# Financial Frictions and Business Cycles in Middle Income Countries*

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**Abstract**

Standard DSGE small open economy models have failed to generate the cyclical properties of middle-income countries (MICs). These models, compared to the data, predict excessive consumption smoothing, low procyclicality of investment and procyclical, instead of counter cyclical, real net exports. In the literature the solution to this problem has been to increase the persistence of shocks or to lower the intertemporal elasticity of substitution. This paper tackles this problem by introducing market imperfections relevant for MICs into an otherwise standard model. More specifically, we build a model with limited access to the foreign capital market, identified as an external borrowing constraint, and asymmetric financing opportunities across tradable and non-tradable sectors, identified as sector-specific labor financing wedges. Given the lack of data on the overall economy's net foreign asset position and on sectoral financing costs, the exercise consists on deducing the key parameters associated with these market imperfections to replicate the data for Chile between 1986 and 2004. This exercise permits to lower the discussion to whether the cyclical properties of these variables make sense according to theory, or whether they can be representing some other distortions not identified in the model.

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# 1 Introduction

Empirical analysis suggest three regularities that stand out for MICs: 1) Consumption is highly procyclical and more volatile than output, 2) investment is highly procyclical and three to four times as volatile as output, and 3) real net exports are countercyclical and highly volatile. Standard DSGE small open economy models have failed to match these regularities, as they predict excessive consumption smoothing, low procyclicality and volatility of investment, and procyclical real net exports. Previous studies have atacked these problems by increasing the persistence of shocks (Aguiar and Gopinath [1]) or by setting a lower intertemporal elasticity of substitution, as when utilizing the preferences introduced by Greenwood et. al [26] (GHH henceforth), for which such elasticity is zero (Mendoza [35] and [36], and Neumeyer and Perri [37]).

This study attempts to account for these empirical regularities by recognizing market imperfections that are relevant for MICs; limited access to the foreign capital market, identified as an external borrowing constraint on the households, and asymmetric financing opportunities across tradable and non-tradable firms, identified as sector-specific labor financing wedges (Caballero [12] and Tornell and Westermann [44]). The key parameters associated to these frictions are deduced to match the data for Chile between 1986 and 2004, obeying to the lack of data on the overall economy's net foreign asset position and on sectoral financing costs. However, deducing these parameters permit to lower the discussion to whether the cyclical properties of these variables make sense according to theory, or whether they can be representing some other distortions not identified in the model.

This study concludes that a model with imperfect access to the foreign capital market can capture the procyclical and volatile path of investment, and reproduce the cyclical regularities of real net exports. However, it generates counter cyclical employment and does not increase consumption volatility. Introducing asymmetric financing opportunities across tradable and non tradable firms enables the model to reproduce the cyclical properties of these other variables as well. Moreover, the cyclical properties of the external borrowing constraint multiplier and the sector specific labor financing wedges are consistent with previous studies (Caballero [12] and Tornell and Westermann [44]).

The external borrowing constraint may arise from problems of enforceability and risk of default. Atkeson and Rios-Rull [6] and Caballero and Krishnamurthy [13] identified this friction as a collateral constraint, in which part of the exportable sector's profits or revenues could be seized by external lenders in case of default. Eaton and Gersovitz [19], Bulow and Rogoff [10], Atkeson [5], Kehoe and Levine [29], Kocherlacota [30], Alvarez and Jermann [4] and Jeske [28] considered the exclusion from the external capital market as the punishment by defaulting.

Atkeson [5] presents a nice theoretical justification for an external borrowing constraint in MICs, which will be used in this paper to discuss the implications of such friction. In his study, foreign lending takes place under moral hazard and risk of repudiation. External lenders can not observe whether borrowers are investing the borrowed funds efficiently or consuming them, and sovereign borrowers can repudiate their debt at any time. When there is no moral hazard and risk of repudiation, the optimal contract produces full risk sharing between domestic agents and external lenders. But when these problems exist, external lenders can only infer the domestic agents' allocations after output is realized. The optimal lending contract would reduce risk sharing, trespassing part of the output risk to the domestic borrowers, inducing them to undertake efficient investment decisions and repay their loans.

In this study, and for practical convenience, the constraint is specified as the external lenders' requirement to the domestic households to self finance a fraction $0 < \Psi_t < 1$ of their expenditures with their current income at each date $t$, as in Mendoza [36]. The requirement $(\Psi_t)$ is deduced to match the path of the real net exports in Chile between 1986 and 2004. This specification can replicate the optimal contract under Atkeson [5] setup: Full risk sharing would be equivalent to a sufficiently procyclical $\Psi_t$, so that domestic agents could borrow more relative to income in bad times, smoothing the impact of shocks on their expenditures. With moral hazard and risk of repudiation, the optimal contract would be consistent with a less than sufficiently procyclical $\Psi_t$, thus with less risk sharing. In this case the constraint would always bind to avoid domestic agents building savings that would make them repudiate their debt.

In the simulations for Chile, the external constraint gets slacker when the economy receives positive shocks, and tighter when facing negative shocks, but not enough to produce full risk sharing. External financing becomes more (less) expensive during recessions (booms), increasing the procyclicality and volatility of investment, and reducing the procyclical fluctuations in the exportable output as there is less reallocation of production factors to this sector in response to shocks, making net exports as counter cyclical as in the data. However, introducing only this friction makes employment countercyclical, which is procyclical in the data, and does not increase enough consumption volatility, particularly in the non tradable sector. Counter cyclical labor financing wedges would help the model match these moments by increasing the procyclical fluctuation on labor demand.

The sectoral labor financing wedges reflect credit constraints at the firm level. They may arise from informational, moral hazard or enforcement problems, which could be particularly severe for small and medium size firms with lack of collateral to secure their loans. Holmstrom and Tirole [27] derive them from moral hazard problems, while Bernanke and Gertler [9] do it from costly state verification problems. Albuquerque and Hopenhayn [3] and Medina [32] derive them from enforcement problems. Kiyotaki and Moore [31] and Caballero and Krishnamurthy [13] represent them as collateral constraints.

Tornell and Westermann [44], using firm level data for 27 MICs, find that financing is a more severe obstacle for firms in the non tradable sector to run their businesses, as they are mostly small and medium size firms with lack of collateral to secure their loans. This paper sets this friction as firms' specific labor financing wedges, which represent the cost of paying wages in advance to production as in Chari et al [16]. The wedges can be interpreted as a lending spread over the market interest rate that each firms pays according to their availability of collateral. They are deduced to allow the model replicate output dynamics similar to the data for each sector.

Consistent with economic theory, the resulting wedges are counter cyclical, particularly in the non tradable sector, reflecting a lower cost of domestic financing during booms when the value of firm's collateral increases, and a higher cost during downturns when the opposite valuation effect occurs. The fluctuations in the wedges allow the model generate procyclical employment as labor demand becomes more procyclical and volatile, and increase consumption volatility, particularly of non tradable goods.

Although this study does not endogeneize the source of market imperfections, it presents a simulated scenario for a lower incidence of frictions as to show what would have been the cyclical properties of the economy for an environment of enhanced transparency on economic and financial data, as well as of improved supervision of the financial and corporate sector. The self financing requirement is made more procyclical and volatile to get an invariant borrowing constraint multiplier over time, and the sector specific labor financing wedges cyclical fluctuations are reduced. This exercise shows that the cyclical properties of the economy would be qualitatively similar to the friction less economy case. The volatility of consumption and investment would be smaller, and total hours of work and output of exportable goods would be more procyclical and volatile, resulting in procyclical and less volatile real net exports. This scenario would be welfare improving, as households value a smoother path of consumption over time.

The paper is organized as follows: section 2 presents a discussion of the empirical evidence and related literature, section 3 presents the model and simulations for the standard friction-less economy, sections 4 presents the model and simulations for an externally credit constrained economy, section 5 presents the model and simulations of an economy with asymmetric financing opportunities, section 6 presents the model and simulations for an economy that features both frictions, and Section 7 concludes.

# 2 Empirical Evidence and Related Literature

This section compares some cyclical moments between MICs and small developed economies (SDEs) to highlight those features that are particular to MICs. Table 1 presents selected statistics for output, consumption, investment and real net exports for a sample of 16 SDEs and 28 MICs for annual data between 1980 and 2004. Each series was detrended using the Hodrick-Prescott filter, with a smoothing parameter of 100, and the statistics are calculated over the log-deviation of each variable from its trend. These are the first order autocorrelation and standard deviation of GDP (columns 1 and 2 respectively), and the contemporaneous cross-correlations and relative standard deviations of consumption, investment and real net exports with respect to GDP (columns 3, 4, 5, 6, 7 and 8 respectively).

The first distinct feature of the data is that on average MICs' GDP is almost twice as volatile as in the SDEs, but only slightly less persistent. The second one is that while investment shows roughly the same volatility relative to output in both groups of countries, consumption and real net exports are significantly more volatile relative to output in the MICs than in the SDEs. Finally, the third distinct feature is that all three expenditure items present roughly the same contemporaneous cross-correlation with GDP in both groups of countries.

These findings are robust to different data frequency. Table 2 from Aguiar et al. [1] presents similar evidence at a quarterly frequency for a sample of 13 SDEs and 13 MICs between 1980 and 2003. They find that the same differences in volatility, and similarities in contemporaneous cross-correlations with output, remain when looking at quarterly data, with the only difference on the ratio of real net exports to GDP, which is more countercyclical in the MICs than in the SDEs at quarterly frequency.

One concern with the regularities for MICs presented in tables 1 and 2 is whether they are representative of normal business cycles fluctuations or are biased as result of crises. Although tables 1 and 2 do not abstract from periods of crises, Tornell et al [43] argued that the typical lending booms that characterize MICs business cycles commonly end in a soft landing with the same moments than in periods of crises, although with less volatility. To avoid this problem, this paper studies the case of Chile between 1986 and 2004, abstracting from its last crises in 1982.

Three different approaches have been proposed in the literature to explain the higher volatility of consumption and real net exports in MICs than in SDEs: a lower intertemporal elasticity of substitution of leisure, a higher persistence of shocks, and more severe financial frictions, particularly in the access to the foreign capital market and the domestic financing opportunities across tradable and non tradable sectors. For the first approach, Mendoza [35] and [36] and Neumeyer at al. [37] used DSGE small open economy models to replicate the cyclical moments of Mexico and Argentina respectively. In all three studies the authors approached the problem by setting GHH preferences (Mendoza [36] and Neumeyer et al [37]), or by setting standard preferences with a lower intertemporal elasticity of substitution (Mendoza [35] and Neumeyer et al. [37] in the appendix). The GHH preferences make the labor-leisure decision independent of consumption and wealth, setting it only as a function of real wages. This makes hours of work, and consequently consumption and investment, more procyclical and volatile, and makes real net exports counter cyclical. Standard preferences with a low intertemporal elasticity of substitution of leisure produces roughly the same cyclical moments

Although some empirical studies have estimated a lower intertemporal elasticity of substitution for MICs than for SDEs (Ostry et al. [38] and Barrionuevo [7]), Domeij [18] showed that such estimates would be biased downwards if there are borrowing constraints ignored in the estimation. Applying standard econometric methods on artificial data constructed for credit constrained agents, but ignoring the constraints in the estimation, they estimated an intertemporal elasticity of substitution 50 percent lower than the true elasticity with which the data was built.

For the second approach, Aguiar et al. [1] introduced a permanent shock to the trend growth rate of productivity, into an otherwise standard DSGE small open economy model, to replicate the cyclical regularities of Mexico. Such a model was able to replicate the high volatility of consumption and real net exports observed in the MICs, but relied largely on the strong persistence of the shock to the trend growth of productivity, which creates larger procyclical fluctuations in consumption and investment, and larger counter cyclical fluctuations in real net exports relative to the ones produced by the standard shocks to productivity around a trend.

There is no evidence, however, that foreign or domestic shocks are more persistent in MICs than in SDEs. Although there is no data on total factor productivity across countries, we can infer so by looking at the cyclical properties of output and investment. Presumably, more persistent productivity shocks would result in more persistent fluctuations in output and more procyclical and persistent fluctuations in investment as the marginal productivity of capital varies directly with the shock. However, column 1 in Table 1 shows that output is slightly less persistent in the MICs than in the SDEs, while columns 3 and 4 in Table 3 show that fixed capital formation is less procyclical and persistent in the MICs. For foreign shocks, Table 3, columns 6 and 7, shows that the terms of trade are less persistent in the MICs, although more volatile, while the foreign interest rate shocks should be as persistent and volatile across groups as long as each country's risk premium is endogenous.

Finally, there is some empirical support for the third approach. Caballero [11] studied the source of volatility on three Latin American MICs: Argentina, Chile and Mexico, finding that they were weak in two dimensions: the links with the foreign capital market and the development of the domestic financial market. The former is observed in the low levels of current account deficits compared to a neoclassical benchmark, the large swings in capital flows with little relation to fundamentals, and the high volatility of sovereign spreads. The latter is observed in the high illiquidity of stocks, low levels of M3, claims on the private sector and stock market capitalization. He concluded that these frictions, either directly or by leveraging a variety of shocks, could account for much of fluctuations and crises in modern Latin America.

Tornell et al. [43] and [44] showed evidence of asymmetric financing opportunities across tradable and non tradable firms for a sample of 27 MICs. Estimating an ordered probit model, they found that financing was a more severe obstacle for the non tradable firms to run their businesses, as they were mostly small and medium size firms with lack of collateral to secure their loans. Their result was robust to controlling by the firm's age and share of government's property.

Caballero and Krishnamurthy [10] analyzed the interaction of this two frictions in a stylized model with two types of collateral constraints: Firms in the domestic economy have limited borrowing capacity from international investors, and limited borrowing capacity with each other. The interaction between these two frictions produced two suboptimal allocations. The first is disintermediation: a fire sale of domestic assets causes banks to fail reallocating resources across firms leading to wasted international collateral. The second is a dynamic effect, in which firms with limited domestic collateral and a binding international collateral constraint will not adequately precaution against adverse shocks, increasing their severity. However, they did not evaluate the role of these frictions in a DSGE framework.

Chile is taken as a case study in this paper for three reasons: First, it presents roughly the same cyclical regularities than other MICs, although a lower output volatility. Comparing the moments in Chile between 1986 and 2004 (columns 1 to 4 in Table 6) with those of MICs between 1980 and 2004 (columns 1 to 8 in Table 1), we see that the first order autocorrelation of output is roughly the same, while the standard deviation of output in Chile is about half the average of MICs. Consumption and investment are both a little more procyclical in Chile than in other MICs, but as volatile, while real net exports are more counter cyclical in Chile, but a little less volatile. Second, Chile is frequently cited in the literature by its disciplined economic policy, which makes it reasonable to abstract the analysis from monetary and fiscal policy shocks, reducing the model to a simple exchange - production economy, similar to the ones used by Aguiar [1], Mendoza [35] and [36], and Neumeyer et al [37].

Third, Caballero [11] and [12] discussed the active role of the two financial frictions studied in this paper as source or amplifier of Chile's business cycles during the 1990s. Regarding the limited access to the foreign capital market, he showed that in 1999 consumption and the current account deficit fell more than what could be explained by the negative terms of trade shock, the remaining explained in part by the decline in capital inflows. Regarding the domestic financing opportunities, he showed that domestic banks reacted to the shock by slowing down private loans even though domestic deposits continued growing fast. They substituted private domestic loans by public debt and external assets, and allocated a higher fraction of their credit to large firms, reducing considerably the access to credit to small and medium size firms. Large firms, most of them in the tradable sector, could substitute their financial needs in the domestic financial market, while small and medium size firms, most of them in the non tradable sector, were not able to do so.

The objective of this study is to evaluate quantitatively, in a DSGE framework, whether considering an external borrowing constraint and sector specific labor financing wedges into an otherwise standard small open economy model, can replicate the high volatility of consumption and counter cyclicality of net exports observed in MICs. The model is calibrated and simulated to match the cyclical moments of Chile's between 1986 and 2004. First, a friction-less version of the model is simulated for exogenous shocks to the terms of trade, foreign interest rate and total factor productivity. Then, consecutively each friction is considered separately into the model to quantify its specific role in the domestic cycles. Finally, a model that features both frictions is simulated for the same shocks.

# 3 Model 1: Friction-Less Small Open Economy

Consider a small open economy perfectly integrated to the world in goods, but faces an aggregate upward sloping supply of external funds:

$$R_t = R_t^* + \eta \left(\overline{b} - b_t\right) \tag{1}$$

where $R_t$ is the domestic rate of return, $R_t^*$ the foreign rate of return, $b_t$ is the net foreign assets position, $\overline{b}$ the level of foreign assets at which the risk premium is zero, and $\eta$ the elasticity of such premium with respect to $b_t$. The external interest rate is stochastic, according to the following process:

$$R_t^* = \exp(\varepsilon_t^R) R^* \tag{2}$$

where $R^*$ is its unconditional mean and $\varepsilon_t^R$ its stochastic shock, which follows a first order autoregressive process:

$$\varepsilon_{t+1}^R = \rho^R \varepsilon_t^R + v_{t+1}^R \qquad with \;\; E\left[v_{t+1}^R\right] = 0 \;\; and \;\; V\left[v_{t+1}^R\right] = \sigma_R^2. \tag{3}$$

This is an approximation to a friction-less setup, in which households have free and cost-less access to foreign financing. As noted by Correia et al. [17], when this model is log-linearized around the steady state, it yields a unit root process for consumption, work hours, investment, net exports and net foreign assets. To have a unique steady state it is necessary to anchor the level of external debt in equilibrium. This can be done by setting an upward sloping supply of external funds, a cost function of adjusting the external asset portfolio or an endogenous discount factor. Schmitt-Grohe et al. [40] showed that either form yields the same first and second moments. The first was chosen to be consistent with the later specifications, and $\eta$ was made small to make this model a good approximation of the friction-less setup.

There are three goods in this economy: an exportable ($X$), an importable ($M$) and a non tradable ($N$), and two production factors, labor ($L$) and capital ($K$). The home economy produces the exportable and non tradable goods, using labor and capital inputs. Capital is sector specific and labor is freely mobile across sectors. The law of one price holds for both tradable goods. The external price of the importable good is normalized to one and assumed constant, while the external price of the exportable is stochastic, according to the following process:

$$P_t^X = \exp(\varepsilon_t^{P^X}) P^{X*} \tag{4}$$

where $P^{X*}$ is its unconditional mean and $\varepsilon_t^{PX}$ is the terms of trade shock, which follows a first order auto regressive process:

$$\varepsilon_{t+1}^{PX} = \rho^{PX} \varepsilon_t^{PX} + v_{t+1}^{PX}, \qquad with \;\; E\left[v_{t+1}^{PX}\right] = 0 \;\; and \;\; V\left[v_{t+1}^{PX}\right] = \sigma_{PX}^2 \tag{5}$$

There are two types of domestic agents: households and firms. Households own the firms, consume the non tradable and importable goods, which is also the investment good, and supply labor and capital to the firms. They are the only ones with access to foreign financing. There are two firms, the exportable and the non tradable, both use labor and capital to produce their goods. The economy follows a balanced growth path at the rate of growth $(\gamma - 1)$ and population is constant. In the following, the model is set in stationary form.

## 3.1 Households

Households maximize their lifetime utility 6:

$$U = E_0 \left[ \sum_{t=0}^{\infty} \beta^{*t} \frac{\left\{ c_t^{\alpha} \left(1 - h_t\right)^{1-\alpha} \right\}^{1-\sigma}}{1 - \sigma} \right] \tag{6}$$

where $\beta^* = \beta\gamma^{\alpha(1-\sigma)}$, $\beta$ is the intertemporal discount factor, $h_t$ are the normalized hours of work and $c_t$ is the following CES aggregation of consumption of importable $\left(c_t^M\right)$ and non tradable $\left(c_t^N\right)$ goods:

$$c_t = \left( \varpi c_t^{M\,\rho} + \left(1 - \varpi\right) c_t^{N\,\rho} \right)^{\frac{1}{\rho}} \tag{7}$$

Where $\dfrac{1}{\sigma}$ and $\dfrac{1}{1-\rho}$ are the intertemporal elasticity of substitution and the elasticity of substitution between imported and non traded goods respectively. The upward sloping supply of funds not only reproduces a unique steady state, but also allows the rate of time preference to be different from the external interest rate. Since the international traded bond and capital are the only assets in this economy, markets of contingent claims are incomplete and the economy's wealth varies with the state of nature. The households flow budget constraint is:

$$w_t h_t + q_t^X k_t^X + q_t^N k_t^N + R_t b_t = c_t^M + P_t^N c_t^N + i_t^X + i_t^N + \gamma b_{t+1} \tag{8}$$

where $w_t$ is the wage rate, $q_t^j$ the rental rate of capital in sectors $j = X, N$, $k_t^j$ the capital stock in sectors $j = X, N$, $P_t^N$ the relative price of non tradable to importable goods, and $i_t^j$ the investment expenditures for capital in sectors $j = X, N$. Investment is used to replace depreciated capital, accumulate new capital and cover the capital adjustment costs, according to the following law of motion:

$$\gamma k_{t+1}^j = \left(1 - \delta\right) k_t^j + i_t^j - \frac{\theta}{2}\left(i_t^j\right)^2 \qquad For \;\; j = X, N \tag{9}$$

where $\delta$ is the depreciation rate and $\theta$ the coefficient on the quadratic adjustment costs. Households choose the sequence $\left\{c_t^M, c_t^N, h_t, i_t^X, i_t^N, k_{t+1}^X, k_{t+1}^N, b_{t+1}\right\}_{t=0}^{\infty}$ to maximize 6, subject to 8 and 9. Their first order conditions are:

$$\alpha\varpi\left(\varpi c_t^{M\ \rho}+(1-\varpi)\, c_t^{N\ \rho}\right)^{\frac{\alpha}{\rho}(1-\sigma)-1}(1-h_t)^{(1-\alpha)(1-\sigma)}\, c_t^{M\ (\rho-1)}=\lambda_t \tag{10}$$

$$\alpha(1-\varpi)\left(\varpi c_t^{M\ \rho}+(1-\varpi)\, c_t^{N\ \rho}\right)^{\frac{\alpha}{\rho}(1-\sigma)-1}(1-h_t)^{(1-\alpha)(1-\sigma)}\, c_t^{N\ (\rho-1)}=P_t^N\lambda_t \tag{11}$$

$$(1-\alpha)\left(\varpi c_t^{M\ \rho}+(1-\varpi)\, c_t^{N\ \rho}\right)^{\frac{\alpha}{\rho}(1-\sigma)}(1-h_t)^{\alpha(\sigma-1)-\sigma}=\lambda_t w_t \tag{12}$$

$$\phi_t^X=\lambda_t+\phi_t^X\ \theta\ i_t^X \tag{13}$$

$$\phi_t^N=\lambda_t+\phi_t^N\ \theta\ i_t^N \tag{14}$$

$$\gamma\phi_t^X=\beta E_t\left\{\lambda_{t+1}q_{t+1}^X+\phi_{t+1}^X(1-\delta)\right\} \tag{15}$$

$$\gamma\phi_t^N=\beta E_t\left\{\lambda_{t+1}q_{t+1}^N+\phi_{t+1}^N(1-\delta)\right\} \tag{16}$$

$$\gamma\lambda_t=\beta E_t\left\{\lambda_{t+1}R_{t+1}\right\} \tag{17}$$

$$E_t\left[\lim_{t\to\infty}\beta^t\lambda_t\left(k_{t+1}^X+k_{t+1}^N+b_{t+1}\right)\right]=0 \tag{18}$$

where $\lambda_t$, $\phi_t^X$ and $\phi_t^N$ are the lagrange multipliers on 8 and 9, respectively.

