

# Overoptimism, Boom-Bust Cycles and Monetary Policy in Small Open Economies\*

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## Abstract

This paper analyzes boom-bust cycles in emerging market economies triggered by misperception about future productivity. Using a small open economy DSGE model we show that non-materialized news about future productivity improvements (i.e. overoptimism) generate boom-bust cycles that replicate the stylized facts of several emerging economies during the 1990s. In this context, we show that the monetary policy faces relevant trade-offs. If the central bank tries to stabilize output, there would be a large real appreciation of the currency and a deep contraction in the tradable goods sector. When the central bank follows a more strict inflation targeting regime, the boom-bust pattern in major aggregate variables would be exacerbated. Finally, if the central bank attempts to sustain the real exchange rate, the perverse effects on the domestic tradable goods sector is only prevented in the short-run, but the boom-bust cycle in other variables is amplified.

**JEL Classification:** E3, F3, F4.

**Keywords:** DSGE model, news shocks, boom-bust cycle.

## 1 Introduction

Several emerging market economies during the 1990s, such as Mexico, south-east Asian countries, and Chile, displayed episodes of peaking growth rates along with increasing current account deficits and appreciating currencies, that ended with abrupt reversions in capital flows and

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recessions.<sup>1</sup>

Previous to the recessions, in all cases there was enhanced optimism about future prospects. Mexico was negotiating its entrance to NAFTA, along with its membership to the OECD. Chile had exhibited a smooth transition to democracy. The mood of investors was increasingly enthusiastic about the prospects of harvesting the benefits of the market reforms of both the previous period and those introduced under democracy. The south-east Asian economies, in turn, had their own reasons for optimism based on their impressive growth record of previous years. In all cases, optimism was grounded on reasonable arguments, but the prospects of future economic growth could not be estimated accurately.

In this paper we show that overoptimistic perceptions regarding the future by domestic private agents –domestic “exuberance”– could have been a cause of the boom-bust cycles observed in some emerging economies during the 1990s. To that end, we develop a multi-sector dynamic stochastic general equilibrium (DSGE) model for a small economy with short-run stickiness in prices and wages, that features expectation driven boom-bust cycles. We show that under standard parametrization, the model is able to closely match most of the stylized facts observed in the boom-bust episodes in emerging markets. In the model, private agents are rational and forward looking. Therefore, their current decisions rely on their assessment on future productivity prospects. An overoptimistic assessment about future productivity makes them to accumulate excess capital and to over increase their consumption, leading to a boom that is accompanied by a current account deficit. When agents realize that productivity will grow by less than expected, they must readjust their investment and consumption profiles, generating a current account reversal and a recession.

Our analytical approach follows closely Christiano, Ilut, Motto, and Rostagno (2007) (hereafter CIMR). Unlike them, we show that overoptimism about productivity trends, rather than transitory productivity gains, are the source of boom-bust cycles in open economies such as the one observed during the 1990s. We show that if productivity changes follow a stationary process, where expected productivity improvements are perceived to be transitory, news about future productivity improvements are not able to replicate the real appreciation of the currency and the current account deterioration along the boom as observed in the data. This result is related to the work of Aguiar and Gopinath (2007), who show that the observed strong counter-cyclicly of the current account in emerging economies can be explained by productivity trend shocks in a standard real business cycle model. In our case, cycles are generated by miss-perceptions about future productivity growth rather than actual changes in this variable.

According to our model, a boom-bust cycle generated by domestic agents overoptimism is

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<sup>1</sup>A similar pattern can also be observed in industrial economies, such as the US at the end of the 1990s, and in emerging markets at the end of the 1970s.

observational equivalent to a cycle driven by exogenous fluctuations in foreign financial conditions. Several authors have claimed that swings in external financial conditions were significant factors behind the observed patterns of macroeconomic variables during the 1990s in many emerging markets (Neumeyer and Perri, 2005; Uribe and Yue, 2006; Valdés, 2007). In this sense, our results can be interpreted as a plausible alternative –although complementary– explanation for the episodes of abrupt current account deterioration in emerging markets during the 1990s.

Among the policy implications, our model show that the trade-offs faced by the monetary policy in a boom-bust cycle driven by expectations are not trivial. If the central bank tries to stabilize output, the result will be a large fall in inflation and a contraction in output in the tradable goods sector. On the other hand, if the central bank targets inflation more strictly, then the boom in activity, the current account deterioration and the exchange rate appreciation will be larger, and the subsequent recession more severe. If we modify the policy rule to include an endogenous response of the interest rate to exchange rate fluctuation, then the perverse effects on the domestic tradable goods sector are only prevented in the short run, but the boom-bust cycle in other variables is amplified.

