</tr>
<tr>
<td>177</td>
<td>Preference for Flexibility and Bayesian Updating</td>
<td>Gil Riella</td>
<td>Dec/2008</td>
</tr>
<tr>
<td>178</td>
<td>An Econometric Contribution to the Intertemporal Approach of the Current Account</td>
<td>Wagner Piazza Gagliano and João Victor Issler</td>
<td>Dec/2008</td>
</tr>
<tr>
<td>179</td>
<td>Are Interest Rate Options Important for the Assessment of Interest Rate Risk?</td>
<td>Caio Almeida and José Vicente</td>
<td>Dec/2008</td>
</tr>
<tr>
<td>180</td>
<td>A Class of Incomplete and Ambiguity Averse Preferences</td>
<td>Leandro Nascimento and Gil Riella</td>
<td>Dec/2008</td>
</tr>
<tr>
<td>181</td>
<td>Monetary Channels in Brazil through the Lens of a Semi-Structural Model</td>
<td>André Minella and Nelson F. Souza-Sobrinho</td>
<td>Apr/2009</td>
</tr>
<tr>
<td>182</td>
<td>Avaliação de Opções Americanas com Barreiras Monitoradas de Forma Discreta</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Giuliano Carrozza Uzêda Iorio de Souza e Carlos Patrício Samanez</td>
<td></td>
<td></td>
</tr>
<tr>
<td>183</td>
<td>Ganhos da Globalização do Capital Acionário em Crises Cambiais</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marcio Janot e Walter Novaes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>184</td>
<td>Behavior Finance and Estimation Risk in Stochastic Portfolio Optimization</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>José Luiz Barros Fernandes, Juan Ignacio Peña and Benjamin Miranda Tabak</td>
<td></td>
<td></td>
</tr>
<tr>
<td>185</td>
<td>Market Forecasts in Brazil: performance and determinants</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fabia A. de Carvalho and André Minella</td>
<td></td>
<td></td>
</tr>
<tr>
<td>186</td>
<td>Previsão da Curva de Juros: um modelo estatístico com variáveis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>macroeconômicas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>André Luís Leite, Romeu Braz Pereira Gomes Filho e José Valentim Machado</td>
<td></td>
<td></td>
</tr>
<tr>
<td>187</td>
<td>The Influence of Collateral on Capital Requirements in the Brazilian</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Financial System: an approach through historical average and logistic</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>regression on probability of default</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Alan Cosme Rodrigues da Silva, Antônio Carlos Magalhães da Silva,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Jaqueline Terra Moura Marins, Myrian Beatriz Eiras da Neves and Giovani</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Antonio Silva Brito</td>
<td></td>
<td></td>
</tr>
<tr>
<td>188</td>
<td>Pricing Asian Interest Rate Options with a Three-Factor HJM Model</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Claudio Henrique da Silveira Barbudo, José Valentim Machado Vicente and</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Octávio Manuel Bessada Lion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>189</td>
<td>Linking Financial and Macroeconomic Factors to Credit Risk Indicators of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brazilian Banks</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Marcos Souto, Benjamin M. Tabak and Francisco Vazquez</td>
<td></td>
<td></td>
</tr>
<tr>
<td>190</td>
<td>Concentração Bancária, Lucratividade e Risco Sistêmico: uma</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>abordagem de contágio indireto</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bruno Silva Martins e Leonardo S. Alencar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>191</td>
<td>Concentração e Inadimplência nas Carteiras de Empréstimos dos</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bancos Brasileiros</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Patrícia L. Tecles, Benjamin M. Tabak e Roberta B. Staub</td>
<td></td>
<td></td>
</tr>
<tr>
<td>192</td>
<td>Inadimplência do Setor Bancário Brasileiro: uma avaliação de suas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>medidas</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clodoaldo Aparecido Annibal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>193</td>
<td>Loss Given Default: um estudo sobre perdas em operações prefixadas no</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>mercado brasileiro</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Antonio Carlos Magalhães da Silva, Jaqueline Terra Moura Marins e</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Myrian Beatriz Eiras da Neves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>194</td>
<td>Testes de Contágio entre Sistemas Bancários – A crise do subprime</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Benjamin M. Tabak and Manuela M. de Souza</td>
<td></td>
<td></td>
</tr>
<tr>
<td>195</td>
<td>From Default Rates to Default Matrices: a complete measurement of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Brazilian banks' consumer credit delinquency</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ricardo Schechtman</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The role of macroeconomic variables in sovereign risk
Marco S. Matsumura and José Valentim Vicente
Oct/2009

Forecasting the Yield Curve for Brazil
Daniel O. Cajueiro, Jose A. Divino and Benjamin M. Tabak
Nov/2009

Impacto dos Swaps Cambiais na Curva de Cupom Cambial: uma análise segundo a regressão de componentes principais
Alessandra Pasqualina Viola, Margarida Sarmiento Gutierrez, Octávio Bessada Lion e Cláudio Henrique Barbedo
Nov/2009

Delegated Portfolio Management and Risk Taking Behavior
José Luiz Barros Fernandes, Juan Ignacio Peña and Benjamin Miranda Tabak
Dec/2009

Evolution of Bank Efficiency in Brazil: A DEA Approach
Roberta B. Staub, Geraldo Souza and Benjamin M. Tabak
Dec/2009

Efeitos da Globalização na Inflação Brasileira
Rafael Santos e Márcia S. Leon
Jan/2010

Considerações sobre a Atuação do Banco Central na Crise de 2008
Mário Mesquita e Mario Torós
Mar/2010

Hiato do Produto e PIB no Brasil: uma Análise de Dados em Tempo Real
Rafael Tiecher Cusinato, André Minella e Sabino da Silva Pôrto Júnior
Abr/2010