## 3.2 Firms

Both firms have Cobb-Douglas constant return to scale technologies and choose $\left\{h_t^{fj}, k_t^{fj}\right\}_{t=0}^{\infty}$ to maximize profits, with $j=X,N$. Their first order conditions are:

**Non Tradable Firm**

$$w_t=(1-\alpha_N)P_t^N\exp\left(\varepsilon_t^N\right)\left(\frac{k_t^{fN}}{h_t^{fN}}\right)^{\alpha_N} \tag{19}$$

$$q_t^N=\alpha_N P_t^N\exp\left(\varepsilon_t^N\right)\left(\frac{h_t^{fN}}{k_t^{fN}}\right)^{(1-\alpha_N)} \tag{20}$$

**Exportable Firm**

$$w_t=(1-\alpha_X)P_t^X\exp\left(\varepsilon_t^X\right)\left(\frac{k_t^{fX}}{h_t^{fX}}\right)^{\alpha_X} \tag{21}$$

$$q_t^X=\alpha_X P_t^X\exp\left(\varepsilon_t^X\right)\left(\frac{h_t^{fX}}{k_t^{fX}}\right)^{(1-\alpha_X)} \tag{22}$$

Where $\varepsilon_t^j$ is the productivity shock in each sector $j=X,N$ respectively, which follow a first order auto regressive process:

$$\varepsilon_{t+1}^j=\rho^j\varepsilon_t^j+v_{t+1}^j,\qquad with\ \ E\left[v_{t+1}^j\right]=0\ \ and\ \ V\left[v_{t+1}^j\right]=\sigma_j^2 \tag{23}$$

## 3.3 Competitive Equilibrium

Given $b_0$, $k_0^X$ and $k_0^N$, and shocks' processes $\left(\varepsilon_t^R, \varepsilon_t^{P^X}, \varepsilon_t^X, \varepsilon_t^N\right)$, a competitive equilibrium correspond to sequences of allocations $\left\{c_t^M, c_t^N, h_t, i_t^X, i_t^N, k_{t+1}^X, k_{t+1}^N, b_{t+1}\right\}_{t=0}^{\infty}$, $\left\{h_t^{fX}, h_t^{fN}, k_t^{fX}, k_t^{fN}\right\}_{t=0}^{\infty}$ and prices $\left\{P_t^X, P_t^N, q_t^X, q_t^N, w_t, R_t\right\}_{t=0}^{\infty}$, such that:

Given prices, $b_0$, $k_0^X$, $k_0^N$ and shocks' processes, $\left\{c_t^M, c_t^N, h_t, i_t^X, i_t^N, k_{t+1}^X, k_{t+1}^N, b_{t+1}\right\}_{t=0}^{\infty}$ solve the households' problem.

Given prices and shocks' processes, $\left\{h_t^{fX}, k_t^{fX}\right\}_{t=0}^{\infty}$ solve firm X's problem.

Given prices and shocks processes, $\left\{h_t^{fN}, k_t^{fN}\right\}_{t=0}^{\infty}$ solve firm N's problem.

Market clearing conditions are satisfied:

$c_t^N = y_t^N$, $k_t^X = k_t^{fX}$, $k_t^N = k_t^{fN}$ and $h_t = h_t^{fX} + h_t^{fN}$

The resource constraint is satisfied: $R_t b_t + P_t^X Y_t^X - c_t^M - i_t^X - i_t^N - \gamma b_{t+1} = 0$

## 3.4 Steady State and Calibration

The parameters were calibrated to match Chile's average macroeconomic ratios between 1986 and 2004. Table 4 presents them and the ratios in the data and implied by the model in steady state. The external risk premium elasticity $\eta$ was set at 0.001 as in Schmitt-Grohe et al [40], the steady state level of net foreign assets was set at -19 percent of GDP, while $\bar{b}$ was set at 8.8 percent of GDP to get a spread between the domestic and the foreign interest rate of 200 basis points in steady state. The value of $\gamma$ was set equal to 1.056, reflecting the average annual growth of GDP in the sample, while $\beta$ was set at 0.94 according to equation 17 in steady state.

Before calibrating the other parameters, it is necessary to construct the sectoral series of output and hours of work. For output, the sectoral series of GDP from national accounts were allocated as exportable or non tradable following the criteria used by Stockman et al [41] and Mendoza [35]. The exportable sector's GDP was defined as the sum of GDP in the Mining, Agriculture and Forestry, Fishery and Manufacturing sectors, equivalent to 36 percent of GDP, while the non tradable sector's GDP corresponds to the sum of GDP of the Wholesale and Retail Trade, Construction, Electricity, Gas and Water, Financial Services, Housing, Personal Services, Public Administration and Transport, Storage and Communication sectors, equivalent to 64 percent of GDP.

A similar aggregation was used to construct the sectoral series of hours of work. Assuming that the average hours of work per employee is similar across sectors, the relative allocation of total hours of work corresponds to the sectoral allocation of employees. Employment in the exportable sector is defined as the sum of total employees in the Mining, Agriculture, Hunting and Fishery, and Manufacturing sectors, equivalent to 33 percent of total employment, while the non tradable sector's employment corresponds to the sum of total employees in the Construction, Electricity, Gas and

Water, Trade, Transport and Communication, Financial Services and Social Services sectors, equivalent to 67 percent of total employment.

Consumption of non tradable was made equal to non tradable output, while consumption of importable goods is equal to the rest of total consumption. Note that in steady state the current account balance has to be equal to zero, while in the data it is in deficit, which required to adjust some ratios in the model to calibrate a consistent steady state. The ratio of exportable GDP to total GDP was increased from 0.37 in data to 0.40 in the model, the one of investment was reduced from 0.30 in data to 0.29 in the model, and the one of consumption of importable goods was reduced from 0.13 in the data to 0.10 in the model. As result, the ratio of real net exports to GDP was increased from -0.06 in the data to 0.01 in the model.

The relative allocations of hours of work were also adjusted proportionally to be consistent with the adjustments in output. The ratio of hours of work in the exportable sector to total hours of work was increased from 0.33 in the data to 0.36 in the model, while the one of the non tradable sector was reduced from 0.67 in the data to 0.64 in the model. The relative prices of exportable and non tradable goods to the importable one were both set equal to one in steady state.

The values of $\sigma$ and $\rho$ were set as in Mendoza [35] for the industrialized economies[1], while $\alpha$, $\varpi$, $\lambda$, $\phi^X$ and $\phi^N$ were calibrated from equations 10 to 14 in steady state respectively. The capital income shares in the exportable and non tradable sectors, $\alpha_X$ and $\alpha_N$ respectively, were calibrated to generate a sectoral allocation of labor consistent with the adjusted ratios in the model and with an overall capital income share of 0.46, as estimated by Gallego et al [22] and Garcia et al [24]. Table 3 shows that the calibration is consistent with the macroeconomic ratios in the data, except for the adjustments made to calibrate a consistent steady state.

## 3.5 Simulations

### 3.5.1 Shocks processes

The model is simulated for exogenous shocks to the terms of trade, foreign real interest rate and productivity in the exportable and non tradable sectors. The foreign real interest rate is defined as the US Fed Funds rate minus ex-post inflation, and the terms of trade as the ratio of prices of exports to imports of goods and services. The total factor productivity for each sector corresponds to the Solow residual, for which the sectoral series of output described in the previous section were used, while the aggregate and sectoral series of hours of work and capital were constructed.

The series of total hours of work was built using total employment from the National Institute of Statistics and average hours worked per employee from the

[1] The benchmark parameters for industrialized economies were chosen because the ones for the developing economies can be biased due to more severe credit constraints ignored in the estimation.

ILO. The normalized hours of work correspond to the average hours worked times the number of employees, divided by the potential working time of the working age population. Its sectoral allocation was estimated assuming that labor is freely mobile across sectors and that both sectors present Cobb-Douglas production functions with constant return to scale. The sectoral allocation of labor is derived equating its marginal productivity in both sectors according to equation 24:

$$\frac{h_t^N}{h_t^X} = \frac{(1-\alpha_N) P_t^N y_t^N}{(1-\alpha_X) P_t^X y_t^X} \tag{24}$$

The aggregate capital stock ($k_t$) was estimated using the following law of motion:

$$\gamma k_{t+1} = (1-\delta) k_t + i_t - \frac{\theta}{2} i_t^2 \tag{25}$$

Where $k_t$ and $i_t$ are overall capital and fixed capital investment at date $t$ respectively. The sectoral allocation of capital was derived assuming that capital is sector specific, but investment is freely allocable to either sector's capital stock. A three step procedure was used: First, the relative allocation for freely mobile capital was obtained, equating its marginal productivity across sectors according to equation 26:

$$\frac{k_t^N}{k_t^X} = \frac{\alpha_N P_t^N y_t^N}{\alpha_X P_t^X y_t^X} \tag{26}$$

Second, the implicit series of investment were derived from these allocations considering capital as sector specific. Third, a non negativity condition for investment in each sector was checked, finding that the freely mobile allocation was consistent with positive investment in both sectors. Then, acknowledging that sector specific capital would only create one period discrepancies in the sectoral allocation of capital relative to freely mobile capital, it was decided to take the latter as the historical one[2].

Figure 1 presents the trajectories of all four shocks in log deviation from their HP trend between 1986 and 2004. Table 5 presents the autocorrelations, standard deviations, and cross-correlations among the innovations of all four shocks. The persistence of the two productivity shocks and the terms of trade is low, with autocorrelations coefficients ranging between 0.3 and 0.4. Only the foreign real interest rate is more persistent. The terms of trade shocks are the most volatile, with a standard deviation about three times the one of output, while both productivity shocks and foreign real interest rate are less volatile than GDP. Finally, the innovations to all four shocks are positively cross-correlated among them, particularly between both productivity shocks, and between the terms of trade and the foreign real interest rate.

[2] This allocation can be interpreted as optimal if domestic agents could foresee the future shocks and take their investment decisions accordingly.

### 3.5.2 Results

The model was log-linearized around the steady state, thus the variables represent percentage deviations from their steady state values. Table 6, columns (5) to (8), present the cyclical moments of the main aggregates when model 1 is simulated for the shocks described in the previous subsection. When compared to the data, columns (1) to (4), it is appreciated that model 1 predicts an excessive consumption smoothing of both goods, importable and non tradable, a lower volatility and procyclicality of investment, and procyclical, instead of counter cyclical, real net exports.

The households incentives to smooth consumption result in a less procyclical and volatile output of non tradable goods, but in a more procyclical and volatile output of exportable goods. As the temporary terms of trade shocks are the main drivers of the domestic cycles, the economy react to them by reallocating hours of work from (to) the non tradable sector to (from) the exportable sector in response to positive (negative) shocks respectively. Hours of work in the exportable sector are highly procyclical, which contrast with the high counter cyclicality of those in the non tradable sector. At the same time, households react to these shocks by making the aggregate hours of work more volatile and procyclical.

Figure 2 presents the series in the data and simulated by Model 1 between 1986 and 2004. The model predicts a smaller fall in aggregate and non tradable consumption between 1990 and 1991 and between 2001 and 2003, but a lower expansion in them between 1994 and 1998, resulting in the lower procyclicality and volatility relative to the data in Table 6. A similar pattern is observed for investment, for which the model predicts a lower expansion in 1989 and between 1995 and 1998, and a smaller fall between 1991 and 1992 and between 1999 and 2004, which also results in the lower volatility and procyclicality of this variable relative to the data in Table 6.

Aggregate and exportable hours of work present a similar path than the terms of trade shocks, as these are the main driver of the domestic cycles in the model. Households make labor supply more procyclical and volatile than in the data, which together with the large procyclical reallocations of labor from the non tradable to the exportable sector, results in highly volatile and procyclical output and employment in the exportable sector. This, together with the smooth path of consumption and investment result in procyclical, instead of counter cyclical, real net exports.

To highlight the importance of the choice of the intertemporal elasticity of substitution, Table 7 presents simulated moments for the same economy and shocks, but for different values of such elasticity. It shows that lowering such elasticity increases the volatility of consumption, specially of non tradable goods, and makes real net exports counter cyclical as result of more procyclical investment and consumption of importable goods. However, hours of work become too volatile, particularly in the non tradable sector, the volatility of investment never reaches the values of the data, and real net exports become counter cyclical only at the cost of making aggregate consumption too volatile compared to the data.

Table 8 presents a similar exercise, in which besides changing the elasticity of substitution, the coefficient on the adjustment cost of investment ($\theta$) was modified in each case to make the model replicate the volatility of investment in the data. In this case it is still observed that reducing the intertemporal elasticity of substitution increases the volatility of consumption and the counter cyclicality of the real net exports, although not as much as in the previous case. However, the aggregate hours of work are still too volatile and the real net exports are not as counter cyclical as in the data, despite the higher volatility of consumption.

Thus a friction-less DSGE small open economy with standard preferences, and for a wide range of values for the intertemporal elasticity of substitution, is not able to generate the empirical regularities observed in most MICs. For normal values of such elasticity, the model predicts excessive consumption smoothing and procyclical real net exports, while that for lower values of it the model is able to reproduce the counter cyclical pattern of real net exports, but at the cost of making aggregate hours of work and consumption too volatile relative to the data. The next section explores wether adding an external borrowing constraint to this friction-less setup can improve the ability of the model to reproduce these cyclical moments.

# 4 Model 2: Borrowing Constrained Economy

Consider a small open economy perfectly integrated to the world in goods, but faces individual specific external borrowing constraints identified as the external lenders' requirement to the domestic households to finance at least a fraction $\Psi_t$ of their expenditures with their current income at date $t$ (Mendoza [36]):

$$w_t h_t + q_t^X k_t^X + q_t^N k_t^N \geq \Psi_t \left( c_t^M + P_t^N c_t^N + i_t^X + i_t^N - R_t b_t \right) \tag{27}$$

Where the left hand side is the households' current income and the right hand side the minimum fraction of expenditures to be self financed. Combining equations 27 and 8, and imposing equilibrium conditions, this constraint can re-expressed as:

$$b_{t+1} \geq -\frac{1-\Psi_t}{\gamma \Psi_t} \left( P_t^X Y_t^X + P_t^N Y_t^N \right) \tag{28}$$

Such constraint can replicate an optimal contract in a setup as Atkeson [5], in which foreign lending occurs under moral hazard and risk of repudiation. External lenders can not observe if borrowers are investing the borrowed funds efficiently or consuming them, and sovereign borrowers could repudiate their debt at any time. The optimal contract is such that external lenders trespass part of the output risk to the domestic borrowers, inducing them to undertake efficient investment decisions and repay their loans. Furthermore, the external borrowing constraint should always bind to avoid domestic accumulating savings that would induce them not to repay their loans.

When there is no moral hazard and risk of repudiation, the optimal contract produces full risk sharing between domestic agents and external lenders. But when these problems exist, external lenders can only infer the domestic agents' allocations after output is realized. For a bad realization of it, is more likely that a bad allocation of investment was made in the previous period, while that for a good one it is more likely the opposite. The optimal lending contract would reduce risk sharing, trespassing part of the output risk to the domestic borrowers, inducing them to undertake efficient investment decisions and repay their loans.

In our setup, full risk sharing would be equivalent to a sufficiently procyclical $\Psi_t$, so that domestic agents can borrow more relative to income in bad times, smoothing the impact of shocks in their expenditures. An optimal contract with moral hazard and risk of repudiation would be consistent with a less than sufficiently procyclical $\Psi_t$, thus with less expenditures' smoothing. The exercise consists in deducing $\Psi_t$ at each date $t$ to allow the model replicate the net repayment made by households to the foreign lenders, proxied by the path of real net exports in the data. Then, the deduced $\Psi_t$ and the corresponding borrowing constraint multiplier are discussed to see whether they make sense according to theory.

The rest of the model is the same. There are three types of agents: Domestic households and firms, and foreign lenders. Foreign lenders set the borrowing constraint on the domestic households. Domestic households own firms, consume the importable and non tradable goods, and supply labor and capital to the firms. There are two firms, the exportable and the non tradable, which demand capital and labor to produce their goods. The economy follows a balanced growth path and population is assumed constant. In the following, the model is set in stationary terms.

## 4.1 Households

Households choose the sequence $\left\{c_t^M, c_t^N, l_t, i_t, k_{t+1}, b_{t+1}\right\}_{t=0}^{\infty}$ to maximize their lifetime utility 6 subject to 8, 9 and 27. Their first order conditions are:

$$\alpha\varpi\left(\varpi c_t^{M\rho}+(1-\varpi)\,c_t^{N\rho}\right)^{\frac{\alpha}{\rho}(1-\sigma)-1}(1-h_t)^{(1-\alpha)(1-\sigma)}\,c_t^{M(\rho-1)}=(\lambda_t+\mu_t\Psi_t) \tag{29}$$

$$\alpha\,(1-\varpi)\left(\varpi c_t^{M\rho}+(1-\varpi)\,c_t^{N\rho}\right)^{\frac{\alpha}{\rho}(1-\sigma)-1}(1-h_t)^{(1-\alpha)(1-\sigma)}\,c_t^{N(\rho-1)}=P_t^N\,(\lambda_t+\mu_t\Psi_t) \tag{30}$$

$$(1-\alpha)\left(\varpi c_t^{M\rho}+(1-\varpi)\,c_t^{N\,\rho}\right)^{\frac{\alpha}{\rho}(1-\sigma)}(1-h_t)^{\alpha(\sigma-1)-\sigma}=(\lambda_t+\mu_t)\,w_t \tag{31}$$

$$\phi_t^X=(\lambda_t+\mu_t\Psi_t)+\phi_t^X\;\theta\;i_t^X \tag{32}$$

$$\phi_t^N=(\lambda_t+\mu_t\Psi_t)+\phi_t^N\;\theta\;i_t^N \tag{33}$$

$$\gamma\phi_t^X=\beta E_t\left\{\left(\lambda_{t+1}+\mu_{t+1}\right)q_{t+1}^X+\phi_{t+1}^X\,(1-\delta)\right\} \tag{34}$$

$$\gamma\phi_t^N=\beta E_t\left\{\left(\lambda_{t+1}+\mu_{t+1}\right)q_{t+1}^N+\phi_{t+1}^N\,(1-\delta)\right\} \tag{35}$$

$$\gamma\lambda_t = \beta E_t \left\{ \left(\lambda_{t+1} + \mu_{t+1}\Psi_{t+1}\right) R_{t+1} \right\} \tag{36}$$

$$E_t \left[ \lim_{t\to\infty} \beta^t \lambda_t \left( k^X_{t+1} + k^N_{t+1} + b_{t+1} \right) \right] = 0 \tag{37}$$

Where $\lambda_t$, $\phi^X_t$, $\phi^N_t$ and $\mu_t$ are the lagrange multipliers on 8, 9 and 27 respectively.

## 4.2 Firms

Both firms solve the same problem as in Model 1, thus their first order conditions are given by equations 19 and 20 for the non tradable firm and by equations 21 and 22 for the exportable one respectively.