Expectations driven macroeconomic fluctuations may be drawn back to at least Pigou (1926). Recently, this hypothesis has received renewed attention in modern macroeconomics. Marfán (2005) analyzes boom-bust cycles provoked by excess optimism and concentrates mainly on the role of fiscal policy in an extended Mundell-Fleming context. The optimist-pessimist mood of the private sector in his model is completely exogenous. Beaudry and Portier (2004), Jaimovich and Rebelo (2006, 2007), Mertes (2007) and CIMR present different unique equilibrium rational expectation models where business cycles are generated by changes in expectations regarding productivity prospects. Jaimovich and Rebelo (2006, 2007) discuss which elements are needed in a standard Real Business Cycle (RBC) models to generate the co-movement observed in the data in response to non-materialized productivity shocks. They show that in a closed economy environment, adjust cost in investment and/or labor, variable capital utilization, and weak wealth effects on labor supply are key to replicate the co-movement in the data. In an open economy set up, variable capital utilization is not that crucial. CIMR, using a sticky-price sticky-wages model, emphasize the role played by the monetary policy in generating expectation driven boom-bust cycles. They show that to generate a sizeable output expansion and a boom in stock prices in response to news about increased future productivity, monetary policy has to respond aggressively to the induced fall in inflation. Thus, the boom is amplified by a loose monetary policy. Mertes (2007) shows that an expectation-driven RBC model is able to replicate relevant stylized facts of the Sudden Stop faced by Korea at the end of the 1990s.

The expectations driven business cycle approach in this literature is related to the literature on multiple equilibria and sunspots cycles (Farmer, 1993). It can also be view as complementary to

the literature on rational herding and information cascades lead cycles (Banerjee, 1992; Chamley and Gale, 1994; Caplin and Leahy, 1993 and Zeira, 1994). In particular, this strand of literature has emphasized how information may occasionally be aggregated improperly thereby leading to non-fundamental cycles. In this paper, we examining whether the quantitative implications of (rational/non-systematic) aggregate forecast errors can explain the observed pattern of recessions of small open economies within a fully specified dynamic model that features an unique general equilibrium.

The paper has five sections including this introduction. The second section provides a motivation about boom-bust cycles as well as a broad view of such cycles in the 1990s in Chile, Korea and Mexico. It also discusses stylized effects of structural reforms and innovations on future growth. The third section describes in a detailed way the theoretical model, and the calibration of the parameters. The fourth section analyzes the dynamics of the empirical model and discusses the tradeoffs faced by the monetary policy. The fifth and final section summarizes the main findings.

## 2 Structural Reforms and Boom-bust Cycles in Emerging Markets

During the 1980s and the 1990s several emerging market economies engaged in reforms. Also, at the beginning of the 1990s the concomitant global context was promissory: The fall of the Berlin wall was perceived as a generalized stimulus for accelerating and expanding market globalization, emerging economies had resumed access to voluntary financial flows under favorable conditions, and trade markets were mutating towards increasing levels of regional integration (NAFTA, EU, APEC, MERCOSUR and FTAA among many others). The international forums increasingly concentrated on TICS, a New International Financial Architecture, the expansion of market institutions in transition economies, the “New Economy”, etc. While this macro context was prone to boost productivity, the actual effect of the reforms, due to no previous precedent, was hard to evaluate.

### 2.1 Structural reforms and innovations

We define a systemic innovation as one which affects productivity of all firms, and may be generated by an intended public policy initiative (reform) or by an across the board technological change. So if  $F_{i,t}$  denotes the production function of a generic firm  $i$  at moment  $t$ , after the reform the concomitant production function would be  $F'_{i,t} = F_{i,t}A_t$ , where  $A_t$  measures the impact of the reform at instant  $t$ . Figure 1 exhibits different types of reforms initiated at  $t = 0$ .

First, we depict a Schumpeterian innovation such as the steam machine, electricity and, more recently, ICT. Initially there is a destruction of capital, jobs, skills and public goods related to the old technology, which dominates the creation process of the blossoming innovation. At longer horizons the benefits of the new technology outpace the costs of destroying the old one. It is possible that at a very long time span the  $A_t$  curve may turn concave showing decreasing returns. Second, we present the case of a pro-market reform (e.g., a trade-opening reform). Initially, as in the Schumpeterian case, there is a destruction of rents associated to the market imperfection removed, with a negative cost benefit balance. As time goes by, the balance improves converging to a long term productivity gain  $A^*$ , once the reform is completely internalized. A similar pattern would follow from an education-improving reform. There is an initial period where significant resources are deviated from other activities to implement the reform, with no immediate productive effects. The benefits of the reform start to be harvested when the new well educated generations are graduated, and the reform is completed once the labor force is entirely educated. Whichever the innovation introduced, there is no previous history permitting economic agents to accurately predict its impact through time. Agents may know the functional form followed by  $A_t$  through time but the values of certain parameters such as  $A^*$  are initially uncertain. In this context, agents react initially setting notional values for  $A^*$ , which may differ from their actual values.