## 4.3 Competitive Equilibrium

Given $b_0$, $k^X_0$ and $k^N_0$, and shocks' processes $\left(\varepsilon^R_t, \varepsilon^{PX}_t, \varepsilon^X_t, \varepsilon^N_t, \Psi_t\right)$, a competitive equilibrium correspond to sequences of allocations $\left\{c^M_t, c^N_t, h_t, i^X_t, i^N_t, k^X_{t+1}, k^N_{t+1}, b_{t+1}\right\}^\infty_{t=0}$, $\left\{h^{fX}_t, h^{fN}_t, k^{fX}_t, k^{fN}_t\right\}^\infty_{t=0}$ and prices $\left\{P^X_t, P^N_t, q^X_t, q^N_t, w_t, R_t\right\}^\infty_{t=0}$, such that:

Given prices, $b_0$, $k^X_0$, $k^N_0$ and shocks' processes, $\left\{c^M_t, c^N_t, h_t, i^X_t, i^N_t, k^X_{t+1}, k^N_{t+1}, b_{t+1}\right\}^\infty_{t=0}$ solve the households' problem.

Given prices and shocks' processes, $\left\{h^{fX}_t, k^{fX}_t\right\}^\infty_{t=0}$ solve firm X's problem.

Given prices and shocks processes, $\left\{h^{fN}_t, k^{fN}_t\right\}^\infty_{t=0}$ solve firm N's problem.

Market clearing conditions are satisfied:
$c^N_t = y^N_t$, $k^X_t = k^{fX}_t$, $k^N_t = k^{fN}_t$ and $h_t = h^{fX}_t + h^{fN}_t$

The resource constraint is satisfied: $R_t b_t + P^X_t Y^X_t - c^M_t - i^X_t - i^N_t - \gamma b_{t+1} = 0$

## 4.4 External Lenders

External lenders are risk neutral and face a complete asset market. Their problem is to maximize their profit function 38 subject to the borrowing constraint they impose over the domestic households 27:

$$\Pi^* = E_0 \left[ \sum_{t=0}^{\infty} Q_t \, \gamma^t \left\{ R_t b_t - (1+\Phi)\gamma b_{t+1} \right\} \right] \qquad With \;\; Q_t = \frac{1}{\prod_{s=0}^{t} R^*_s} \tag{38}$$

where $\Phi$ is the marginal cost of extending new loans. Their first order conditions are:

$$Q_t (1+\Phi) = Q_{t+1} R_{t+1} \left(1 - \mu_{t+1}\Psi_{t+1}\right) \tag{39}$$

which yields the following endogenous upward sloping supply of funds:

$$R_t - R^*_t = R^*_t \Theta + R_t \mu_t \Psi_t \tag{40}$$

This supply of funds does not depend only on net foreign assets as in Model 1, but also on current expenditures and income, all of which get reflected in the multiplier $\mu_t$. As before, this functional form allows the model to have a unique steady state.

## 4.5 Steady State and Calibration

The parameters are calibrated to match Chile's average macroeconomic ratios between 1986 and 2004. These, and the implied macroeconomic ratios from the model in steady state, are the same as in the friction-less setup as the calibrated value of $\mu$ is small. The only difference with respect to Model 1 is that the parameters associated to the previous upward supply of funds $\left(\eta \text{ and } \bar{b} \text{ in equation 1}\right)$ not longer apply, but rather the coefficients associated to the endogenous upward supply of funds ($\Psi$ and $\mu$ in equation 40), which are presented in Table 4.

## 4.6 Simulations

### 4.6.1 Shocks Processes

The self financing requirement $\Psi_t$ is introduced as a shock, and is deduced to allow the model replicate Chile's real net exports between 1986 and 2004. The model is simulated for this shock and for the other four shocks studied in Model 1. Table 7 presents the autocorrelation and standard deviation of $\Psi_t$, as well as the cross-correlation between its innovations and the ones of the other shocks. It shows that $\Psi_t$ is highly persistent, with an autocorrelation of 0.7, and almost twice as volatile as output. Its innovations are positively cross correlated to all other shocks, particularly to the terms of trade and to a lower extent to productivity in the exportable sector. Note that a high cross correlation between the innovations to $\Psi_t$ and the terms of trade is consistent with a high risk sharing between domestic households and foreign lenders when shocks are observable, while the lower cross correlation with the innovations to productivity is consistent with a lower risk sharing when the shocks are not observable.

Figure 3, Panel A, presents the series of $\Psi_t$ and $\mu_t$ between 1986 and 2004. Households were required to self finance an increasing fraction of their expenditures between 1986 and 1995, a decreasing one afterwards until 1998, remaining stable until 2003, and increasing again in 2004. The multiplier shows that the constraint became suddenly more binding in 1990 and 1991, when the domestic economy faced negative shocks to productivity and terms of trade, coinciding with the sharp increase in real net exports in the data. Then, it became continuously slacker when the economy faced positive shocks to productivity and terms of trade (1992 and 1998), coinciding with the continuous deterioration in real net exports observed in this period. Finally, the constraint became suddenly more binding again in 1999 when the economy received negative shocks, and real net exports increased. Thus, this constraint may have contributed to the boom between 1995 and 1998, and to the bust between 1999 and 2003, by not accommodating enough to isolate expenditures from shocks.

### 4.6.2 Results

Table 6, columns (9) to (12), present the cyclical moments when this economy is simulated for shocks to $\Psi_t$, $r_t^*$, $P_t^X$, $z_t^X$ and $z_t^N$. Comparing them to Model 1, columns (5) to (8), we see that Model 2 reproduces better the volatilities of output of exportable and non tradable goods, consumption of importable goods and aggregate investment. It also reduces the excessive volatility of hours of work in the exportable sector, but increases the volatility of the aggregate and non tradable ones relative to the data.

Figure 4 presents the trajectories of these series in the data and the simulations for Model 1 and 3 between 1986 and 2004. It shows that introducing the external borrowing constraint to replicate the path of real net exports in the data, improves the model's ability to reproduce the trajectories of investment, consumption of importable goods and output of exportable. As discussed in Model 1, the low persistence of the terms of trade shocks does not create enough procyclicality and volatility of investment, but the deduced $\Psi_t$ is more persistent and highly correlated to these shocks, increasing the procyclicality and volatility of investment. The tighter constraint between 1990 and 1991, and between 1999 and 2003, increased the spread between the domestic and foreign interest rates, producing larger and longer lasting reductions in investment, while the slacker one between 1992 and 1998 reduced such spread, generating larger and longer lasting expansions on investment.

On the other hand, when the economy receives positive shocks and the constraint gets slacker, as between 1992 and 1998, makes households increase consumption of importable and non tradable goods, and reduce labor effort. The former can be obtained abroad, while the latter has to be produced domestically, generating a reallocation of labor from the exportable to the non tradable sector. The reduction in overall labor effort further reduces employment in the exportable sector and partially compensates the increase in employment in the non tradable one. Thus, the demand for tradable goods increases, and its domestic production falls, relative to the friction-less setup, generating counter cyclical real net exports. A negative shock triggers the opposite.

The main drawback of this setup is that hours of work are counter cyclical and overall and non tradable consumption are smoother than in the data. Figure 5 shows that the simulated hours of work are significantly higher in the period of negative shocks and tighter constraint (1990 - 1991 and 1999 - 2003 respectively) than in the period of positive shocks and slacker constraint (1992-1998), which contributes to generate a smoother path of output and consumption of non tradable goods than in the data. As the counter cyclical fluctuations in work hours are produced by counter cyclical shifts in the labor supply, the next section explores whether considering counter cyclical labor financing wedges across exportable and non tradable firms can produce sufficiently procyclical fluctuations in the labor demand to make the model replicate the cyclical properties of hours of work and output in the data.

# 5 Model 3: Asymmetric Financing Costs

Consider a small open economy perfectly integrated to the world in goods, but faces an aggregate upward sloping supply of external funds given by equation 1. There are two types of domestic agents: households and firms. Households own firms, consume the importable and non tradable goods, and supply labor and capital to the firms. The exportable and non tradable firms demand capital and labor, facing a specific labor financing wedge that captures their asymmetric access to domestic financing.

Chari et al [16] and Appendix 1 show that this specification has the same reduced form than a model in which firms face a collateral credit in advance constraint, in which they need to borrow resources from domestic banks to pay workers in advance to production, and this credit by the firm's specific availability of collateral. This friction is motivated by the evidence found by Tornell et al [43] and [44] about asymmetric financing opportunities across tradable and non tradable firms in MICs, and by similar evidence presented by Caballero [12] specifically for Chile.

Given the lack of data on sectoral financing costs, the exercise consists on deducing the sector specific labor financing wedges that would make the model replicate the trajectories of output of both sectors in the data between 1986 and 2004. The wedges and simulated moments are then discussed to see whether they make sense according to theory. The economy follows a balanced growth path and population is constant. In the following the model is set as stationary.

## 5.1 Households

Households solve the same problem as in the friction-less economy setup, thus their first order conditions are given by equations 10 to 18 respectively.

## 5.2 Firms

Each firm's labor financing wedge is set as augmenting the cost of labor by a fraction $\tau_t^j$, with $j = X, N$ respectively. Their total cost of production is given by 41:

$$q_t^j k_t^j + w_t l_t^j (1 + \tau_t^j) \qquad For \quad j = X, N \tag{41}$$

The costs associated to the wedges are rebated to the households as a lump sum transfer such that the resource constraint remain unchanged with respect to the previous specifications. The firms' static problem is to choose the allocation $\left\{ l_t^j, k_t^j \right\}$ to maximize profits, and their first order conditions are given by:

**Non Tradable Firm**

$$w_t (1 + \tau_t^N) = (1 - \alpha_N) P_t^N \exp\left(\varepsilon_t^N\right) \left( \frac{k_t^N}{l_t^N} \right)^{\alpha_N} \tag{42}$$

$$q_t^N = \alpha_N P_t^N \exp\left(\varepsilon_t^N\right)\left(\frac{l_t^N}{k_t^N}\right)^{(1-\alpha_N)} \tag{43}$$

**Exportable Firm**

$$w_t(1+\tau_t^X) = (1-\alpha_X) P_t^X \exp\left(\varepsilon_t^X\right)\left(\frac{k_t^X}{l_t^X}\right)^{\alpha_X} \tag{44}$$

$$q_t^X = \alpha_X P_t^X \exp\left(\varepsilon_t^X\right)\left(\frac{l_t^X}{k_t^X}\right)^{(1-\alpha_X)} \tag{45}$$

## 5.3 Competitive Equilibrium

Given $b_0$, $k_0^X$ and $k_0^N$, and shocks' processes $\left(\varepsilon_t^R, \varepsilon_t^{P^X}, \varepsilon_t^X, \varepsilon_t^N, \tau_t^X, \tau_t^N\right)$, a competitive equilibrium correspond to sequences of allocations $\left\{c_t^M, c_t^N, h_t, i_t^X, i_t^N, k_{t+1}^X, k_{t+1}^N, b_{t+1}\right\}_{t=0}^{\infty}$, $\left\{h_t^{fX}, h_t^{fN}, k_t^{fX}, k_t^{fN}\right\}_{t=0}^{\infty}$ and prices $\left\{P_t^X, P_t^N, q_t^X, q_t^N, w_t, R_t\right\}_{t=0}^{\infty}$, such that:

Given prices, $b_0$, $k_0^X$, $k_0^N$ and shocks' processes, $\left\{c_t^M, c_t^N, h_t, i_t^X, i_t^N, k_{t+1}^X, k_{t+1}^N, b_{t+1}\right\}_{t=0}^{\infty}$ solve the households' problem.

Given prices and shocks' processes, $\left\{h_t^{fX}, k_t^{fX}\right\}_{t=0}^{\infty}$ solve firm X's problem.

Given prices and shocks processes, $\left\{h_t^{fN}, k_t^{fN}\right\}_{t=0}^{\infty}$ solve firm N's problem.

Market clearing conditions are satisfied:
$c_t^N = y_t^N$, $k_t^X = k_t^{fX}$, $k_t^N = k_t^{fN}$ and $h_t = h_t^{fX} + h_t^{fN}$

The resource constraint is satisfied: $R_t b_t + P_t^X Y_t^X - c_t^M - i_t^X - i_t^N - \gamma b_{t+1} = 0$

## 5.4 Steady State and Calibration

Both wedges, $\tau_t^X$ and $\tau_t^N$, are set as in Model 4 to ensure consistency across specifications, in which the wedge for the non tradable firm in steady state is about one percentage point above the one of the exportable firm. This specification only changes marginally the relative allocation of labor across sectors in steady state, while the other parameters and macroeconomic ratios remain as in Model 1.

## 5.5 Simulations

### 5.5.1 Shocks processes

The labor financing wedges, $\tau_t^X$ and $\tau_t^N$, are introduced as shocks, and deduced so that the model replicates the path of output of exportable and non tradable goods between 1986 and 2004 respectively. The model is simulated for these shocks and for the other four shocks studied in Model 1. Table 10 presents all shocks' autocorrelations, standard deviations and contemporaneous cross-correlations among their innovations.

Note that the non tradable firm's wedge is more persistent and less volatile than the one of the exportable firm. Its innovations are negatively cross-correlated to both productivity shocks and roughly uncorrelated to the terms of trade, while the innovations to the exportable firm's wedge are highly cross-correlated to the terms of trade, and to a lower extent, to productivity. The negative cross-correlation between the wedge and productivity of the non tradable sector is consistent with the hypothesis that the cost of domestic credit for small and medium size firms is lower during booms than during recessions, particularly if the collateral corresponds to a fraction of the firms output. However, the positive cross-correlations between the exportable firm's wedge and the terms of trade is not consistent with theory, and it might be just reducing the excessive reallocation of hours of work across sectors in response to the shocks instead of measuring changes in the cost of domestic financing.

Figure 3, Panel B, presents the deducted trajectories of $\tau_t^X$ and $\tau_t^N$ between 1986 and 2004. The wedge of the non tradable firm $\left(\tau_t^N\right)$ decreased continuously between 1991 and 1998 and increased suddenly in 1999, after which remained stable at high levels until 2004. This mirrors the path of non tradable output, which increased between 1991 and 1998 and fell suddenly in 1999, remaining low until 2004. On the other hand, the labor wedge of the exportable firm $\left(\tau_t^X\right)$ mimics the path of the terms of trade in the data, likely reducing the excessive reallocation of labor across sectors rather than measuring changes in domestic financing costs.

### 5.5.2 Results

Table 11, columns 5 to 8, presents the simulated moments for Model 3, which compared to the data, columns 1 to 4, shows that it does replicate the moments of output in both sectors by construction. Relative to Model 2, Model 3 is more able to reproduce the volatility and procyclicality of aggregate consumption, and total and sectoral hours of work, but not the observed procyclicality and volatility of investment and consumption of importable goods, or the counter cyclicality of real net exports.

Figure 5 presents the series in the data and simulated by models 1 and 3 between 1986 and 2004. As discussed above, Model 3 replicates better aggregate consumption, as the model replicates the path of consumption of non tradable by construction. Also, as the wedges generate a procyclical labor demand, Model 3 replicates better the path of total and non tradable hours of work, in particular the increase in employment between 1994 and 1998, and its sudden fall between 1999 and 2003. It does not, however, capture the path of hours of work in the exportable sector.

The main drawback of Model 3 is that real net exports are procyclical, as the model does not generate sufficiently procyclical and volatile investment and consumption of importable goods. Thus, both financial frictions seem to complement each other: The external borrowing constraint creates a procyclical and volatile demand for imported goods, and a lower reallocation of labor across sectors, while that the labor financing wedges create a more procyclical and volatile consumption of non tradable goods and hours of work. The next section considers both frictions at the same time.

# 6 Model 4: External Borrowing Constraint and Asymmetric Financing Costs

Consider a small open economy perfectly integrated to the world in goods, but with a limited access to the external capital market. There are two types of domestic agents, households and firms, and foreign lenders. Foreign lenders set individual specific borrowing constraints on the domestic households according to equation 27. Households own firms, consume the importable and non tradable goods, and supply labor and capital to the firms. The exportable and non tradable firms demand capital and labor to produce their goods, facing a specific labor financing wedge that captures their asymmetric access to domestic financing.

As in Models 2 and 3, the exercise consists on deducing the self financing requirement $\Psi_t$ and the sector specific labor financing wedges, $\tau_t^X$ and $\tau_t^N$, that would allow the model replicate the trajectories of real net exports and output of exportable and non tradable goods in the data between 1986 and 2004 respectively. The cyclical properties of $\Psi_t$, $\tau_t^X$ and $\tau_t^N$, as well as the simulated moments from the model are then compared to those of Models 2 and 3, and discussed to see whether they make sense according to theory. The economy follows a balanced growth path and population is constant. In the following the model is set as stationary.

## 6.1 Households

Households solve the same problem as in Model 2, thus their first order conditions are given by equations 29 to 37 respectively.

## 6.2 Firms

Both firms solve the same problem as in Model 3, thus their first order conditions are given by equations 42 and 43 for the non tradable firm, and by equations 44 and 45 for the exportable firm respectively.

## 6.3 Competitive Equilibrium

Given $b_0$, $k_0^X$ and $k_0^N$, and shocks' processes $\left(\varepsilon_t^R, \varepsilon_t^{PX}, \varepsilon_t^X, \varepsilon_t^N, \Psi_t, \tau_t^X, \tau_t^N\right)$, a competitive equilibrium correspond to sequences of allocations $\left\{h_t^{fX}, h_t^{fN}, k_t^{fX}, k_t^{fN}\right\}_{t=0}^{\infty}$, $\left\{c_t^M, c_t^N, h_t, i_t^X, i_t^N, k_{t+1}^X, k_{t+1}^N, b_{t+1}\right\}_{t=0}^{\infty}$ and prices $\left\{P_t^X, P_t^N, q_t^X, q_t^N, w_t, R_t\right\}_{t=0}^{\infty}$, such that:

Given prices, $b_0$, $k_0^X$, $k_0^N$ and shocks' processes, $\left\{c_t^M, c_t^N, h_t, i_t^X, i_t^N, k_{t+1}^X, k_{t+1}^N, b_{t+1}\right\}_{t=0}^{\infty}$ solve the households' problem.

Given prices and shocks' processes, $\left\{h_t^{fX}, k_t^{fX}\right\}_{t=0}^{\infty}$ solve firm X's problem.

Given prices and shocks processes, $\left\{h_t^{fN}, k_t^{fN}\right\}_{t=0}^{\infty}$ solve firm N's problem.

Market clearing conditions are satisfied:
$c_t^N = y_t^N$, $k_t^X = k_t^{fX}$, $k_t^N = k_t^{fN}$ and $h_t = h_t^{fX} + h_t^{fN}$

The resource constraint is satisfied: $R_t b_t + P_t^X Y_t^X - c_t^M - i_t^X - i_t^N - \gamma b_{t+1} = 0$

## 6.4 Steady State and Calibration

The self financing requirement $\Psi_t$ is set as in Model 2, while both wedges, $\tau_t^X$ and $\tau_t^N$, are set such that they are always greater or equal to zero[3]. The non tradable firm's wedge in steady state is about one percentage point above the one of the exportable firm, changing only marginally the relative allocation of labor across sectors, while the other parameters and macroeconomic ratios remain as in Models 1 and 2.

## 6.5 Simulations

### 6.5.1 Shocks processes

As before, $\Psi_t$, $\tau_t^X$ and $\tau_t^N$ are introduced as shocks, and deduced so that the model replicates the path of real net exports and sectoral output in the data between 1986 and 2004 respectively. The model is simulated for these shocks and for the shocks to $r_t^*$, $P_t^X$, $z_t^X$ and $z_t^N$. Table 12 presents all shocks' autocorrelations, standard deviations and contemporaneous cross-correlations among their innovations.

The new $\Psi_t$ presents roughly the same moments as in Model 2, while the new wedges are slightly less persistent than in Model 3, but more volatile particularly in the non tradable sector. The innovations to both wedges are highly cross-correlated, while in Model 3 they were uncorrelated, suggesting that the exportable firm's wedge is now playing a smaller role in reducing the excessive reallocation of labor across sectors, as the external borrowing constraint reduces the incentives to do so.

As in Model 3, the innovations to the non tradable firm's wedge are negatively correlated to productivity in both sectors, but now they are also negatively correlated to the terms of trade and roughly uncorrelated to the innovations to $\Psi_t$. The innovations to the exportable firm's wedge are no longer as correlated to the terms of trade, but are highly correlated to the innovations to $\Psi_t$. The lower but still high correlation with $P_t^X$ shows that although the external credit constraint reduces the incentive for labor reallocation across sectors, the wedge is still playing some role in doing so. The high correlation with the innovations to $\Psi_t$ could reflect a spurious correlation, as the innovations to $\Psi_t$ and $P_t^X$ are highly cross-correlated.

[3] In fact, they are equal to zero in 1998, and grater than zero in all other years in the sample.

Figure 6 presents the deduced trajectories of $\Psi_t$, $\mu_t$, $\tau_t^X$ and $\tau_t^N$ between 1986 and 2004. Panel A shows that the labor financing wedges do not affect how the external borrowing constraint affects households, as the self financing requirement and borrowing constraint multiplier present a similar path as in Model 2. Panels B shows that although the new non tradable wedge is more volatile than in Model 3, it presents roughly the same path than before, falling continuously between 1991 and 1998, raising suddenly in 1999 and remaining high until 2004. The new exportable wedge, however, is more similar to the one of the non tradable firm, although higher in the years of large positive terms of trade shocks, suggesting that it is more representative of the cost of domestic financing for that sector than in Model 3.