In all cases, it takes time for the reforms to materialize into actual productivity gains, making it hard to evaluate ex-ante their real impact.

Figure 2 provides an example on how an assessment of the “long-term” productivity may have evolved over time in the case of Chile. When “long-term” productivity growth is calculated using a 1960-1990 sample, we observe a gloomy behavior of overall efficiency. Using the samples 1960-1993 and 1960-1997 show not only a much more buoyant scenario for the years added, but they also rewrite the history of the late 1980s. The 1960-2012 sample shows that, although there was a basis for optimism, contemporaneous data on TFP may lead to a less optimistic assessment about the future.<sup>2</sup>

## 2.2 Some Stylized Facts

We describe some stylized facts for three selected emerging markets that engaged in reforms and experienced a boom-bust cycle during the 90s: Chile, Korea and Mexico.

Although Chile had introduced reforms since the 1980s, as of 1990 the democratic administrations gave high priority to overall macroeconomic equilibrium, and reinforced and deepened the

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<sup>2</sup>Data from 2007 to 2012 correspond forecast made by the committee of experts that defines key fiscal policy parameters.

structural reforms. The signaling to economic agents was that a strong impulse to productivity growth was coming. Jadresic and Zahler (2000) claim, based on a time series modelling, that key factors underlying the rapid productivity growth in the 1990s were deepening of the democracy and the introduction of new structural reforms. Mexico engaged in a trade liberalization policy with the US and Canada during the 1990s that involved future opening of its economy to trade and capital flows. Before that, a stabilization plan was implemented at the end of the 1980s. At the same time, a privatization program was carried over. Korea, prior to the financial crisis of 1997, had experienced a long period of rapid growth, low inflation, and a sustained improvement in standards of living. High domestic savings and investment contributed to the rapid transformation of Korea. The government had begun an economic reform program—which gained momentum in 1993-96— to gradually liberalize financial markets and the capital account.

Figure 3 presents some stylized facts for the three economies for the period 1990-2002.<sup>3</sup> In all three cases we identify a phase where output rises above trend together with an increase in investment and consumption. During the boom phase, we also observe a real appreciation of the currency and current account deterioration in the three countries. For Mexico, the expansion in output was less dramatic than in Korea and Chile, but the consumption boom was comparable to the one in those countries. In all three cases, there was an abrupt reversion of the boom, with a fall in output, consumption and investment, and a steep reversion of the current account deficit. In Mexico and Korea, the bust coincided with a depreciation of the currency of almost 40%. In Chile, the depreciation of the currency during the bust was slower than in the other two countries.

The boom-bust cycle in these three countries involved swings in output and consumption of about 10% in a brief period of time. In the case of investment, swings were much larger, with differences of more than 20% from peak to trough. In Mexico and Chile the contraction of the current account deficit did not lead to a surplus in this variable. For Korea, the current account deficit of almost 6% of GDP was followed by a similar surplus a couple of years after the peak of the boom. Unlike Chile and Mexico, Korea had a stunning recovery from the Asian Crisis and output regained its pre-crisis level. In the case of Chile, growth has not recovered the 1990's rate.

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<sup>3</sup>To build the stylized facts we use Chilean quarterly data for the period 1990:Q1 to 2002:Q4 from the Central Bank of Chile and the National Institute of Statistics (INE). For Mexico and Korea the source is the IFS. For all series, we applied an HP filter with a large smoothing parameter ( $\lambda = 3 \times 10^6$ ) in order to obtain an almost lineal trend. Once we have the filtered series we compute the respective cycles. Then we proceeded to filter again these series in order to obtain a smoother pattern.

### 3 Model Economy

In this section, we present a multi-sector small open economy model with short-run nominal and real rigidities. The model is aimed at replicating prominent features of business cycles of emerging market economies. There are two domestic productive sectors: one that produces tradable goods ( $H$ ) and another that produces non-tradable goods ( $N$ ). Domestic agents also import foreign goods ( $F$ ). Prices and wages are sticky in the short-run, and the exchange rate pass-through to imported goods price is incomplete in the short run. Households exhibit habits in their preferences, investment is subject to incremental adjustment costs and the utilization rate of capital is variable. The introduction of nominal and real rigidities is meant to generate richer and more realistic propagation mechanisms.