The path of both wedges is similar to the external borrowing constraint multiplier, with a cross-correlation of 0.7, suggesting that both frictions are related. According to Appendix 1, a high correlation between $\tau_t^j$ and $\mu_t$ would suggest that the firm $j$'s cost of financing will not only vary with the domestic interest rate, but also with additional direct changes in its specific lending spread. When the economy faces negative shocks and a tighter external borrowing constraint, the firms' domestic financing becomes more expensive not only because the domestic interest rate increases above the foreign one, but also because the firm's specific lending spread over the domestic rate raises. At the same time, domestic financing becomes cheaper when the economy faces positive shocks and a slacker external borrowing constraint, as the domestic interest rate and the firms' specific lending spread fall.

### 6.5.2 Results

Table 11, columns 9 to 12, presents the simulated moments for Model 4, which match the moments in the data for real net exports and output of both sectors by construction. Relative to Models 2 and 3, this specification reproduces better the volatility and procyclicality of aggregate consumption and investment, as well as the observed counter cyclicality and volatility of real net exports. Although it also replicates better the observed volatility and cross-correlation with output of hours of work in the exportable and non tradable sectors, it does so at the cost of over estimating the volatility and procyclicality of total hours of work.

Figure 7 present the time series in the data and simulated by models 2 and 4 between 1986 and 2004. As previously discussed, Model 4 replicates better aggregate consumption as it replicates the path of consumption of non tradable goods in the data by construction. It also replicates better the path of investment and consumption of importable goods, which is required to reproduce the counter cyclical path of real net exports in the data. Regarding total hours of work, Model 4 under estimates employment in 1991, when the borrowing constraint multiplier and wedges are highest, and underestimate employment in 1997 and 1998, when both were lower. As the procyclical labor demand generated by the counter cyclical labor financing wedges more than offset the counter cyclical labor supply generated by the external borrowing constraint, employment becomes more procyclical and volatile than in the data, particularly in the non tradable sector.

This exercise suggests that an adequate characterization of Chile's business cycles since the mid 1980's, and of those of most MICs, should consider the two financial frictions considered in this section, a external borrowing constraint and sector specific labor financing wedges. The former makes investment and consumption of importable goods more procyclical and volatile, reduces the excessive reallocation of labor across sectors, and makes real net exports as counter cyclical and volatile as in the data The latter makes hours of work and consumption of non tradable goods as procyclical and volatile as in the data, which together with the more procyclical and volatile consumption of importable goods results in a better reproduction of the cyclical properties of aggregate consumption as well.

## 6.6 Lower incidence of Frictions

Although this study does not endogeneize the source of the market imperfections considered to draw policy implications, it presents a simulated scenario for a lower incidence of frictions as to give a sense of what would have been the cyclical properties of the economy for an environment of enhanced transparency on economic and financial data, as well as of improved supervision of the financial and corporate sector. The self financing requirement is made more procyclical and volatile to get an invariant borrowing constraint multiplier over time, and the standard deviations of the sector specific labor financing wedges are reduced to a thirty percent of its value in the data. Figure 8 presents the trajectories of this variables, showing that $\Psi_t$ should have been higher than in Model 4 between 1996 and 2001, but lower in 2002 and 2003.

Table 13 presents the autocorrelations, standard deviations and cross-correlations of innovations in this new set of shocks. Two distinct features arise from this exercise. First, $\Psi_t$ should have been a little less persistent, but a little more volatile, to obtain a higher degree of risk sharing between the domestic households and the external lenders. Second, a higher risk sharing would have also required a higher correlation between $\Psi_t$ and the shocks to the terms of trade and productivity in both sectors.

Figure 9 and Table 14 present the trajectories and cyclical moments of the main macroeconomic variables in the data, Model 4 and the hypothetical reduced incidence of frictions scenario. It shows that the cyclical properties of the economy would be qualitatively similar to the friction less economy case. The volatility of consumption and investment would have been smaller, and total hours of work and output of exportable goods would have been more procyclical and volatile, resulting in procyclical and less volatile real net exports. This scenario would have also been welfare improving compared to the data and Model 4, as households value a smoother path of consumption over time.

# 7 Conclusions

Business cycles in middle income countries are characterized by a highly procyclical and volatile consumption and by counter cyclical and volatile real net exports. Standard DSGE small open economy models have failed reproducing these features, as they predict an excessive consumption smoothing, and procyclical, instead of countercyclical, real net exports. Previous work have approached the problem either by increasing the persistence of shocks or by lowering the intertemporal elasticity of substitution, as when setting GHH preferences.

This study shows that data and theory can be reconciled, without changing preferences or shocks' persistence, if two market frictions relevant for MICs are considered into an otherwise standard DSGE small open economy model: An imperfect access to the foreign capital market and asymmetric financing opportunities across tradable and non tradable firms. The former, identified as an external borrowing constraint on the households, generates more procyclical and volatile investment and consumption of importable goods, reduces the excessive reallocation of labor between the exportable and non tradable sectors and lowers the volatility of exportable output, resulting in counter cyclical and volatile real net exports. However, it produces counter cyclical employment, and does not increase enough consumption volatility.

The asymmetric financing opportunities across sectors, identified as sector specific labor financing wedges, create procyclical fluctuations in the labor demand, increasing the procyclicality and volatility of hours of work and output of non tradable goods, and through this increases the procyclicality and volatility of aggregate consumption. The exercise suggests that an adequate characterization of Chile's business cycles since the mid 1980's, and probably of those of most MICs, should consider the role played by these two frictions, as they seem to complement each other to generate the observed regularities in the data.

Finally, although this study does not endogeneize the source of the market imperfections considered to draw policy implications, it presents a simulated scenario for a lower incidence of frictions to give a sense of the cyclical properties of the economy for an environment of enhanced transparency on economic and financial data, as well as of improved supervision of the financial and corporate sector. The self financing requirement is made more procyclical and volatile to get a constant borrowing constraint multiplier over time, and the sector specific labor financing wedges cyclical fluctuations are reduced. This exercise shows that the cyclical properties of the economy would be qualitatively similar to the friction less economy case, the volatility of consumption and investment would be smaller, and total hours of work and output of exportable goods would be more procyclical and volatile, resulting in procyclical and less volatile real net exports. This would have been welfare improving, as households value a smoother path of consumption over time.

# Appendix

### 7.0.1 Labor Financing Wedges Based on Collateral Constraints

Consider a small open economy perfectly integrated to the world in goods, but faces individual specific external borrowing constraints identified as the external lenders requirement to the domestic households to finance at least a fraction $\Psi_t$ of their expenditures with their current income at date $t$ according to equation 27.

There are four types of agents in this environment: Foreign lenders and domestic households, firms and banks. The foreign lenders set the individual specific external borrowing constraints on the domestic households. Households own firms and banks, consume the importable and non tradable goods, and supply labor and capital to the firms. They supply funds infinitely elastically to internal banks within the period at the internal rate of return $R_t$, and demand funds infinitely elastically from the firms within the period at the same rate.

There are two firms, the exportable and the non tradable. Both have constant return to scale Cobb-Douglas technologies, and use labor and capital as inputs. They pay their wages before production is realized, facing a credit in advance constraint in the domestic financial market. The timing is as follows: Firms get credit from the banks at the beginning of each period at a rate of return $R_t^{lj}$ with $j = X, N$, but have to pay wages only at the end of the period, just before production is materialized. Thus, after receiving the loan, they can lend it to the households intraperiod at the rate of return $R_t$, which results in a net interest cost of the loan of $R_t^{lj} - R_t \geq 0$.

Banks face an infinitely elastic supply of deposits from households within the period at the rate of return $R_t$, and lend to each firm subject to firms' specific collateral constraints. The collateral corresponds to the fraction of the firm's output they can seize at the end of the period, once production is realized. This results in a lending rate $R_t^{lj}$ with $j = X, N$ greater than the domestic rate of return $R_t$. All costs caused by this distortion are rebated to the households as a lump sum transfer such that the resource constraint does not change. The economy follows a balanced growth path and population is constant. In the following the model is set in stationary terms.

**Households** The households problem is the same as in Model 2, thus they choose the sequence $\left\{c_t^M, c_t^N, l_t, i_t^X, i_t^N, k_{t+1}^X, k_{t+1}^N, b_{t+1}\right\}_{t=0}^{\infty}$ to maximize 6 subject to 8, 9 and 27. Their first order conditions are given by equations 29 to 37 respectively.

**Firms** Both firms get the credit at the beginning of each period, after the shocks are realized, and repay it at the end of the same period once production is realized. They lend this credit within the period to the households at the rate of return $R_t$. As the lending rate of return $R_t^{lj}$ is greater than the domestic rate of return $R_t$, their optimal decision is to hold just the necessary credit to pay wages in advance in each period. Thus, the credit in advance constraint is satisfied in equality:

$$z_t^j = w_t l_t^j \qquad For \quad j = X, N \tag{46}$$

Where $z_t^j$ is the credit received by firm $j$ from the domestic banks. The total cost of production for each firm is:

$$w_t l_t^j (1 + R_t^{lj} - R_t) + q_t^j k_t^j \qquad For \quad j = X, N \tag{47}$$

The static problem for each firm is to choose the allocation $\left\{l_t^j, k_t^j\right\}$ in each period to maximize profits. Their first order conditions are:

**Non Tradable Firm**

$$w_t(1 + R_t^{lN} - R_t) = (1 - \alpha_N) P_t^N \exp\left(\varepsilon_t^N\right) \left(\frac{k_t^N}{l_t^N}\right)^{\alpha_N} \tag{48}$$

$$q_t^N = \alpha_N P_t^N \exp\left(\varepsilon_t^N\right) \left(\frac{l_t^N}{k_t^N}\right)^{(1-\alpha_N)} \tag{49}$$

**Exportable Firm**

$$w_t(1 + R_t^{lX} - R_t) = (1 - \alpha_X) P_t^X \exp\left(\varepsilon_t^X\right) \left(\frac{k_t^X}{l_t^X}\right)^{\alpha_X} \tag{50}$$

$$q_t^X = \alpha_X P_t^X \exp\left(\varepsilon_t^X\right) \left(\frac{l_t^X}{k_t^X}\right)^{(1-\alpha_X)} \tag{51}$$

**Banks** The banking industry is perfectly competitive. The role of banks is to take deposits from the households and lend them to the firms, for which they need to secure the loans with collateral. Banks can only seize a fraction $\Omega_t^j$ of firm $j$'s output at the end of the period, which is the collateral. Thus, they face the following constraint when allocating the loans:

$$\Omega_t^j Y_t^j \geq z_t^j \qquad For \quad j = X, N \tag{52}$$

The banks static problem is to choose the allocation $\left\{z_t^X, z_t^N\right\}$ in each period to maximize their profits. Their first order conditions are:

$$R_t^{lX} - R_t = \eta_t^X \tag{53}$$

$$R_t^{lN} - R_t = \eta_t^N \tag{54}$$

Where $\eta_t^X$ and $\eta_t^N$ are the lagrange multipliers on 52, for X and N respectively.

**Competitive Equilibrium** Given initial values of foreign assets $b_0$, capital $k_0^X$ and $k_0^X$ and shocks' processes $\left(\varepsilon_t^R, \varepsilon_t^{PX}, \varepsilon_t^X, \varepsilon_t^N, \Psi_t, \Omega_t^X, \Omega_t^N\right)$, a competitive equilibrium is a sequence of allocations $\left\{c_t^M, c_t^N, l_t, l_t^X, l_t^N, i_t^X, i_t^N, k_{t+1}^X, k_{t+1}^N, b_{t+1}, z_t^X, z_t^N\right\}_{t=0}^{\infty}$ and prices $\left\{P_t^X, P_t^N, q_t^X, q_t^N, w_t, R_t, R_t^{lX}, R_t^{lN}\right\}_{t=0}^{\infty}$, such that:

Given prices, $b_0$, $k_0^X$, $k_0^X$ and shocks' processes, $\left\{c_t^M, c_t^N, l_t, i_t^X, i_t^N, k_{t+1}^X, k_{t+1}^N, b_{t+1}\right\}_{t=0}^{\infty}$ solve the household's problem.

Given prices and shocks' processes, $\left\{l_t^X, k_t^X, z_t^X\right\}_{t=0}^{\infty}$ solve firm X's problem.

Given prices and shocks processes, $\left\{l_t^N, k_t^N, z_t^N\right\}_{t=0}^{\infty}$ solve firm N's problem.

Given prices and shocks processes, $\left\{z_t^X, z_t^N\right\}_{t=0}^{\infty}$ solve bank's problem.

Market clearing conditions are satisfied: $c_t^N = y_t^N$, and $l_t = l_t^X + l_t^N$.

The resource constraint is satisfied: $R_t b_t + P_t^X Y_t^X - c_t^M - i_t^X - i_t^N - \gamma b_{t+1} = 0$

### 7.0.2 Equivalence to Labor Financing Wedges

Note that the reduced for of this model is the same as the one of Model 4, with $\tau_t^j = \eta_t^j = R_t^{lX} - R_t$. Thus, the sector specific labor financing wedges deducted in Models 3 and 4 can be interpreted as the spread that each firm pays by its credit over the domestic interest rate.

Figure 1. Chile: Main Domestic and External Shocks.

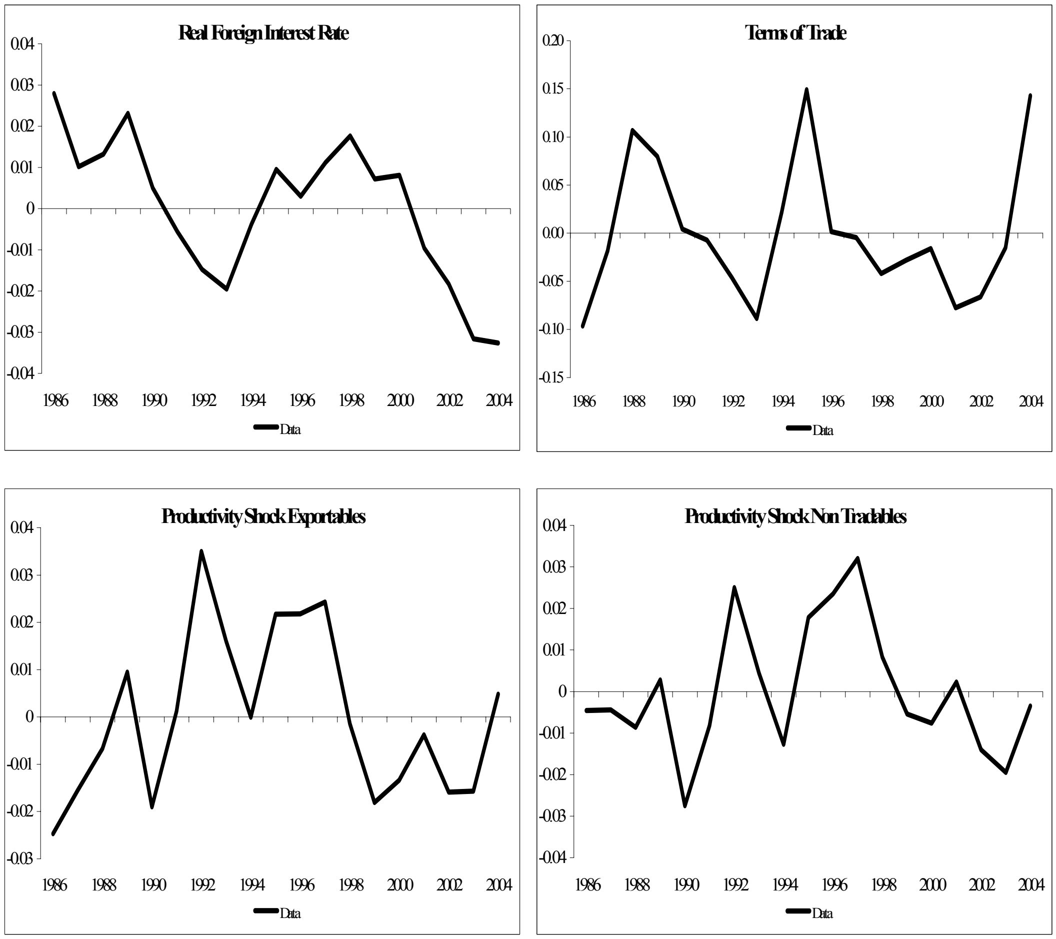


Figure 2. Data and Model 1 Simulations.

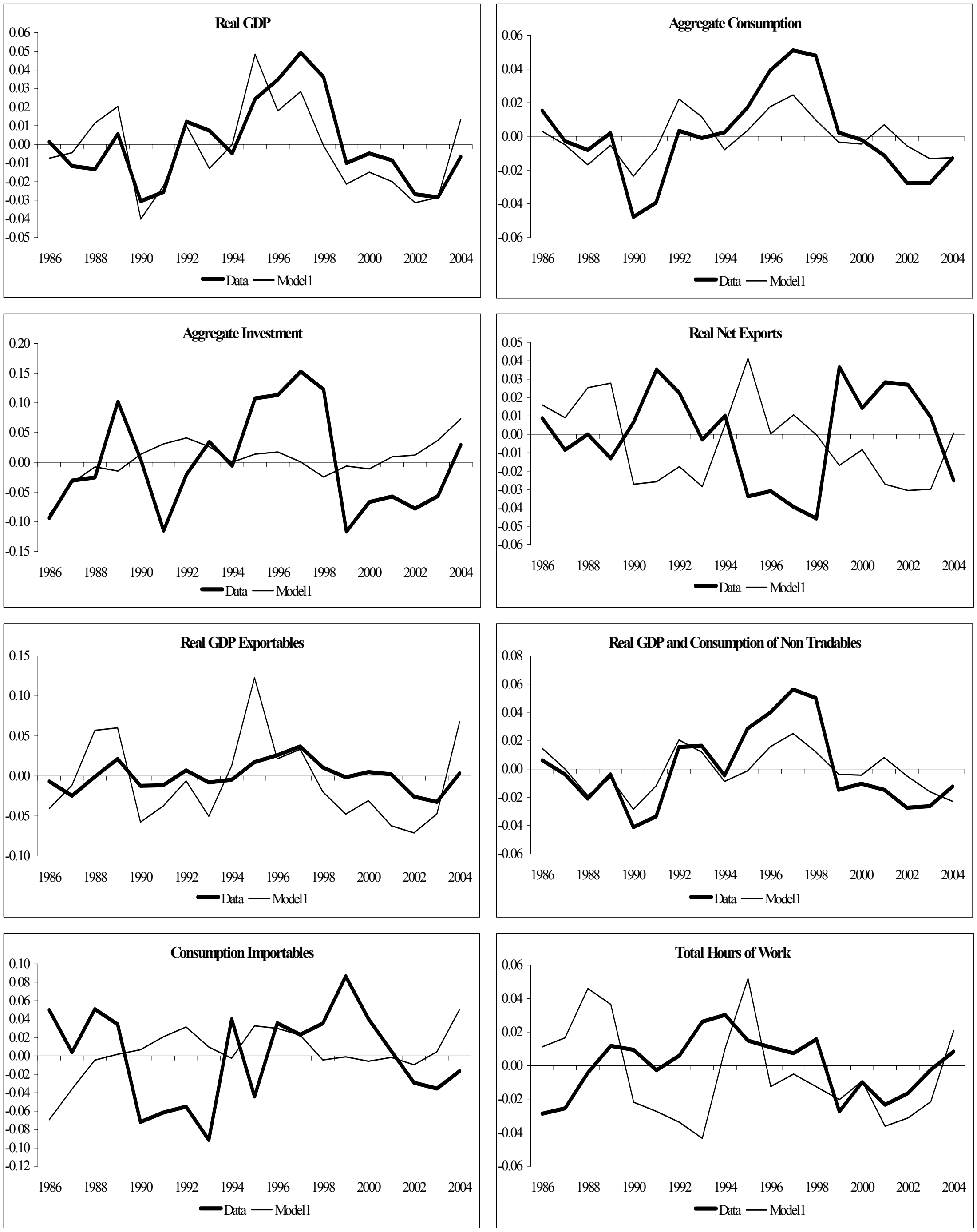
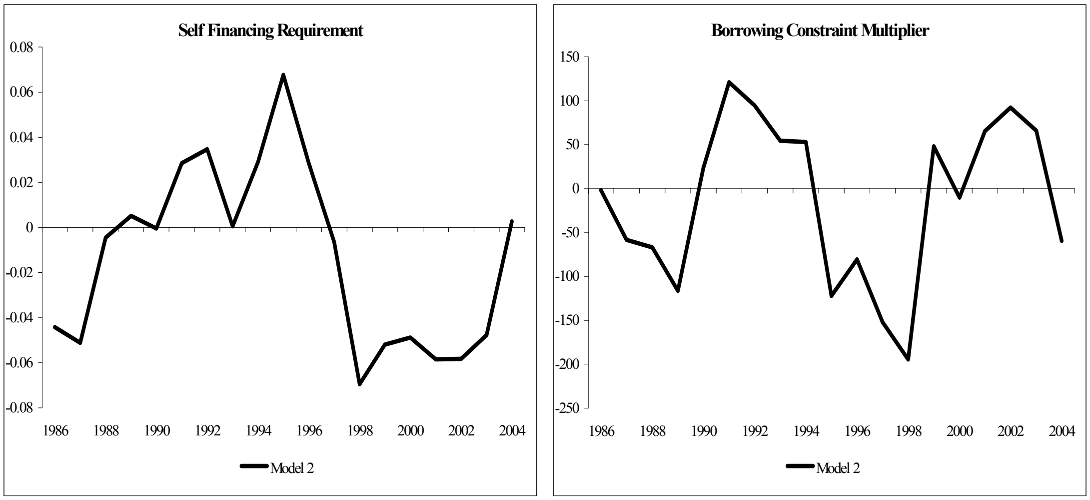


Figure 2. Data and Model 1 Simulations (Continuation)

Figure 3. Self Financing Requirement and Labor Financing Wedges

**Panel A**




**Panel B**

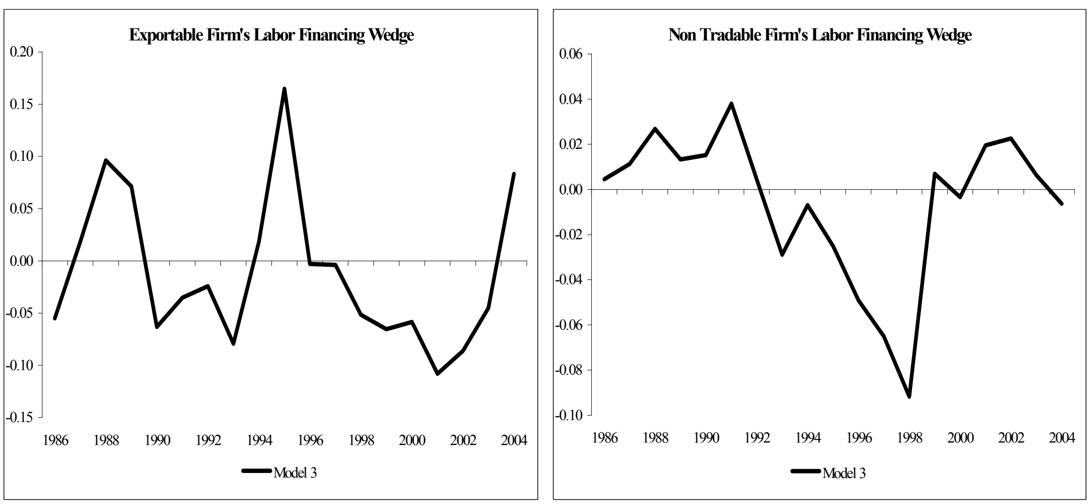


Figure 4. Data, Model 1 and Model 2 Simulations.

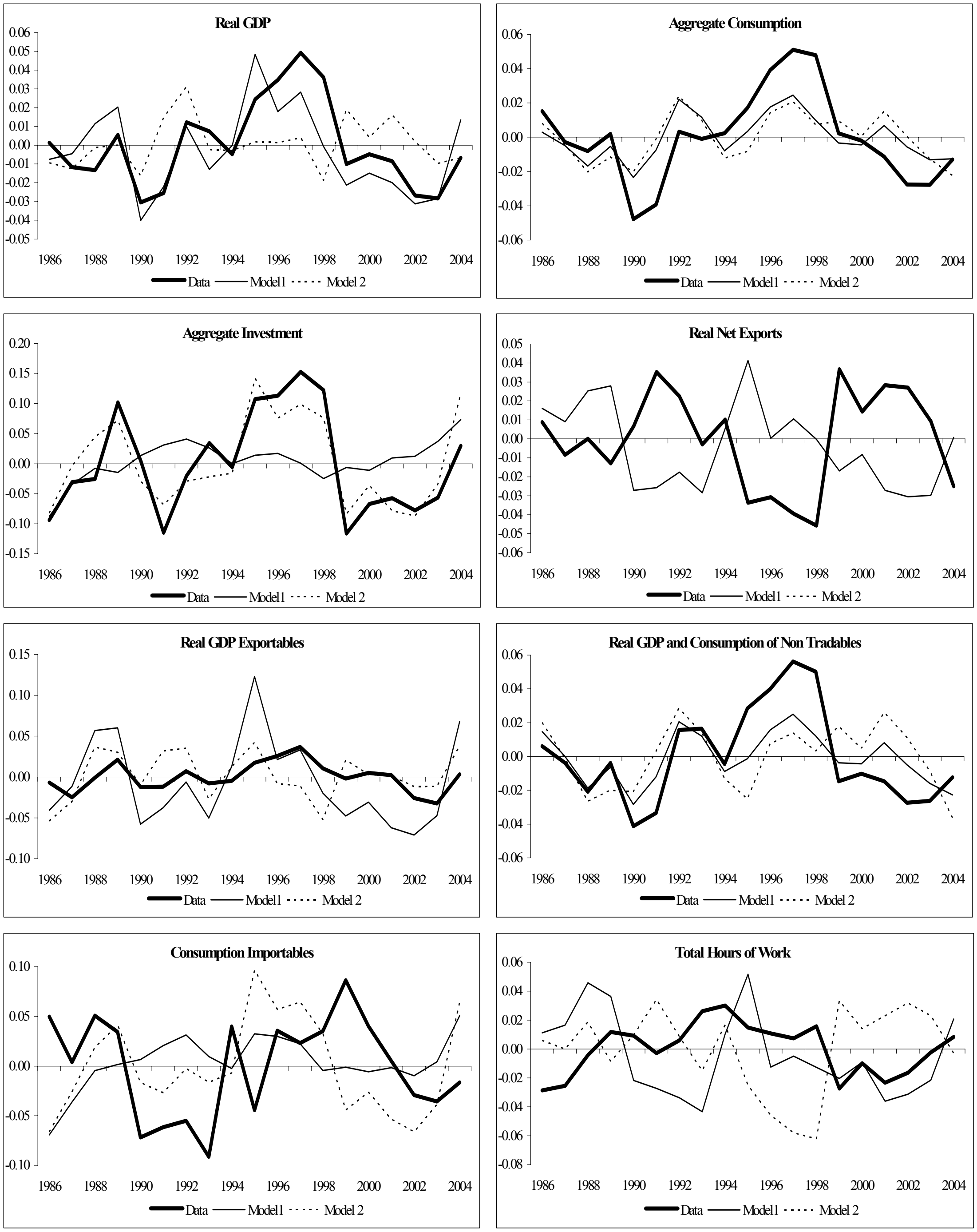


Figure 4. Data, Model 1 and Model 2 Simulations (Continuation).

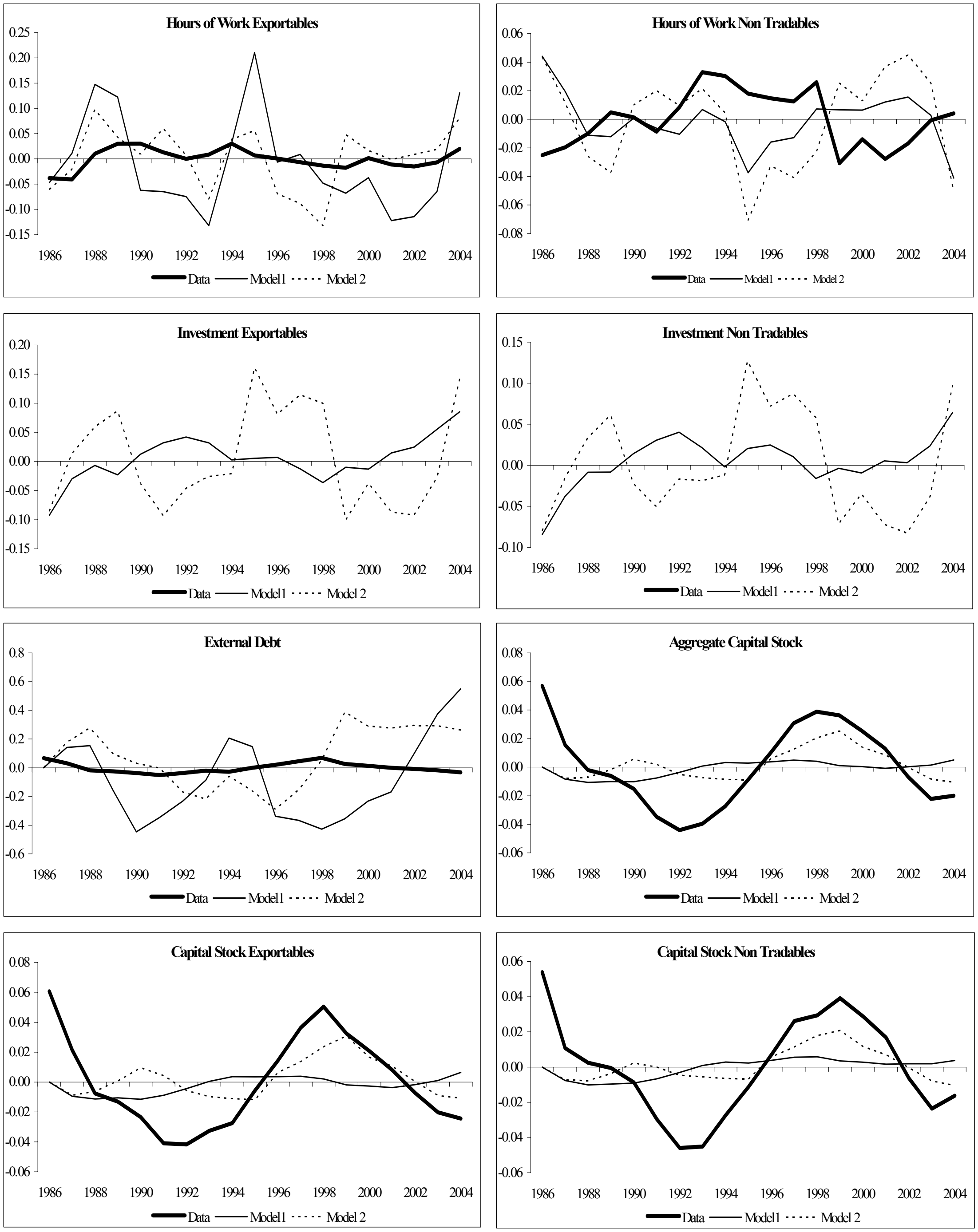


Figure 5. Data, Model 1 and Model 3 Simulations.

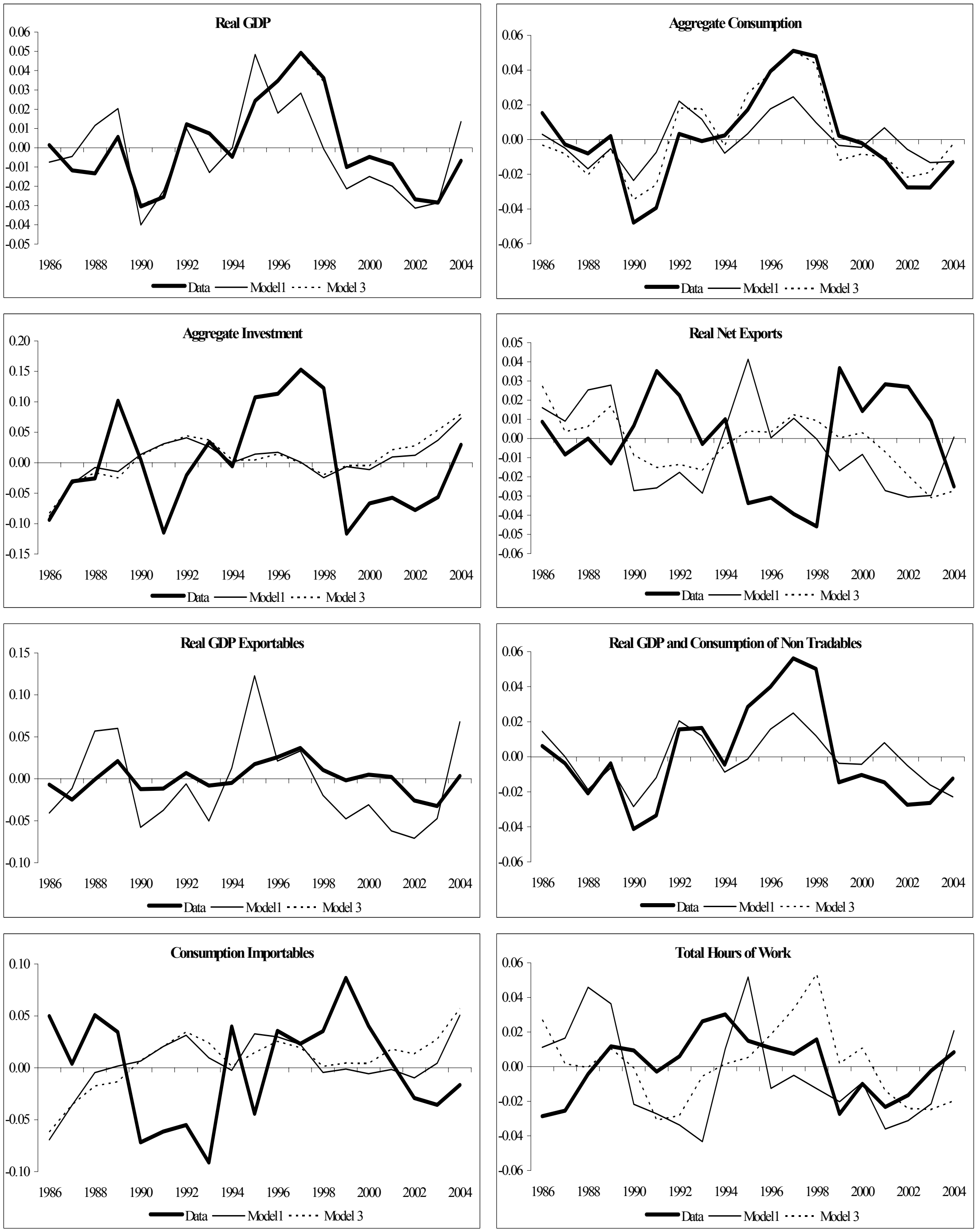


Figure 5. Data, Model 1 and Model 3 Simulations (Continuation).

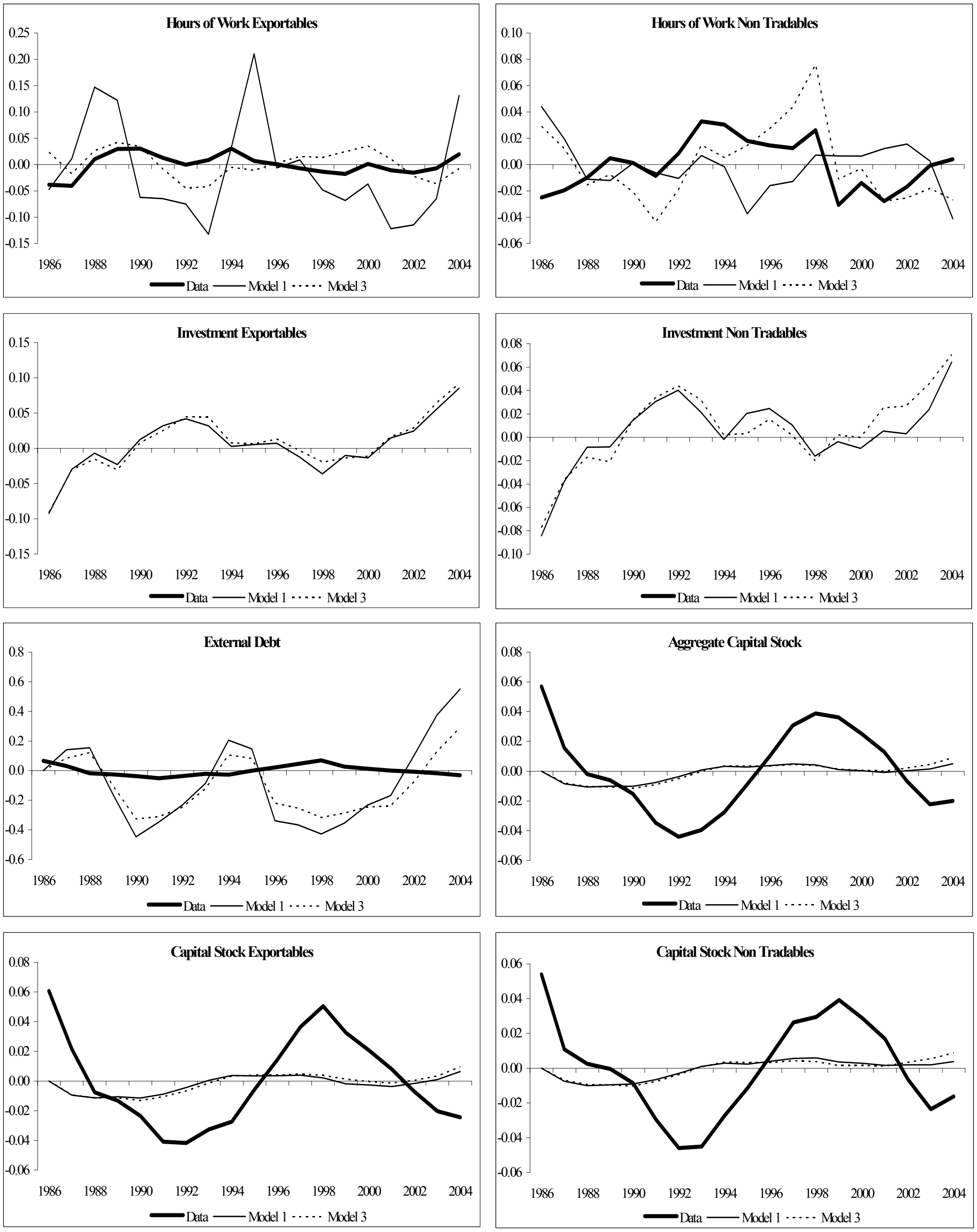
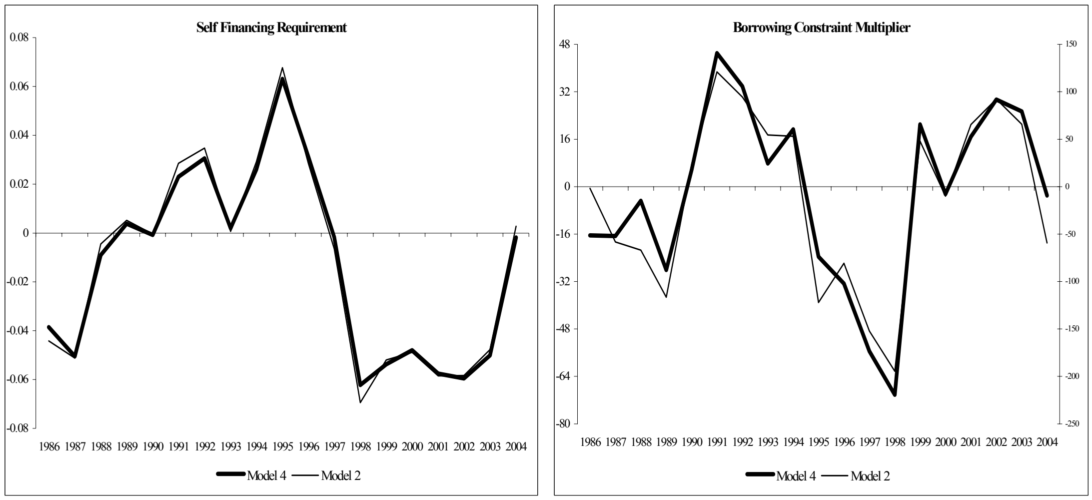


Figure 6. Self Financing Requirement and Labor Financing Wedges.

**Panel A**




**Panel B**

Figure 7. Data, Model 2 and Model 4 Simulations.

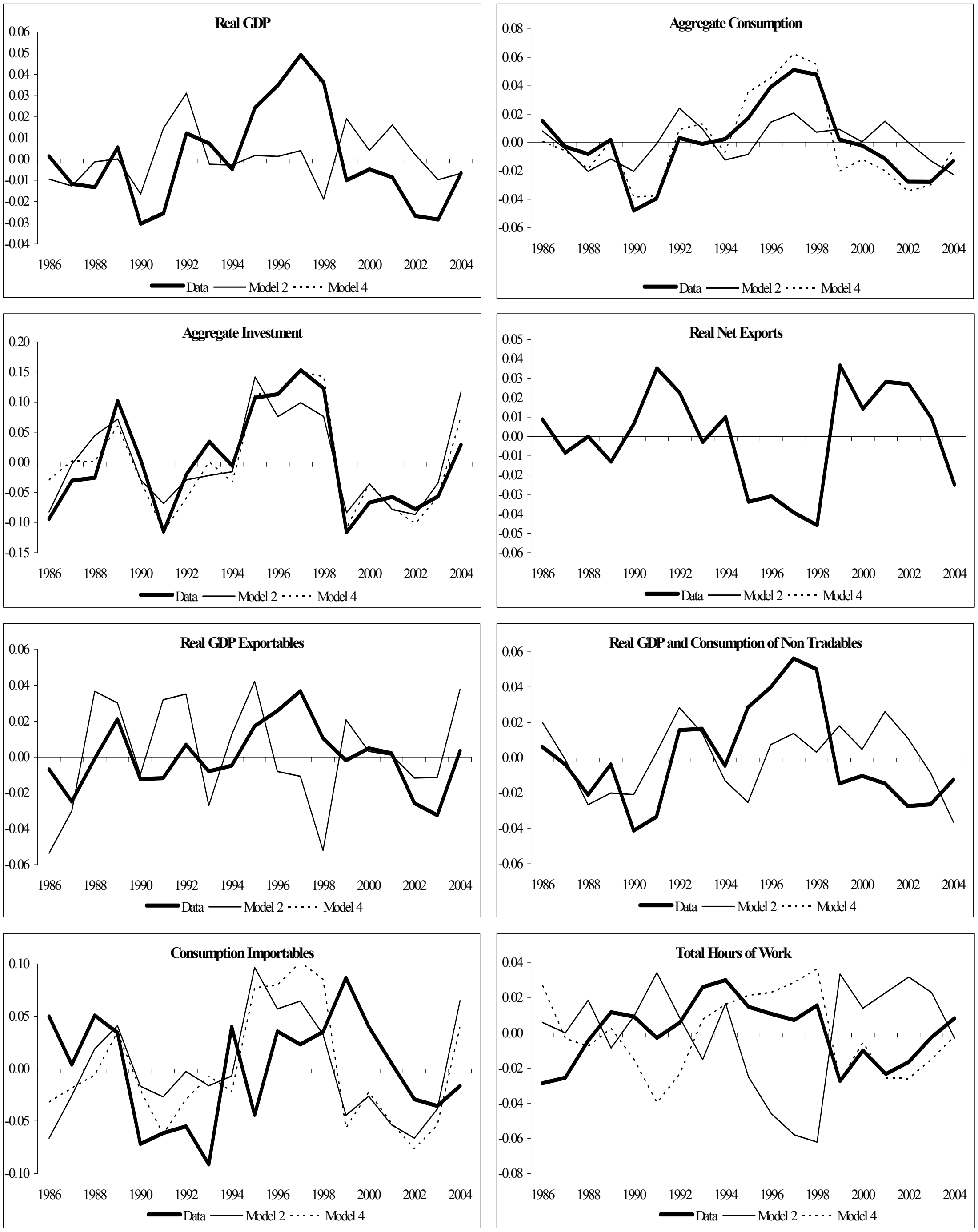


Figure 7. Data, Model 2 and Model 4 Simulations (Continuation).