#### 3.1 Households

The domestic economy is inhabited by a continuum of households indexed by  $j \in [0, 1]$ . At time  $t$ , household  $j$  maximizes the expected present value of its utility which is given by:

$$U_t(j) = E_t \left\{ \sum_{i=0}^{\infty} \beta^i \left[ \log(C_{t+i}(j) - hC_{t+i-1}) + \frac{\zeta_M}{\mu} \left( \frac{\mathcal{M}_{t+i}(j)}{P_{C,t+i}} \right)^\mu - \zeta_L \frac{l_{t+i}(j)^{1+\sigma_L}}{1+\sigma_L} \right] \right\}, \quad (1)$$

where  $l_t(j)$  is labor effort,  $C_t(j)$  is its total consumption, and  $\mathcal{M}_t(j)$  corresponds to nominal balances held at the beginning of period  $t$ . Parameter  $\sigma_L$  is the inverse real-wage elasticity of labor supply. Habit formation in preferences is determined by parameter  $h$ . Household  $j$  consumes a basket composed of tradable goods,  $C_T$ , and non-tradable goods,  $C_N$ :

$$C_t(j) = \left[ \alpha_C^{1/\eta_C} (C_{T,t}(j))^{\frac{\eta_C-1}{\eta_C}} + (1-\alpha_C)^{1/\eta_C} (C_{N,t}(j))^{\frac{\eta_C-1}{\eta_C}} \right]^{\frac{\eta_C}{\eta_C-1}},$$

Traded goods are a composite of domestically produce tradable goods ( $H$ ) and imported goods ( $F$ ),  $C_{T,t}(j) = \left[ \gamma_C^{1/\omega_C} (C_{H,t}(j))^{\frac{\omega_C-1}{\omega_C}} + (1-\gamma_C)^{1/\omega_C} (C_{F,t}(j))^{\frac{\omega_C-1}{\omega_C}} \right]^{\frac{\omega_C}{\omega_C-1}}$ . Parameters  $\alpha_C$  and  $\gamma_C$  determine the share of each type of goods in the consumption basket while  $\eta_C$  and  $\omega_C$  are the price elasticities associated. By minimizing the cost of the consumption basket, and aggregating all households, we obtain the aggregate demands for the three types of goods. The consumption price index (CPI) is given by  $P_{C,t} = \left( \alpha_C P_{T,t}^{1-\eta_C} + (1-\alpha_C) P_{N,t}^{1-\eta_C} \right)^{\frac{1}{1-\eta_C}}$ , where  $P_{T,t}$  is the price index of the tradable consumption basket (which includes imported and domestic tradable goods), and  $P_{N,t}$  is the price index of non-tradable goods.

##### 3.1.1 Consumption-savings decisions

Households have access to three types of assets: money  $\mathcal{M}_t(j)$ , one-period non-contingent foreign bonds (denominated in foreign currency)  $B_t^*(j)$ , and one-period domestic contingent bonds

$\mathcal{D}_{t+1}(j)$  which pays out one unit of domestic currency in a particular state (state contingent securities). The budget constraint of households  $j$  is given by:

$$P_{C,t}C_t(j) + E_t \{d_{t,t+1}\mathcal{D}_{t+1}(j)\} + \frac{\mathcal{E}_t B_t^*(j)}{(1+i_t^*)\Theta(\mathcal{B}_t)} + \mathcal{M}_t(j) = \\ W_t(j)l_t(j) + \Pi_t(j) - \mathcal{T}_t + \mathcal{D}_t(j) + \mathcal{E}_t B_{t-1}^*(j) + \mathcal{M}_{t-1}(j),$$

where  $\Pi_t(j)$  are profits received from domestic firms,  $W_t(j)$  is the nominal wage set by the household,  $\mathcal{T}_t$  is per-capita lump-sum net taxes from the government, and  $\mathcal{E}_t$  is the nominal exchange rate (expressed as units of domestic currency per one unit of foreign currency). Variable  $d_{t,t+1}$  is the period  $t$  price of one-period domestic contingent bonds normalized by the probability of the occurrence of the state. Assuming the existence of a full set of contingent bonds ensures that consumption of all households is the same, independently of the labor income they receive each period.

Variable  $i_t^*$  is the interest rate on foreign bonds denominated in foreign currency, and  $\Theta(\cdot)$  is a premium domestic households have to pay when borrowing from abroad. This premium is function of the net foreign asset positions relative to GDP,  $\mathcal{B}_t = \frac{\mathcal{E}_t B_t^*}{P_{Y,t}Y_t}$  where  $P_{Y,t}Y_t$  is nominal GDP and  $B_t^*$  is the aggregate net asset position of the economy.<sup>4</sup>

Each household chooses a consumption path and the composition of its portfolio by maximizing (1) subject to its budget constraint. The first order conditions on different contingent claims over all possible states define the following Euler equation for consumption:

$$\beta E_t \left\{ (1+i_t) \frac{P_{C,t}}{P_{C,t+1}} \left( \frac{C_{t+1}(j) - hC_t}{C_t(j) - hC_{t-1}} \right) \right\} = 1, \quad (2)$$

where  $i_t$  is the domestic risk-free interest rate. From this expression and the first order condition with respect to foreign bonds denominated in foreign currency we obtain the following expression for the uncovered interest parity (UIP) condition:

$$\frac{1+i_t}{(1+i_t^*)\Theta(\mathcal{B}_t)} = E_t \frac{\mathcal{E}_{t+1}}{\mathcal{E}_t} + cov_t. \quad (3)$$

where  $cov_t$  is a covariance term that disappears in the log-linear version of the model.