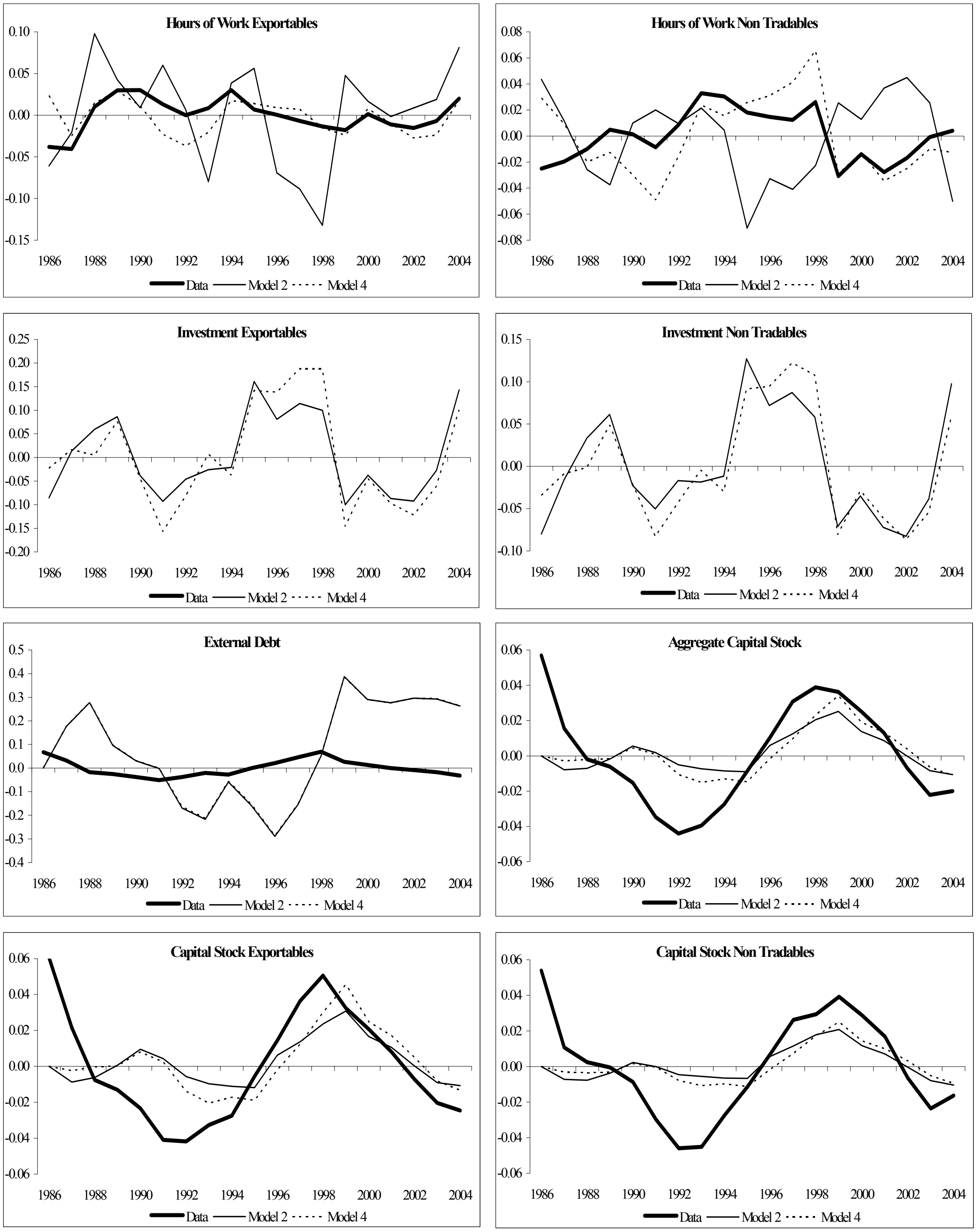
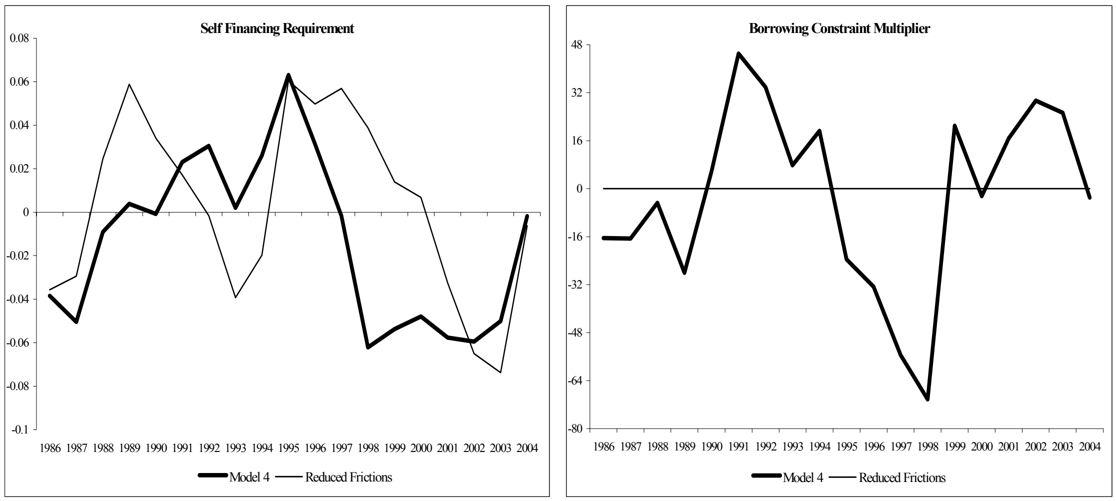


Figure 8. Self Financing Requirement and Labor Financing Wedges.

**Panel A**




**Panel B**

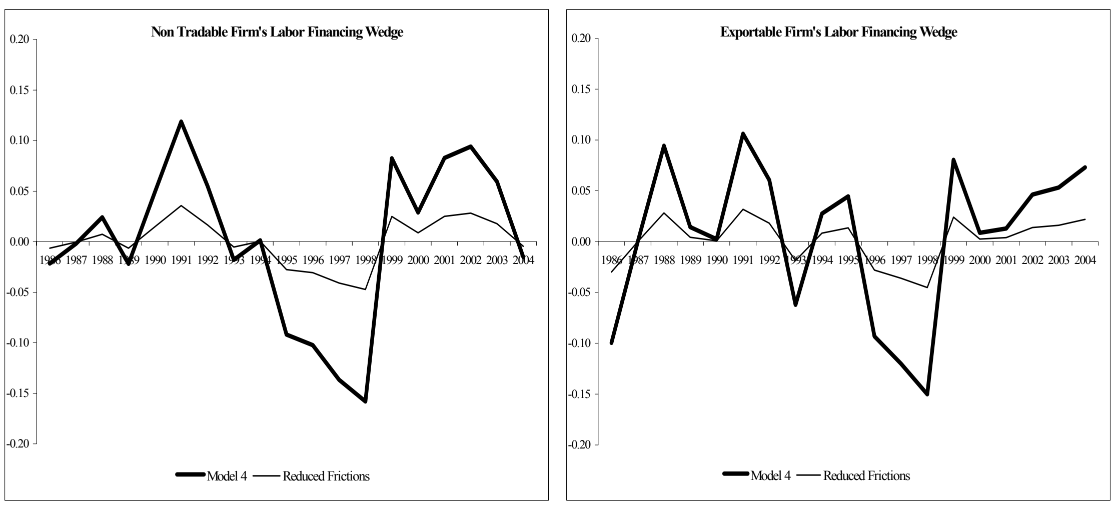


Figure 9. Data, Model 4 and Lower Incidence of Frictions

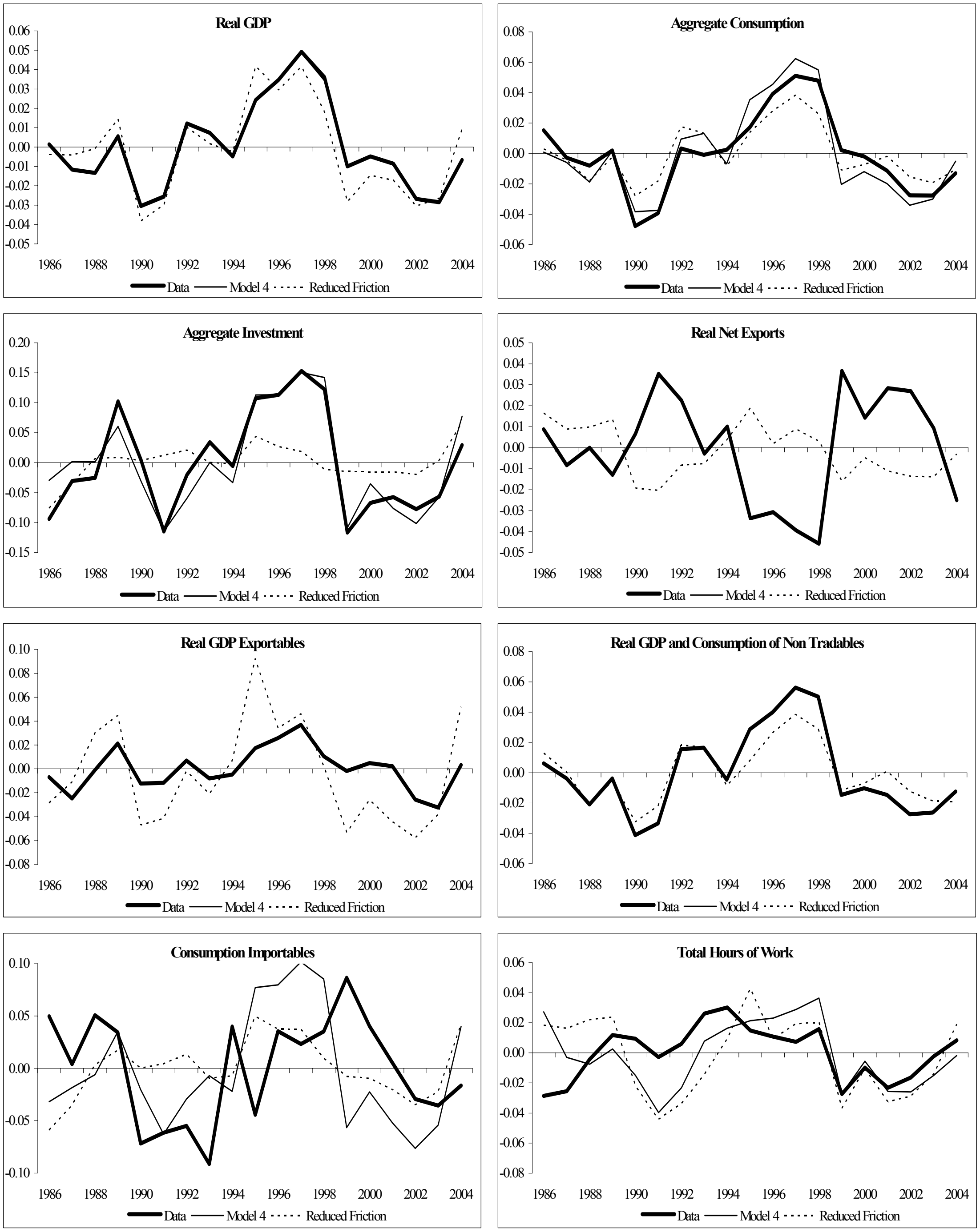


Figure 9. Data, Model 4 and Lower Incidence of Frictions (Continuation)

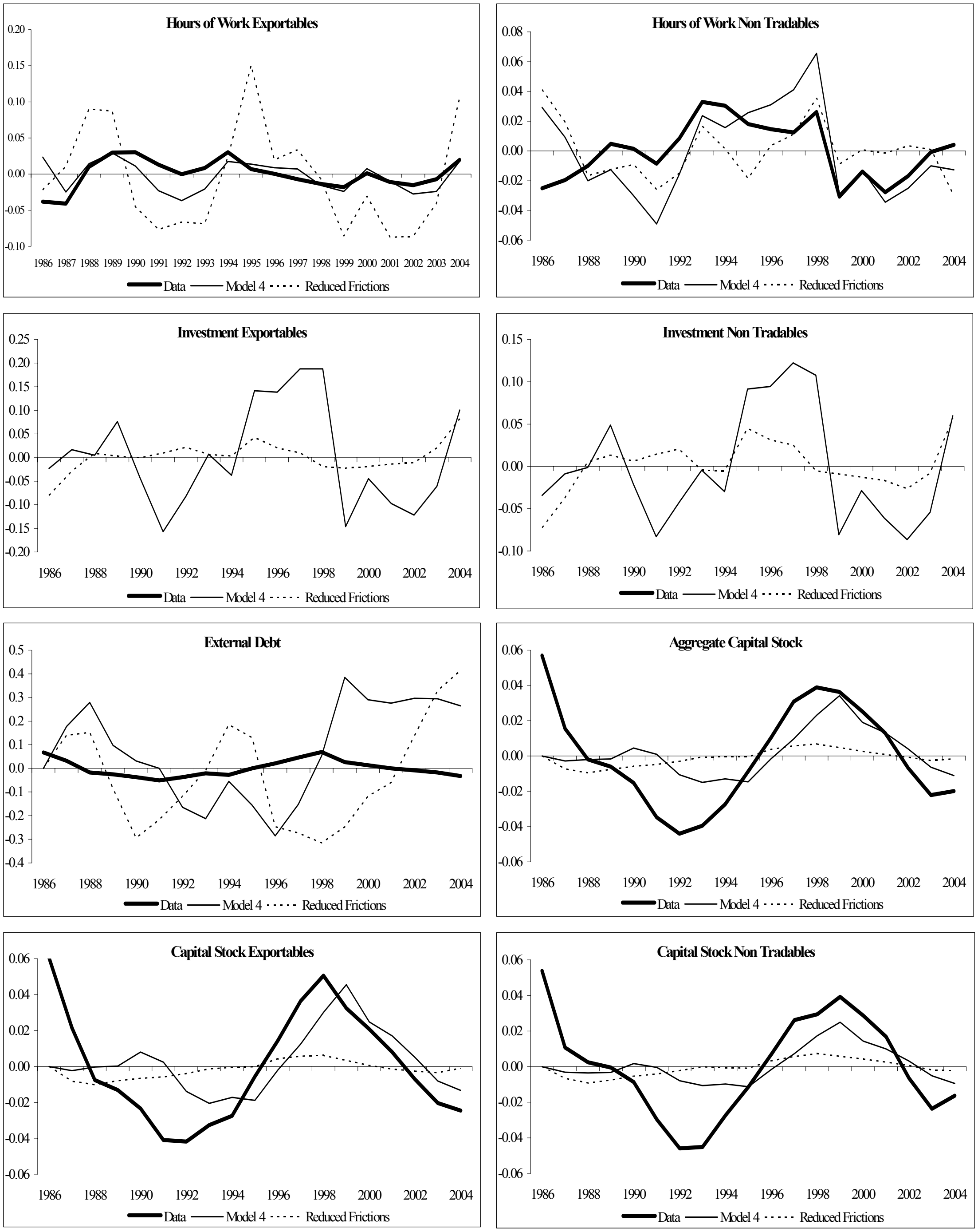


Table 1. Business Cycles Moments, Annual Data: 1980 - 2004.

| | (1) Autocorr Y | (2) St.Dev. Y | (3) Correl. C to Y | (4) SD C/ SD Y | (5) Correl. I to Y | (6) SD I/ SD Y | (7) Correl. NE/Y to Y | (8) St.Dev. NE/Y |
|---|---|---|---|---|---|---|---|---|
| **Small Developed Countries** | | | | | | | | |
| Australia | 0.505 | 0.017 | 0.578 | 0.620 | 0.873 | 4.573 | -0.354 | 1.103 |
| Austria | 0.634 | 0.014 | 0.797 | 0.789 | 0.584 | 3.076 | 0.184 | 0.764 |
| Belgium | 0.666 | 0.016 | 0.798 | 0.693 | 0.858 | 5.723 | -0.566 | 1.134 |
| Canada | 0.635 | 0.024 | 0.784 | 0.761 | 0.825 | 3.285 | -0.275 | 1.266 |
| Denmark | 0.702 | 0.019 | 0.641 | 0.771 | 0.926 | 5.637 | -0.780 | 1.417 |
| Finland | 0.782 | 0.039 | 0.917 | 0.832 | 0.977 | 3.232 | -0.626 | 1.525 |
| Greece | 0.532 | 0.020 | 0.616 | 0.781 | 0.821 | 3.255 | -0.045 | 1.028 |
| Iceland | 0.674 | 0.034 | 0.871 | 1.269 | 0.764 | 3.678 | -0.530 | 3.137 |
| Ireland | 0.660 | 0.027 | 0.724 | 0.924 | 0.825 | 4.230 | -0.565 | 1.086 |
| Netherlands | 0.691 | 0.019 | 0.883 | 0.831 | 0.878 | 3.260 | -0.430 | 0.743 |
| Norway | 0.721 | 0.021 | 0.799 | 0.789 | 0.782 | 4.478 | -0.487 | 1.558 |
| New Zealand | 0.584 | 0.023 | 0.815 | 0.976 | 0.746 | 4.257 | -0.484 | 1.155 |
| Portugal | 0.771 | 0.032 | 0.929 | 1.085 | 0.887 | 2.908 | -0.753 | 1.820 |
| Spain | 0.830 | 0.023 | 0.910 | 1.182 | 0.971 | 3.860 | -0.923 | 1.749 |
| Sweden | 0.725 | 0.023 | 0.710 | 0.895 | 0.840 | 4.991 | -0.531 | 1.197 |
| Switzerland | 0.635 | 0.018 | 0.854 | 0.613 | 0.760 | 3.317 | -0.003 | 0.882 |
| **Average** | **0.672** | **0.023** | **0.789** | **0.863** | **0.832** | **3.985** | **-0.448** | **1.348** |
| **Middle Income Countries[1]** | | | | | | | | |
| Argentina | 0.552 | 0.059 | 0.926 | 1.215 | 0.906 | 3.270 | -0.904 | 2.168 |
| Bolivia | 0.816 | 0.030 | 0.558 | 0.881 | 0.552 | 5.586 | 0.167 | 2.960 |
| Brazil | 0.574 | 0.038 | 0.912 | 0.973 | 0.906 | 2.778 | -0.407 | 1.119 |
| Chile | 0.668 | 0.057 | 0.971 | 1.224 | 0.932 | 3.083 | -0.899 | 2.559 |
| Colombia | 0.710 | 0.025 | 0.864 | 1.212 | 0.714 | 6.250 | -0.560 | 3.128 |
| Costa Rica | 0.569 | 0.035 | 0.809 | 1.205 | 0.657 | 4.211 | -0.381 | 3.423 |
| Dominican Rep. | 0.496 | 0.033 | 0.793 | 1.396 | 0.700 | 3.659 | -0.589 | 3.722 |
| Ecuador | 0.291 | 0.030 | 0.810 | 1.019 | 0.687 | 5.029 | -0.470 | 3.837 |
| El Salvador | 0.660 | 0.030 | 0.839 | 1.166 | 0.301 | 3.531 | -0.014 | 2.425 |
| Guatemala | 0.848 | 0.031 | 0.982 | 0.853 | 0.576 | 4.118 | -0.002 | 1.248 |
| Honduras | 0.396 | 0.023 | -0.052 | 1.760 | 0.534 | 7.200 | 0.051 | 1.965 |
| Hong Kong | 0.263 | 0.030 | 0.714 | 1.020 | 0.544 | 3.345 | -0.140 | 2.715 |
| Indonesia | 0.627 | 0.047 | 0.637 | 1.225 | 0.942 | 3.266 | -0.483 | 3.215 |
| Korea, Rep. of | 0.504 | 0.032 | 0.887 | 1.116 | 0.862 | 3.356 | -0.650 | 2.868 |
| Malaysia | 0.686 | 0.047 | 0.854 | 1.464 | 0.950 | 4.292 | -0.830 | 6.729 |
| Mexico | 0.643 | 0.043 | 0.929 | 1.051 | 0.838 | 3.893 | -0.635 | 3.099 |
| Panama | 0.648 | 0.055 | 0.602 | 1.103 | 0.809 | 5.886 | -0.663 | 3.402 |
| Paraguay | 0.764 | 0.039 | 0.649 | 1.293 | 0.910 | 3.109 | -0.408 | 3.435 |
| Peru | 0.618 | 0.067 | 0.890 | 1.072 | 0.762 | 2.477 | -0.641 | 1.599 |
| Philipines | 0.696 | 0.043 | 0.926 | 0.563 | 0.916 | 3.998 | -0.585 | 2.466 |
| Singapur | 0.634 | 0.042 | 0.657 | 0.677 | 0.841 | 3.512 | -0.432 | 2.518 |
| Sri Lanka | 0.578 | 0.018 | 0.773 | 1.352 | 0.592 | 5.485 | -0.335 | 3.253 |
| Taiwan | 0.581 | 0.025 | 0.728 | 1.101 | 0.792 | 4.362 | -0.379 | 2.584 |
| Thailand | 0.748 | 0.054 | 0.966 | 0.916 | 0.949 | 3.876 | -0.847 | 4.400 |
| Turkey | 0.177 | 0.034 | 0.894 | 1.052 | 0.847 | 3.669 | -0.629 | 2.726 |
| Uruguay | 0.680 | 0.061 | 0.972 | 1.207 | 0.886 | 3.705 | -0.889 | 3.786 |
| Venezuela | 0.373 | 0.046 | 0.691 | 1.175 | 0.783 | 5.389 | -0.525 | 4.058 |
| **Average** | **0.585** | **0.040** | **0.785** | **1.122** | **0.766** | **4.161** | **-0.485** | **3.015** |

Source: International Monetary Fund, World Economic Outlook Database.

[1] Exclude middle-income countries from Africa and the Middle East.

Table 2. Business Cycles Moments, Quarterly Data: 1980-2003.

| | (1) $\rho(Y_t, Y_{t-1})$ | (2) $\sigma(Y)$ | (3) $\rho(C,Y)$ | (4) $\sigma(C)/\sigma(Y)$ | (5) $\rho(I,Y)$ | (6) $\sigma(I)/\sigma(Y)$ | (7) $\rho(NX/Y,Y)$ | (8) $\sigma(NX/Y)$ |
|---|---|---|---|---|---|---|---|---|
| **A. Small Developed Economies** | | | | | | | | |
| Australia | 0.84 | 1.39 | 0.48 | 0.69 | 0.80 | 3.69 | -0.43 | 1.08 |
| Austria | 0.90 | 0.89 | 0.74 | 0.87 | 0.75 | 2.75 | 0.10 | 0.65 |
| Belgium | 0.79 | 1.02 | 0.67 | 0.81 | 0.62 | 3.72 | -0.04 | 0.91 |
| Canada | 0.91 | 1.64 | 0.88 | 0.77 | 0.77 | 2.63 | -0.20 | 0.91 |
| Denmark | 0.49 | 1.02 | 0.36 | 1.19 | 0.51 | 3.90 | -0.08 | 0.88 |
| Finland | 0.85 | 2.18 | 0.84 | 0.94 | 0.88 | 3.26 | -0.45 | 1.11 |
| Netherlands | 0.77 | 1.20 | 0.72 | 1.07 | 0.70 | 2.92 | -0.19 | 0.71 |
| New Zealand | 0.77 | 1.56 | 0.76 | 0.90 | 0.82 | 4.38 | -0.26 | 1.37 |
| Norway | 0.48 | 1.40 | 0.63 | 1.32 | 0.00 | 4.33 | 0.11 | 1.73 |
| Portugal | 0.72 | 1.34 | 0.75 | 1.02 | 0.70 | 2.88 | -0.11 | 1.16 |
| Spain | 0.82 | 1.11 | 0.83 | 1.11 | 0.83 | 3.70 | -0.60 | 0.86 |
| Sweden | 0.53 | 1.52 | 0.35 | 0.97 | 0.68 | 3.66 | 0.01 | 0.94 |
| Switzerland | 0.92 | 1.11 | 0.58 | 0.51 | 0.69 | 2.56 | -0.03 | 0.96 |
| **Mean** | **0.75** | **1.34** | **0.66** | **0.94** | **0.67** | **3.41** | **-0.17** | **1.02** |
| **B. Middel Income Countries** | | | | | | | | |
| Argentina | 0.85 | 3.68 | 0.90 | 1.38 | 0.96 | 2.53 | -0.70 | 2.56 |
| Brazil | 0.65 | 1.98 | 0.41 | 2.01 | 0.62 | 3.08 | 0.01 | 2.61 |
| Ecuador | 0.82 | 2.44 | 0.73 | 2.39 | 0.89 | 5.56 | -0.79 | 5.68 |
| Israel | 0.50 | 1.95 | 0.45 | 1.60 | 0.49 | 3.42 | 0.12 | 2.12 |
| Korea | 0.78 | 2.51 | 0.85 | 1.23 | 0.78 | 2.50 | -0.61 | 2.32 |
| Malaysia | 0.85 | 3.10 | 0.76 | 1.70 | 0.86 | 4.82 | -0.74 | 5.30 |
| Mexico | 0.82 | 2.48 | 0.92 | 1.24 | 0.91 | 4.05 | -0.74 | 2.19 |
| Peru | 0.64 | 3.68 | 0.78 | 0.92 | 0.85 | 2.37 | -0.24 | 1.25 |
| Philippines | 0.87 | 3.00 | 0.59 | 0.62 | 0.76 | 4.66 | -0.41 | 3.21 |
| Slovak Republic | 0.66 | 1.24 | 0.42 | 2.04 | 0.46 | 7.77 | -0.44 | 4.29 |
| South Africa | 0.89 | 1.62 | 0.72 | 1.61 | 0.75 | 3.94 | -0.54 | 2.57 |
| Thailand | 0.89 | 4.35 | 0.92 | 1.09 | 0.91 | 3.49 | -0.83 | 4.58 |
| Turkey | 0.67 | 3.57 | 0.89 | 1.09 | 0.83 | 2.71 | -0.69 | 3.23 |
| **Mean** | **0.76** | **2.74** | **0.72** | **1.46** | **0.77** | **3.92** | **-0.51** | **3.22** |

Source: Aguiar, M. and G. Gopinath (2004), "Emerging Market Business Cycles: The Cycle is the Trend". Working Paper No. 04-4, Federal Reserve Bank of Boston.

Table 3. Productive Factors and Terms of Trade Moments.

| | (1) Autocorr L | (2) SD L/ SD Y | (3) Autocorr FI | (4) Correl. FI to Y | (5) SD FI/ SD Y | (6) Autocorr. TOT | (7) SD TOT/ SD Y |
|---|---|---|---|---|---|---|---|
| **Small Developed Countries** | | | | | | | |
| Australia | 0.602 | 1.051 | 0.430 | 0.859 | 3.507 | 0.499 | 2.714 |
| Austria | 0.812 | 0.817 | 0.679 | 0.698 | 2.957 | 0.344 | 1.849 |
| Belgium | 0.669 | 0.832 | 0.714 | 0.911 | 4.536 | 0.504 | 1.206 |
| Canada | 0.671 | 0.789 | 0.646 | 0.830 | 2.726 | 0.377 | 0.981 |
| Denmark | 0.809 | 0.894 | 0.718 | 0.907 | 5.038 | 0.546 | 1.124 |
| Finland | 0.798 | 0.902 | 0.782 | 0.955 | 3.121 | 0.748 | 0.795 |
| Greece | 0.284 | 0.610 | 0.333 | 0.706 | 2.704 | 0.504 | 4.348 |
| Iceland | 0.698 | 0.697 | 0.557 | 0.791 | 3.377 | 0.596 | 0.890 |
| Ireland | 0.698 | 0.914 | 0.720 | 0.873 | 3.504 | 0.723 | 1.034 |
| Netherlands | 0.761 | 0.891 | 0.672 | 0.868 | 2.588 | 0.356 | 0.433 |
| Norway | 0.794 | 0.985 | 0.765 | 0.704 | 3.903 | 0.499 | 3.279 |
| New Zealand | 0.434 | 1.478 | 0.553 | 0.819 | 3.528 | 0.407 | 1.533 |
| Portugal | 0.572 | 0.989 | 0.638 | 0.854 | 2.836 | 0.517 | 2.006 |
| Spain | 0.761 | 1.441 | 0.817 | 0.961 | 3.511 | 0.730 | 1.957 |
| Sweden | 0.776 | 1.122 | 0.744 | 0.939 | 4.032 | 0.736 | 1.456 |
| Switzerland | 0.808 | 0.824 | 0.620 | 0.767 | 2.456 | 0.436 | 1.563 |
| **Average** | **0.684** | **0.952** | **0.649** | **0.840** | **3.395** | **0.533** | **1.698** |
| **Middle Income Countries[1]** | | | | | | | |
| Argentina | 0.355 | 0.446 | 0.509 | 0.976 | 3.060 | 0.359 | 1.416 |
| Bolivia | 0.391 | 2.130 | 0.510 | 0.561 | 4.856 | 0.239 | 4.282 |
| Brazil | 0.508 | 0.558 | 0.610 | 0.947 | 2.592 | 0.447 | 0.548 |
| Chile | 0.504 | 0.516 | 0.512 | 0.943 | 2.873 | 0.331 | 1.162 |
| Colombia | 0.545 | 0.955 | 0.655 | 0.745 | 5.716 | 0.242 | 3.177 |
| Costa Rica | 0.338 | 0.755 | 0.434 | 0.837 | 3.676 | 0.477 | 1.902 |
| Dominican Rep. | 0.407 | 0.840 | 0.407 | 0.687 | 3.738 | 0.317 | 2.326 |
| Ecuador | 0.506 | 0.925 | 0.403 | 0.564 | 4.280 | 0.371 | 3.304 |
| El Salvador | 0.576 | 1.907 | 0.595 | 0.506 | 2.566 | 0.211 | 3.589 |
| Guatemala | 0.704 | 0.826 | 0.632 | 0.787 | 4.151 | 0.353 | 2.351 |
| Honduras | 0.463 | 1.180 | 0.585 | 0.497 | 5.929 | 0.239 | 2.326 |
| Hong Kong | 0.773 | 0.513 | 0.677 | 0.370 | 2.984 | 0.195 | 0.386 |
| Indonesia | n.a. | n.a. | 0.865 | 0.483 | 4.897 | 0.564 | 2.847 |
| Korea, Rep. of | 0.606 | 0.654 | 0.604 | 0.866 | 2.900 | 0.826 | 1.427 |
| Malaysia | 0.306 | 0.235 | 0.696 | 0.944 | 4.382 | 0.229 | 0.828 |
| Mexico | 0.485 | 1.007 | 0.535 | 0.914 | 3.353 | 0.629 | 3.171 |
| Panama | 0.270 | 0.537 | 0.600 | 0.881 | 5.650 | 0.504 | 1.356 |
| Paraguay | n.a. | n.a. | 0.719 | 0.915 | 3.284 | 0.318 | 2.034 |
| Peru | 0.389 | 0.101 | 0.621 | 0.793 | 2.396 | 0.367 | 1.723 |
| Philipines | 0.282 | 0.382 | 0.605 | 0.907 | 3.550 | 0.478 | 1.017 |
| Singapur | 0.334 | 0.611 | 0.916 | 0.472 | 5.843 | 0.568 | 0.272 |
| Sri Lanka | n.a. | n.a. | 0.718 | 0.642 | 5.454 | 0.267 | 4.704 |
| Taiwan | 0.548 | 0.363 | 0.707 | 0.641 | 3.542 | 0.583 | 0.980 |
| Thailand | 0.257 | 0.366 | 0.721 | 0.977 | 3.596 | 0.312 | 0.726 |
| Turkey | 0.222 | 0.614 | 0.262 | 0.827 | 2.935 | 0.451 | 2.309 |
| Uruguay | 0.507 | 0.416 | 0.798 | 0.880 | 4.204 | 0.577 | 0.955 |
| Venezuela | 0.460 | 0.474 | 0.390 | 0.927 | 3.252 | 0.318 | 3.656 |
| **Average** | **0.447** | **0.721** | **0.603** | **0.750** | **3.913** | **0.399** | **2.029** |

Source: International Monetary Fund, World Economic Outlook Database.

[1] Exclude middle-income countries from Africa and the Middle East.

Table 4. Calibrated Parameters.

| | | Macroeconomic Ratios | | |
|---|---|---|---|---|
| Parameter | Value | Variable | Data | Model |
| **Model 1: Friction-Less Economy** | | | | |
| Preferences | | Aggregate Demand | | |
| $\beta$ | 0.943 | c/y | 0.762 | 0.696 |
| $\rho$ | -0.350 | $c^N/y$ | 0.634 | 0.600 |
| $\varpi$ | 0.079 | $c^M/y$ | 0.128 | 0.096 |
| $\sigma$ | 1.500 | i/y | 0.297 | 0.292 |
| $\alpha$ | 0.323 | tb/y | -0.059 | 0.012 |
| | | b/y | n.a. | -0.190 |
| Technology | | | | |
| | | Production | | |
| $\alpha_X$ | 0.523 | | | |
| $\alpha_N$ | 0.435 | $y^N/y$ | 0.634 | 0.600 |
| $\theta$ | 0.028 | $y^X/y$ | 0.366 | 0.400 |
| $\delta$ | 0.080 | | | |
| | | Inputs | | |
| Supply of External Funds | | | | |
| | | k/y | n.a. | 1.700 |
| $\bar{b}$ | 0.088 | $k^N/k$ | n.a. | 0.555 |
| $\eta$ | 0.001 | $k^X/k$ | n.a. | 0.445 |
| | | h | 0.267 | 0.267 |
| Long Term Growth | | $h^N/h$ | 0.670 | 0.640 |
| | | $h^X/h$ | 0.330 | 0.360 |
| $\gamma$ | 1.056 | | | |
| **Models 2 and 4: Credit Constraint** | | | | |
| $\Psi$ | 0.833 | | | |
| $\mu$ | 3.24E-08 | | | |
| **Models 3 and 4: Labor Financing Wedges** | | | | |
| $\tau^X$ | 0.162 | $h^N/h$ | 0.670 | 0.638 |
| $\tau^N$ | 0.171 | $h^X/h$ | 0.330 | 0.362 |

Source: Central Bank of Chile and National Institute of Statistics

Table 5. Shocks Processes in Model 1.

**Table 5: Shock Processes in Model 1**

| | | | SD Shock/ | Cross correlation of innovations with | | | |
|---|---|---|---|---|---|---|---|
| Shocks | Statistic | $\rho$ | SD GDP | $P^X$ | $r^*$ | $z^X$ | $z^N$ |
| Terms of Trade | $P^X$ | 0.287 | 3.16 | 1.000 | 0.456 | 0.202 | 0.140 |
| Foreign Interest Rate | $r^*$ | 0.774 | 0.76 | 0.456 | 1.000 | 0.242 | 0.274 |
| Productivity Exportable | $z^X$ | 0.409 | 0.71 | 0.202 | 0.242 | 1.000 | 0.985 |
| Productivity Non Tradable | $z^N$ | 0.357 | 0.68 | 0.140 | 0.274 | 0.985 | 1.000 |

Table 6. Data Moments and Simulations

**Table 6 : Data Moments and Simulations**

| Variable | x | Data HP Filtered (1) $\rho(x_t, y_t)$ | (2) $\rho(x_t, y_{t-1})$ | (3) $\sigma(y)$ | (4) $\sigma(x)/\sigma(y)$ | Model 1: Friction-Less Economy (5) $\rho(x_t, y_t)$ | (6) $\rho(x_t, y_{t-1})$ | (7) $\sigma(y)$ | (8) $\sigma(x)/\sigma(y)$ | Model 2: Credit Constraint (9) $\rho(x_t, y_t)$ | (10) $\rho(x_t, y_{t-1})$ | (11) $\sigma(y)$ | (12) $\sigma(x)/\sigma(y)$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aggregate output | $y$ | 1.00 | 0.59 | 2.29 | 1.00 | 1.00 | 0.31 | 2.28 | 1.00 | 1.00 | 0.02 | 1.26 | 0.55 |
| Output exportables | $y^x$ | 0.84 | 0.39 | 1.78 | 0.78 | 0.92 | 0.17 | 5.35 | 2.35 | 0.57 | -0.41 | 2.99 | 1.31 |
| Output non tradables | $y^n$ | 0.98 | 0.61 | 2.80 | 1.22 | 0.35 | 0.40 | 1.51 | 0.66 | 0.51 | 0.41 | 1.91 | 0.84 |
| Aggregate consumption | $c$ | 0.95 | 0.69 | 2.66 | 1.16 | 0.45 | 0.38 | 1.31 | 0.58 | 0.54 | 0.39 | 1.42 | 0.62 |
| Consumption importables | $c^m$ | 0.25 | 0.45 | 4.98 | 2.17 | 0.38 | 0.01 | 2.64 | 1.16 | -0.12 | -0.18 | 4.82 | 2.12 |
| Consumption non tradables | $c^n$ | 0.98 | 0.61 | 2.80 | 1.22 | 0.35 | 0.40 | 1.51 | 0.66 | 0.51 | 0.41 | 1.91 | 0.84 |
| Investment | $i$ | 0.80 | 0.44 | 8.50 | 3.71 | 0.02 | -0.40 | 3.37 | 1.48 | -0.29 | -0.16 | 7.42 | 3.26 |
| Investment exportable | $i^x$ | n.a. | n.a. | n.a. | n.a. | -0.11 | -0.53 | 3.84 | 1.69 | -0.35 | -0.16 | 8.67 | 3.81 |
| Investment non tradable | $i^n$ | n.a. | n.a. | n.a. | n.a. | 0.13 | -0.25 | 3.14 | 1.38 | -0.23 | -0.16 | 6.54 | 2.87 |
| Real net exports | nx | -0.74 | -0.41 | -- | 2.55 | 0.83 | 0.30 | -- | 2.20 | 0.53 | -0.01 | -- | 2.55 |
| Nominal net exports | nnx | -- | -- | -- | -- | 0.78 | 0.13 | -- | 4.57 | 0.34 | -0.50 | -- | 2.88 |
| Hours of work | $h$ | 0.40 | 0.12 | 1.78 | 0.78 | 0.68 | 0.09 | 2.84 | 1.25 | 0.34 | -0.18 | 2.95 | 1.29 |
| Hours of work exportable | $h^x$ | -0.09 | -0.30 | 2.05 | 0.89 | 0.77 | 0.08 | 9.77 | 4.29 | 0.29 | -0.50 | 6.23 | 2.74 |
| Hours of work non tradable | $h^n$ | 0.53 | 0.25 | 1.96 | 0.85 | -0.63 | -0.04 | 1.94 | 0.85 | 0.16 | 0.27 | 3.40 | 1.49 |
| Aggregate capital | | 0.33 | 0.68 | 2.88 | 1.26 | 0.23 | 0.11 | 0.54 | 0.24 | 0.16 | -0.06 | 1.06 | 0.47 |
| Capital exportable | $k^x$ | 0.43 | 0.75 | 3.06 | 1.34 | 0.34 | 0.11 | 0.58 | 0.25 | 0.16 | -0.10 | 1.26 | 0.55 |
| Capital non tradable | $k^n$ | 0.24 | 0.60 | 2.80 | 1.22 | 0.13 | 0.11 | 0.54 | 0.24 | 0.16 | -0.01 | 0.92 | 0.40 |
| Borr. const. multiplier | $\mu$ | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | 0.46 | 0.16 | 459.97 | 201.91 |

Table 7. Data and Simulations, Different Intertemporal Elasticities of Substitution.