### 3.1.2 Labor supply and wage setting

Each household  $j$  is a monopolistic supplier of a differentiated labor service. There is a set of perfectly competitive labor service assemblers that hire labor from each household and combine

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<sup>4</sup>In the steady state we assume that  $\Theta(\cdot) = \Theta$  and  $\frac{\partial}{\partial \mathcal{B}} \Theta = \varrho$ . When the country is a net debtor,  $\varrho$  corresponds to the elasticity of the upward-sloping supply of international funds. This premium is introduced mainly as a technical device to ensure stationarity (see Schmitt-Grohé and Uribe, 2001).

it into an aggregate labor service unit. This labor unit is then used as an input in production of domestic tradable ( $H$ ) and non-tradable ( $N$ ) sectors. Cost minimization by labor unit assemblers give rise to demands for each type of labor services, which are function of the corresponding relative wages.

Following Erceg *et al.* (2000) we assume that wage setting is subject to a nominal rigidity à la Calvo (1983). In each period, each type of household faces a probability  $1 - \phi_L$  of being able to re-optimize its nominal wage. In this setup, the parameter  $\phi_L$  determines the degree of nominal rigidity in wages. We assume that all those households that cannot re-optimize their wages follow an updating rule considering a geometric weighted average of past CPI inflation, and the inflation target set by the authority,  $\bar{\pi}$ . Once a household has set its wage, it must supply any quantity of labor service demanded at that wage. A particular household  $j$  that is able to re-optimize its wage at  $t$  must solve the following problem:

$$\max_{W_t(j)} = E_t \left\{ \sum_{i=0}^{\infty} \phi_L^i \Lambda_{t,t+i} \left[ \frac{\Gamma_{W,t}^i W_t(j)}{P_{C,t+i}} l_{t+i}(j) - \zeta_{L,t} \frac{l_{t+i}(j)^{1+\sigma_L}}{1+\sigma_L} (C_{t+i} - hC_{t+i-1}) \right] \right\}$$

subject to labor demand and the updating rule for the nominal wage of agents who do not optimize defined by function  $\Gamma_{W,t}^i = \Gamma_{W,t}^{i-1} (1 + \pi_{t+i-1})^{\chi_L} (1 + \bar{\pi})^{1-\chi_L}$ . Variable  $\Lambda_{t,t+i}$  is the relevant discount factor between periods  $t$  and  $t+i$ .<sup>5</sup> These elements give rise a Phillips curve for nominal wages that has backward and forward looking components.

### 3.2 Investment and capital goods

A representative firm owns and rents capital to firms producing in the domestic tradable ( $H$ ) and non-tradable ( $N$ ) sectors. We assume that capital is specific to the sector that rents it. Hence, the representative firm decides how much of each type of capital to accumulate over time. The flow of investment devoted to produce new capital goods for sector  $J$ ,  $I_t(J)$ , is assembled using the following technology:

$$I_t(J) = \left[ \alpha_I^{1/\eta_I} I_{T,t}(J)^{\frac{\eta_I-1}{\eta_I}} + (1 - \alpha_I)^{1/\eta_I} I_{N,t}(J)^{\frac{\eta_I-1}{\eta_I}} \right]^{\frac{\eta_I}{\eta_I-1}} \quad J = H, N$$

where  $I_{T,t}(J) = \left[ \gamma_I^{1/\omega_I} I_{H,t}(J)^{\frac{\omega_I-1}{\omega_I}} + (1 - \gamma_I)^{1/\omega_I} I_{F,t}(J)^{\frac{\omega_I-1}{\omega_I}} \right]^{\frac{\omega_I}{\omega_I-1}}$  is a composite of tradable goods devoted to investment in sector  $J$ . Variable  $I_{D,t}(J)$  corresponds to the amount of good  $D = H, F, N$  used in the assemblage of new capital goods for sector  $J$ .

The representative firm may adjust investment each period, but changing the flow of investment is costly. This assumption is introduced as a way to obtain more inertia in the demand

<sup>5</sup>Since utility exhibits habit formation in consumption the relevant discount factor is given by  $\Lambda_{t,t+i} = \beta^i \left( \frac{C_t(j) - hC_{t-1}}{C_{t+i}(j) - hC_{t+i-1}} \right)$ .

for investment (see Christiano *et al.* (2005)).<sup>6</sup> Let  $Z_t(J)$  and  $u_t(J)$  be the rental price and the utilization rate of capital in sector  $J$ . The representative firm must solve the following problem for each type of capital :

$$V_t(J) = \max_{K_{t+i}(J), I_{t+i}(J), u_{t+i}(J)} E_t \left\{ \sum_{i=0}^{\infty} \Lambda_{t,t+i} \frac{u_{t+i}(J) Z_{t+i}(J) K_{t+i}(J) - P_{I,t+i} I_{t+i}(J)}{P_{C,t+i}} \right\},$$

subject to the law of motion of the capital stock for sector  $J$ ,

$$K_{t+1}(J) = [1 - \delta(u_t(J))] K_t(J) + S \left( \frac{I_t(J)}{I_{t-1}(J)} \right) I_t(J), \quad (4)$$

where  $\delta(u_t)$  is the depreciation rate, which is a function of the utilization rate of capital. We assume that  $\delta(u_t)$  is an increasing function, which implies that higher utilization rate depreciates physical capital faster. Function  $S(\cdot)$  characterizes the adjustment cost for investment. This adjustment cost function satisfies:  $S(1 + g_y) = 1$ ,  $S'(1 + g_y) = 0$ ,  $S''(1 + g_y) = -\mu_S < 0$ , where  $g_y$  is the per capita growth rate of the economy in the steady state.

The optimally conditions for the problem above are the following:

$$\frac{P_{I,t}}{P_{C,t}} = \frac{Q_t(J)}{P_{C,t}} \left[ S \left( \frac{I_t(J)}{I_{t-1}(J)} \right) + S' \left( \frac{I_t(J)}{I_{t-1}(J)} \right) \frac{I_t(J)}{I_{t-1}(J)} \right] - E_t \left\{ \Lambda_{t,t+1} \frac{Q_{t+1}(J)}{P_{C,t+1}} \left[ S' \left( \frac{I_{t+1}(J)}{I_t(J)} \right) \left( \frac{I_{t+1}(J)}{I_t(J)} \right)^2 \right] \right\}, \quad (5)$$

$$\frac{Q_t(J)}{P_{C,t}} = E_t \left\{ \Lambda_{t,t+1} \left[ \frac{Z_{t+1}(J)}{P_{C,t+1}} + \frac{Q_{t+1}(J)}{P_{C,t+1}} (1 - \delta(u_t(J))) \right] \right\}, \quad (6)$$

$$\frac{Z_t(J)}{P_{C,t}} = \delta'(u_t(J)) \frac{Q_t(J)}{P_{C,t}}. \quad (7)$$

Variable  $\frac{P_{I,t}}{P_{C,t}}$  is the real cost of producing new capital goods (the price of the investment bundle deflated by the CPI), where  $P_{I,t} = \left[ \alpha_I P_{I,T,t}^{1-\eta_I} + (1 - \alpha_I) P_{N,t}^{1-\eta_I} \right]^{\frac{1}{1-\eta_I}}$  and  $P_{I,T,t} = \left[ \gamma_I P_{H,t}^{1-\omega_I} + (1 - \gamma_I) P_{F,t}^{1-\omega_I} \right]^{\frac{1}{1-\omega_I}}$ . Equations (5), (6) and (7) simultaneously determine the evolution of the shadow price of capital,  $Q_t(J)$ , real investment expenditure, and the utilization rate of capital for each sector.

### 3.3 Domestic production

There is a large set of firms that use a CES technology to assemble intermediate varieties into *Home* goods sold to households, to firms producing new capital goods and to foreign agents.

<sup>6</sup>This assumption is a short-cut to more cumbersome approaches to model investment inertia, such as time-to-build.

There is also a large set of firms that use a similar CES technology to assemble intermediate varieties into *non-tradable* goods sold to households, and firms producing new capital goods.

Let  $Y_{N,t}$  be the total quantity of *non-tradable* goods sold to domestic agents (households and the representative firm assembling new capital goods). The demand for a generic variety  $z_N$  to assemble *non-tradable* goods is given by:

$$Y_{N,t}(z_N) = \left( \frac{P_{N,t}(z_N)}{P_{N,t}} \right)^{-\epsilon_N} Y_{N,t}, \quad (8)$$

where  $P_{N,t}(z_N)$  is the price of variety  $z_N$ . Analogously, let  $Y_{H,t}$  be quantity of *Home* goods sold domestically, and  $Y_{H,t}^*$  the quantity sold abroad. The demands for a particular variety  $z_H$  to assemble these goods are given by

$$Y_{H,t}^*(z_H) = \left( \frac{P_{H,t}^*(z_H)}{P_{H,t}^*} \right)^{-\epsilon_H} Y_{H,t}^* \quad Y_{H,t}(z_H) = \left( \frac{P_{H,t}(z_H)}{P_{H,t}} \right)^{-\epsilon_H} Y_{H,t} \quad (9)$$