**Table 7: Data and Simulations Moments for Different Intertemporal Elasticities of Substitution**

| | | Model 1 ($\sigma$ = 1) | | | Model 1 ($\sigma$ = 3) | | | Model 1 ($\sigma$ = 5) | | | Model 1 ($\sigma$ = 10) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variable | x | (1) $\rho(x_t, y_t)$ | (2) $\sigma(y)$ | (3) $\sigma(x)/\sigma(y)$ | (4) $\rho(x_t, y_t)$ | (5) $\sigma(y)$ | (6) $\sigma(x)/\sigma(y)$ | (7) $\rho(x_t, y_t)$ | (8) $\sigma(y)$ | (9) $\sigma(x)/\sigma(y)$ | (10) $\rho(x_t, y_t)$ | (11) $\sigma(y)$ | (12) $\sigma(x)/\sigma(y)$ |
| Aggregate output | $y$ | 1.00 | 2.29 | 1.00 | 1.00 | 2.29 | 1.00 | 1.00 | 2.29 | 1.00 | 1.00 | 2.29 | 1.00 |
| Output exportables | $y^x$ | 0.91 | 4.71 | 2.06 | 0.74 | 4.90 | 2.14 | 0.00 | 2.64 | 1.15 | -0.64 | 0.82 | 0.36 |
| Output non tradables | $y^n$ | 0.60 | 1.58 | 0.69 | 0.54 | 2.61 | 1.14 | 0.91 | 4.21 | 1.84 | 1.00 | 4.18 | 1.83 |
| Aggregate consumption | $c$ | 0.57 | 1.18 | 0.52 | 0.55 | 2.51 | 1.10 | 0.91 | 3.76 | 1.64 | 1.00 | 3.63 | 1.59 |
| Consumption importables | $c^m$ | -0.46 | 2.16 | 0.94 | 0.53 | 2.33 | 1.02 | 0.82 | 1.26 | 0.55 | 0.61 | 0.32 | 0.14 |
| Consumption non tradables | $c^n$ | 0.60 | 1.58 | 0.69 | 0.54 | 2.61 | 1.14 | 0.91 | 4.21 | 1.84 | 1.00 | 4.18 | 1.83 |
| Investment | $i$ | -0.64 | 2.53 | 1.10 | 0.37 | 4.42 | 1.93 | 0.84 | 3.47 | 1.52 | 0.85 | 1.47 | 0.64 |
| Investment exportable | $i^x$ | -0.63 | 2.92 | 1.28 | 0.34 | 4.99 | 2.18 | 0.83 | 4.17 | 1.82 | 0.85 | 1.89 | 0.83 |
| Investment non tradable | $i^n$ | -0.62 | 2.38 | 1.04 | 0.39 | 4.03 | 1.76 | 0.84 | 2.96 | 1.29 | 0.84 | 1.17 | 0.51 |
| Real net exports | $nx$ | 0.95 | -- | 2.39 | 0.31 | -- | 2.70 | -0.57 | -- | 1.73 | -0.86 | -- | 0.72 |
| Nominal net exports | $nnx$ | 0.82 | -- | 3.95 | 0.51 | -- | 4.25 | -0.35 | -- | 2.41 | -0.84 | -- | 0.86 |
| Hours of work | $h$ | 0.88 | 3.27 | 1.43 | 0.84 | 2.65 | 1.16 | 0.95 | 3.76 | 1.64 | 1.00 | 4.24 | 1.85 |
| Hours of work exportable | $h^x$ | 0.84 | 8.58 | 3.75 | 0.56 | 8.94 | 3.90 | -0.23 | 4.82 | 2.10 | -0.82 | 1.55 | 0.68 |
| Hours of work non tradable | $h^n$ | 0.18 | 2.34 | 1.02 | 0.15 | 4.09 | 1.79 | 0.84 | 7.33 | 3.20 | 0.99 | 7.38 | 3.22 |
| Capital exportable | $k^x$ | -0.02 | 0.67 | 0.29 | 0.29 | 1.23 | 0.54 | 0.72 | 1.06 | 0.46 | 0.73 | 0.43 | 0.19 |
| Capital non tradable | $k^n$ | -0.30 | 0.54 | 0.24 | 0.26 | 0.98 | 0.43 | 0.67 | 0.72 | 0.31 | 0.69 | 0.25 | 0.11 |

Table 8. Data and Simulations, Different Intertemporal Elasticities of Substitution and Adjustment Cost of Investment.

**Table 8: Data and Simulations Moments, Different IESs and Adjustment Cost of Investment**

| | | Model 1 ($\sigma$ =1) | | | Model 1 ($\sigma$ =3) | | | Model 1 ($\sigma$ = 5) | | | Model 1 ($\sigma$ = 10) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| Variable | x | $\rho(x_t, y_t)$ | $\sigma(y)$ | $\sigma(x)/\sigma(y)$ | $\rho(x_t, y_t)$ | $\sigma(y)$ | $\sigma(x)/\sigma(y)$ | $\rho(x_t, y_t)$ | $\sigma(y)$ | $\sigma(x)/\sigma(y)$ | $\rho(x_t, y_t)$ | $\sigma(y)$ | $\sigma(x)/\sigma(y)$ |
| Aggregate output | $y$ | 1.00 | 2.29 | 1.00 | 1.00 | 2.29 | 1.00 | 1.00 | 2.29 | 1.00 | 1.00 | 2.29 | 1.00 |
| Output exportables | $y^x$ | 0.92 | 4.76 | 2.08 | 0.76 | 4.40 | 1.92 | 0.43 | 2.71 | 1.18 | 0.28 | 1.86 | 0.81 |
| Output non tradables | $y^n$ | 0.59 | 1.51 | 0.66 | 0.64 | 2.48 | 1.08 | 0.88 | 3.45 | 1.51 | 0.95 | 3.66 | 1.60 |
| Aggregate consumption | $c$ | 0.55 | 1.06 | 0.46 | 0.65 | 2.28 | 1.00 | 0.89 | 2.89 | 1.26 | 0.95 | 2.92 | 1.28 |
| Consumption importables | $c^m$ | -0.32 | 1.95 | 0.85 | 0.57 | 1.85 | 0.81 | 0.62 | 0.92 | 0.40 | -0.10 | 0.45 | 0.20 |
| Consumption non tradables | $c^n$ | 0.59 | 1.51 | 0.66 | 0.64 | 2.48 | 1.08 | 0.88 | 3.45 | 1.51 | 0.95 | 3.66 | 1.60 |
| Investment | $i$ | -0.67 | 8.50 | 3.71 | 0.25 | 8.50 | 3.71 | 0.53 | 8.50 | 3.71 | 0.61 | 8.50 | 3.71 |
| Investment exportable | $i^x$ | -0.65 | 7.81 | 3.41 | 0.21 | 8.30 | 3.62 | 0.51 | 8.62 | 3.76 | 0.60 | 8.73 | 3.81 |
| Investment non tradable | $i^n$ | -0.66 | 9.34 | 4.08 | 0.27 | 8.72 | 3.81 | 0.55 | 8.42 | 3.68 | 0.62 | 8.32 | 3.63 |
| Real net exports | $nx$ | 0.88 | -- | 3.60 | 0.20 | -- | 3.18 | -0.28 | -- | 2.69 | -0.42 | -- | 2.49 |
| Nominal net exports | $nnx$ | 0.83 | -- | 4.92 | 0.38 | -- | 4.25 | -0.23 | -- | 3.11 | -0.45 | -- | 2.68 |
| Hours of work | $h$ | 0.84 | 2.94 | 1.28 | 0.82 | 2.38 | 1.04 | 0.91 | 2.93 | 1.28 | 0.94 | 3.58 | 1.56 |
| Hours of work exportable | $h^x$ | 0.82 | 8.22 | 3.59 | 0.54 | 7.79 | 3.40 | 0.10 | 4.34 | 1.90 | -0.04 | 2.42 | 1.06 |
| Hours of work non tradable | $h^n$ | 0.02 | 2.06 | 0.90 | 0.21 | 3.24 | 1.41 | 0.73 | 5.39 | 2.35 | 0.86 | 6.17 | 2.69 |
| Capital exportable | $k^x$ | 0.10 | 1.64 | 0.72 | 0.54 | 1.94 | 0.85 | 0.92 | 2.00 | 0.87 | 0.98 | 1.65 | 0.72 |
| Capital non tradable | $k^n$ | -0.19 | 1.84 | 0.80 | 0.52 | 2.23 | 0.97 | 0.90 | 2.07 | 0.90 | 0.97 | 1.63 | 0.71 |

Table 9. Shocks Processes in Model 2

**Table 9: Shock Processes in Model 2**

| | | | SD Shock/ | Cross correlation of innovations with | | | | |
|---|---|---|---|---|---|---|---|---|
| Shocks | Statistic | $\rho$ | SD GDP | $p^X$ | $r^*$ | $z^X$ | $z^N$ | $\Psi$ |
| Terms of Trade | $p^X$ | 0.287 | 3.16 | 1.000 | 0.456 | 0.202 | 0.140 | 0.754 |
| Foreign Interest Rate | $r^*$ | 0.774 | 0.76 | 0.456 | 1.000 | 0.242 | 0.274 | 0.157 |
| Productivity Exportable | $z^X$ | 0.409 | 0.71 | 0.202 | 0.242 | 1.000 | 0.985 | 0.306 |
| Productivity Non Tradable | $z^N$ | 0.357 | 0.68 | 0.140 | 0.274 | 0.985 | 1.000 | 0.192 |
| Self Financing Requirement | $\Psi$ | 0.709 | 1.75 | 0.754 | 0.157 | 0.306 | 0.192 | 1.000 |

Table 10. Shocks Processes in Model 3

**Table 10: Shock Processes in Model 3**

| Shocks | Statistic | $\rho$ | SD Shock/ SD GDP | Cross correlation of innovations with $P^X$ | $r^*$ | $z^X$ | $z^N$ | $\tau^X$ | $\tau^N$ |
|---|---|---|---|---|---|---|---|---|---|
| Terms of Trade | $P^X$ | 0.287 | 3.16 | 1.000 | 0.456 | 0.202 | 0.140 | 0.935 | 0.070 |
| Foreign Interest Rate | $r^*$ | 0.774 | 0.76 | 0.456 | 1.000 | 0.242 | 0.274 | 0.509 | -0.323 |
| Productivity Exportable | $z^X$ | 0.409 | 0.71 | 0.202 | 0.242 | 1.000 | 0.985 | 0.399 | -0.407 |
| Productivity Non Tradable | $z^N$ | 0.357 | 0.68 | 0.140 | 0.274 | 0.985 | 1.000 | 0.342 | -0.435 |
| Labor Wedge Exportable | $\tau^X$ | 0.337 | 3.14 | 0.935 | 0.509 | 0.399 | 0.342 | 1.000 | -0.024 |
| Labor Wedge Non Tradable | $\tau^N$ | 0.584 | 1.45 | 0.070 | -0.323 | -0.407 | -0.435 | -0.024 | 1.000 |

Table 11. Data Moments and Simulations

**Table 11: Data Moments and Simulations**

| | | Data HP Filtered | | | | Model 3: Labor Wedges | | | | Model 4: Credit Const. and Labor Wed. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) |
| Variable | x | $\rho(x_t, y_t)$ | $\rho(x_t, y_{t-1})$ | $\sigma(y)$ | $\sigma(x)/\sigma(y)$ | $\rho(x_t, y_t)$ | $\rho(x_t, y_{t-1})$ | $\sigma(y)$ | $\sigma(x)/\sigma(y)$ | $\rho(x_t, y_t)$ | $\rho(x_t, y_{t-1})$ | $\sigma(y)$ | $\sigma(x)/\sigma(y)$ |
| Aggregate output | $y$ | 1.00 | 0.59 | 2.29 | 1.00 | 1.00 | 0.58 | 2.29 | 1.00 | 1.00 | 0.58 | 2.29 | 1.00 |
| Output exportables | $y^x$ | 0.84 | 0.39 | 1.78 | 0.78 | 0.86 | 0.40 | 1.78 | 0.78 | 0.86 | 0.40 | 1.78 | 0.78 |
| Output non tradables | $y^n$ | 0.98 | 0.61 | 2.80 | 1.22 | 0.98 | 0.62 | 2.80 | 1.22 | 0.98 | 0.62 | 2.80 | 1.22 |
| Aggregate consumption | $c$ | 0.95 | 0.69 | 2.66 | 1.16 | 0.97 | 0.58 | 2.45 | 1.07 | 0.98 | 0.60 | 3.06 | 1.34 |
| Consumption importables | $c^m$ | 0.25 | 0.45 | 4.98 | 2.17 | 0.08 | -0.24 | 2.64 | 1.15 | 0.86 | 0.47 | 5.52 | 2.41 |
| Consumption non tradables | $c^n$ | 0.98 | 0.61 | 2.80 | 1.22 | 0.98 | 0.62 | 2.80 | 1.22 | 0.98 | 0.62 | 2.80 | 1.22 |
| Investment | $i$ | 0.80 | 0.44 | 8.50 | 3.71 | -0.20 | -0.50 | 3.61 | 1.57 | 0.81 | 0.44 | 8.50 | 3.71 |
| Investment exportable | $i^x$ | n.a. | n.a. | n.a. | n.a. | -0.19 | -0.50 | 4.00 | 1.74 | 0.80 | 0.43 | 10.87 | 4.75 |
| Investment non tradable | $i^n$ | n.a. | n.a. | n.a. | n.a. | -0.20 | -0.49 | 3.36 | 1.47 | 0.82 | 0.44 | 6.78 | 2.96 |
| Real net exports | nx | -0.74 | -0.41 | -- | 2.55 | 0.51 | 0.56 | -- | 1.51 | -0.74 | -0.42 | -- | 2.55 |
| Nominal net exports | nnx | -- | -- | -- | -- | 0.32 | -0.02 | -- | 3.23 | -0.58 | -0.67 | -- | 2.88 |
| Hours of work | $h$ | 0.40 | 0.12 | 1.78 | 0.78 | 0.69 | 0.82 | 2.22 | 0.97 | 0.76 | 0.59 | 2.23 | 0.97 |
| Hours of work exportable | $h^x$ | -0.09 | -0.30 | 2.05 | 0.89 | 0.07 | 0.31 | 2.65 | 1.16 | 0.23 | 0.02 | 2.07 | 0.91 |
| Hours of work non tradable | $h^n$ | 0.53 | 0.25 | 1.96 | 0.85 | 0.78 | 0.80 | 2.93 | 1.28 | 0.79 | 0.66 | 3.03 | 1.33 |
| Aggregate capital | | 0.33 | 0.68 | 2.88 | 1.26 | 0.38 | 0.26 | 0.62 | 0.27 | 0.04 | 0.54 | 1.34 | 0.58 |
| Capital exportable | $k^x$ | 0.43 | 0.75 | 3.06 | 1.34 | 0.43 | 0.30 | 0.67 | 0.29 | 0.02 | 0.52 | 1.75 | 0.77 |
| Capital non tradable | $k^n$ | 0.24 | 0.60 | 2.80 | 1.22 | 0.33 | 0.23 | 0.58 | 0.25 | 0.07 | 0.56 | 1.01 | 0.44 |
| Borr. const. multiplier | $\mu$ | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. | -0.76 | -0.62 | 55.87 | 24.40 |

Table 12. Shocks Processes in Model 4

**Table 12: Shock Processes in Model 4**

| Shocks | Statistic | $\rho$ | SD Shock/ SD GDP | $P^X$ | $r^*$ | $z^X$ | $z^N$ | $\Psi$ | $\tau^X$ | $\tau^N$ |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Cross correlation of innovations with | | | | | | |
| Terms of Trade | $P^X$ | 0.287 | 3.16 | 1.000 | 0.456 | 0.202 | 0.140 | 0.756 | 0.418 | -0.257 |
| Foreign Interest Rate | $r^*$ | 0.774 | 0.76 | 0.456 | 1.000 | 0.242 | 0.274 | 0.175 | -0.255 | -0.523 |
| Productivity Exportable | $z^X$ | 0.409 | 0.71 | 0.202 | 0.242 | 1.000 | 0.985 | 0.340 | -0.152 | -0.508 |
| Productivity Non Tradable | $z^N$ | 0.357 | 0.68 | 0.140 | 0.274 | 0.985 | 1.000 | 0.222 | -0.232 | -0.518 |
| Self Financing Requirement | $\Psi$ | 0.735 | 1.67 | 0.756 | 0.175 | 0.340 | 0.222 | 1.000 | 0.655 | 0.064 |
| Labor Wedge Exportable | $\tau^X$ | 0.257 | 3.30 | 0.418 | -0.255 | -0.152 | -0.232 | 0.655 | 1.000 | 0.693 |
| Labor Wedge Non Tradable | $\tau^N$ | 0.531 | 3.43 | -0.257 | -0.523 | -0.508 | -0.518 | 0.064 | 0.693 | 1.000 |

Table 13. Shocks Processes in Reduced Frictions Model

**Table 13: Shock Processes in Model with Reduced Frictions**

| Shocks | Statistic | $\rho$ | SD Shock/ SD GDP | Cross correlation of innovations with $P^X$ | $r^*$ | $z^X$ | $z^N$ | $\Psi$ | $\tau^X$ | $\tau^N$ |
|---|---|---|---|---|---|---|---|---|---|---|
| Terms of Trade | $P^X$ | 0.287 | 3.16 | 1.000 | 0.456 | 0.202 | 0.140 | 0.835 | 0.418 | -0.257 |
| Foreign Interest Rate | $r^*$ | 0.774 | 0.76 | 0.456 | 1.000 | 0.242 | 0.274 | 0.715 | -0.254 | -0.523 |
| Productivity Exportable | $z^X$ | 0.409 | 0.71 | 0.202 | 0.242 | 1.000 | 0.985 | 0.439 | -0.152 | -0.507 |
| Productivity Non Tradable | $z^N$ | 0.357 | 0.68 | 0.140 | 0.274 | 0.985 | 1.000 | 0.427 | -0.232 | -0.518 |
| Self Financing Requirement | $\Psi$ | 0.639 | 1.82 | 0.835 | 0.715 | 0.439 | 0.427 | 1.000 | 0.043 | -0.471 |
| Labor Wedge Exportable | $\tau^X$ | 0.257 | 0.99 | 0.418 | -0.254 | -0.152 | -0.232 | 0.043 | 1.000 | 0.693 |
| Labor Wedge Non Tradable | $\tau^N$ | 0.530 | 1.03 | -0.257 | -0.523 | -0.507 | -0.518 | -0.471 | 0.693 | 1.000 |

Table 14. Data Moments and Simulations

**Table 14: Data Moments and Simulations**

| Variable | x | Data HP Filtered (1) $\rho(x_t, y_t)$ | (2) $\rho(x_t, y_{t-1})$ | (3) $\sigma(y)$ | (4) $\sigma(x)/\sigma(y)$ | Model 4: Credit Const. and Labor Wed. (5) $\rho(x_t, y_t)$ | (6) $\rho(x_t, y_{t-1})$ | (7) $\sigma(y)$ | (8) $\sigma(x)/\sigma(y)$ | Lower incidence of frictions (9) $\rho(x_t, y_t)$ | (10) $\rho(x_t, y_{t-1})$ | (11) $\sigma(y)$ | (12) $\sigma(x)/\sigma(y)$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aggregate output | $y$ | 1.00 | 0.59 | 2.29 | 1.00 | 1.00 | 0.58 | 2.29 | 1.00 | 1.00 | 0.45 | 2.40 | 1.00 |
| Output exportables | $y^x$ | 0.84 | 0.39 | 1.78 | 0.78 | 0.86 | 0.40 | 1.78 | 0.78 | 0.89 | 0.24 | 4.27 | 1.78 |
| Output non tradables | $y^n$ | 0.98 | 0.61 | 2.80 | 1.22 | 0.98 | 0.62 | 2.80 | 1.22 | 0.75 | 0.56 | 1.97 | 0.82 |
| Aggregate consumption | $c$ | 0.95 | 0.69 | 2.66 | 1.16 | 0.98 | 0.60 | 3.06 | 1.34 | 0.84 | 0.57 | 1.84 | 0.77 |
| Consumption importables | $c^m$ | 0.25 | 0.45 | 4.98 | 2.17 | 0.86 | 0.47 | 5.52 | 2.41 | 0.67 | 0.29 | 2.86 | 1.19 |
| Consumption non tradables | $c^n$ | 0.98 | 0.61 | 2.80 | 1.22 | 0.98 | 0.62 | 2.80 | 1.22 | 0.75 | 0.56 | 1.97 | 0.82 |
| Investment | $i$ | 0.80 | 0.44 | 8.50 | 3.71 | 0.81 | 0.44 | 8.50 | 3.71 | 0.43 | -0.08 | 3.01 | 1.26 |
| Investment exportable | $i^x$ | n.a. | n.a. | n.a. | n.a. | 0.80 | 0.43 | 10.87 | 4.75 | 0.33 | -0.24 | 3.24 | 1.35 |
| Investment non tradable | $i^n$ | n.a. | n.a. | n.a. | n.a. | 0.82 | 0.44 | 6.78 | 2.96 | 0.49 | 0.06 | 2.95 | 1.23 |
| Real net exports | rx | -0.74 | -0.41 | -- | 2.55 | -0.74 | -0.42 | -- | 2.55 | 0.75 | 0.33 | -- | 1.23 |
| Nominal net exports | nnx | -- | -- | -- | -- | -0.58 | -0.67 | -- | 2.88 | 0.59 | 0.04 | -- | 3.51 |
| Hours of work | $h$ | 0.40 | 0.12 | 1.78 | 0.78 | 0.76 | 0.59 | 2.23 | 0.97 | 0.74 | 0.38 | 2.59 | 1.08 |
| Hours of work exportable | $h^x$ | -0.09 | -0.30 | 2.05 | 0.89 | 0.23 | 0.02 | 2.07 | 0.91 | 0.69 | 0.15 | 7.22 | 3.01 |
| Hours of work non tradable | $h^n$ | 0.53 | 0.25 | 1.96 | 0.85 | 0.79 | 0.66 | 3.03 | 1.33 | 0.11 | 0.57 | 1.90 | 0.79 |
| Aggregate capital | | 0.33 | 0.68 | 2.88 | 1.26 | 0.04 | 0.54 | 1.34 | 0.58 | 0.29 | 0.48 | 0.46 | 0.19 |
| Capital exportable | $k^x$ | 0.43 | 0.75 | 3.06 | 1.34 | 0.02 | 0.52 | 1.75 | 0.77 | 0.40 | 0.54 | 0.47 | 0.19 |
| Capital non tradable | $k^n$ | 0.24 | 0.60 | 2.80 | 1.22 | 0.07 | 0.56 | 1.01 | 0.44 | 0.19 | 0.42 | 0.47 | 0.19 |
| Borr. const. multiplier | $\mu$ | n.a. | n.a. | n.a. | n.a. | -0.76 | 0.00 | 55.87 | 24.40 | -0.36 | -0.23 | 0.00 | 0.00 |

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