where  $P_H(z_H)$  is the price of the variety  $z_H$  when used to assemble *Home* goods sold in the domestic market, and  $P_{H,t}^*(z_H)$  is the foreign-currency price of this variety when used to assemble *Home* goods sold abroad. Variables  $P_{H,t}$  and  $P_{H,t}^*$  are the corresponding aggregate price indices. The foreign demand for *Home* goods,  $Y_{H,t}^*$ , is given by,  $Y_{H,t}^* = \zeta^* \left( \frac{P_{H,t}^*}{P_t^*} \right)^{-\eta^*} Y_t^*$ , where  $Y_t^*$  is foreign output,  $\zeta^*$  corresponds to the share of domestic intermediate goods in the consumption basket of foreign agents, and  $\eta^*$  is the price elasticity of the demand.

Intermediate varieties in tradable and non-tradable sectors are produced by monopolistically competitive firms. These firms maximize profits by choosing the prices of their differentiated variety subject to the corresponding demands, and the available technology. Let  $\mathbf{Y}_{J,t}(z_J)$  be the total quantity produced of a particular variety  $z_J$  in sector  $J = H, N$ . The available technology is given by:

$$\mathbf{Y}_{J,t}(z_J) = A_{J,t} [T_t l_t(z_J)]^{\eta_J} [u_t(J) K_t(z_J)]^{1-\eta_J}, \quad \text{for } J = N, H \quad (10)$$

where  $l_t(z_J)$  is the amount of labor and  $K_t(z_J)$  is the amount of physical capital utilized in production. Parameter  $\eta_J$  defines factor in production. The variable  $A_{J,t}$  represents a stationary productivity shock common to all firms in sector  $J$  while  $T_t$  is a stochastic trend in labor productivity that is common in both domestic sectors ( $H$  and  $N$ ). Below we discuss the process followed by these shocks.

We assume that the adjustment in prices of the domestic varieties face nominal rigidities à la Calvo. In every period, the probability that a firm *Home* goods receives a signal for adjusting its price for the domestic market is  $1 - \phi_{H_D}$ , and the probability of adjusting its price for the foreign market is  $1 - \phi_{H_F}$ . Analogously, the probability that a firm producing non-tradable varieties receives a signal for adjusting its price is  $1 - \phi_N$ . These probabilities are the same for all firms,

independently of their history. If a firm does not receive a signal, it updates its price following a simple rule that weights past inflation and the inflation target set by the central bank. Thus, when a firm receives a signal to adjust its price it maximizes the discounted expected value of its profits, conditional on having to passively update its price for a number of periods, and subject to (9) or (8). Given this pricing structure, the paths for inflation of domestic tradable ( $H$ ) and non-tradable ( $N$ ) goods are given by New Keynesian Philips curves with indexation. In their log-linear forms, inflation in sector  $J$  depends on both last period's inflation, expected inflation next period and marginal cost in sector  $J$ .

### 3.4 Import goods retailers

We introduce local-currency price stickiness in order to allow for incomplete exchange rate pass-through into import prices in the short-run. This feature of the model is important in order to mitigate the expenditure switching effect of exchange rate movements for a given degree of substitution between foreign and home goods.

There is a set of competitive assemblers that use a CES technology to combine a continuum of differentiated imported varieties to produce a final *foreign* good  $Y_F$ . This good is consumed by households and used for assembling new capital goods. The optimal mix of imported varieties in the final *foreign* good defines the demands for each of them. In particular, the demand for variety  $z_F$  is given by:

$$Y_{F,t}(z_F) = \left( \frac{P_{F,t}(z_F)}{P_{F,t}} \right)^{-\epsilon_F} Y_{F,t}, \quad (11)$$

where  $\epsilon_F$  is the elasticity of substitution among imported varieties,  $P_{F,t}(z_F)$  is the domestic-currency price of imported variety  $z_F$  in the domestic market, and  $P_{F,t}$  is the aggregate price of import goods in this market.

Importing firms buy varieties abroad and re-sales them domestically to assemblers. Each importing firm has monopoly power in the domestic retailing of a particular variety. They adjust the domestic price of their varieties infrequently, only when receiving a signal. The signal arrives with probability  $1 - \phi_F$  each period. As in the case of domestically produced varieties, if a firm does not receive a signal it updates its price following a “passive” rule that weights past inflation and the inflation target set by the central bank. Therefore, when a generic importing firm  $z_F$  receives a signal, it chooses a new price by maximizing the discounted sum of expected profits subject to the domestic demand for variety  $z_F$  (11) and the updating rule.

Under this specification, changes in the nominal exchange rate will not immediately be passed through into prices of imported good sold domestically. Therefore, exchange rate pass-through will be incomplete in the short-run. In the long-run, firms freely adjust their prices, so the

law-of-one-price for *Foreign* goods holds up to a constant.<sup>7</sup>

### 3.5 Monetary policy rule

Monetary policy is characterized as a simple feedback rule for the interest rate. Under the baseline specification of the model, we assume that the central bank responds to contemporaneous deviations of CPI inflation from target and to deviations of total output from its balanced growth trend.

$$\frac{1+i_t}{1+i} = \left( \frac{1+i_{t-1}}{1+i} \right)^{\psi_i} \left( \frac{Y_t}{\bar{Y}_t} \right)^{(1-\psi_i)\psi_y} \left( \frac{1+\pi_t}{1+\bar{\pi}} \right)^{(1-\psi_i)\psi_\pi}$$

where  $\pi_t = P_{C,t}/P_{C,t-1} - 1$  is consumption price inflation,  $i$  is the steady state value for the nominal interest rate,  $\bar{\pi}$  is the inflation target, and  $\bar{Y}_t$  is the output trend.

### 3.6 Aggregate equilibrium

Once firms producing domestic varieties set their prices, they must supply any quantity demanded at those given prices. Therefore, the market clearing condition for each variety implies that:

$$\mathbf{Y}_{N,t}(z_N) = \left( \frac{P_{N,t}(z_N)}{P_{N,t}} \right)^{-\epsilon_N} Y_{N,t}$$

$$\mathbf{Y}_{H,t}(z_H) = \left( \frac{P_{H,t}(z_H)}{P_{H,t}} \right)^{-\epsilon_H} Y_{H,t} + \left( \frac{P_{H,t}^*(z_H)}{P_{H,t}^*} \right)^{-\epsilon_H} Y_{H,t}^*$$

where  $Y_{N,t} = C_{N,t} + I_{N,t}(H) + I_{N,t}(N)$  and  $Y_{H,t} = C_{H,t} + I_{H,t}(H) + I_{H,t}(N)$ , and where  $Y_{H,t}^*$  was defined above. The equilibrium requires that total labor demanded by intermediate varieties producers must be equal to labor supply:  $\int_0^1 l_t(z_H) dz_H + \int_0^1 l_t(z_N) dz_N = l_t$ , where  $l_t$  is aggregate labor service. Also, the demand for physical capital in sector  $J$  has to be equal to the available amount of it:  $\int_0^1 K_t(z_J) dz_J = K_t(J)$  for  $J = H, N$ .

Using the equilibrium conditions in the goods and labor markets, and the budget constraint of households and the government we obtain the following expression for the evolution of the net foreign asset position:

$$\frac{\mathcal{B}_t}{(1+i_t^*)\Theta(\mathcal{B}_t)} = \mathcal{B}_{t-1} \frac{P_{Y,t-1}Y_{t-1}}{P_{Y,t}Y_t} + \frac{P_{X,t}X_t}{P_{Y,t}Y_t} - \frac{P_{M,t}M_t}{P_{Y,t}Y_t},$$

where  $\mathcal{B}_t$  is the aggregate net (*liquid*) asset position of the economy vis-a-vis the rest of the world relative to nominal GDP, and  $P_{Y,t}Y_t = P_{C,t}C_t + P_{I,t}I_t + P_{X,t}X_t - P_{M,t}M_t$  is the nominal GDP –measured from demand side. Nominal imports and exports are given by  $P_{M,t}M_t = \mathcal{E}_t P_{F,t}^* Y_{F,t}$

<sup>7</sup>Formally, in the long-run  $P_F = \frac{\epsilon_F}{\epsilon_F - 1} \mathcal{E} P_F^*$ .

and  $P_{X,t}X_t = \mathcal{E}_t P_{H,t}^* Y_{H,t}^*$ , respectively. The total quantity of imported goods is  $Y_{F,t} = C_{F,t} + I_{F,t}(H) + I_{F,t}(N)$ .

### 3.7 Model calibration and solution

To solve the model we first tackle the non-stochastic steady-state by using numerical methods. Then we solve the log-linearized decision rules from the behavioral equations of the model. We use the  $QZ$  factorization described in Uhlig (1997). Table 1 presents the value chosen for the structural parameters of the model. The calibration is meant to characterize quarterly data. Many of the parameters were taken directly from the literature. Some other parameters were chosen so as to match long-run features of the Chilean economy. In our simulations, productivity shocks are calibrated so as to match the observed expansion in output during the Chilean boom of the period 1995-2001, as discussed above.

## 4 Boom-bust Cycles in Small Open Economies

Using the model described in the previous section we analyze boom-bust episodes in open economies. We use Chile as a reference country to evaluate the qualitative and quantitative implications of the model. First, we consider a case of favorable external financial conditions that are abruptly reversed. We then analyze the case of overoptimistic perception about future productivity. As recently shown by CIMR (2007) in the context of a closed economy model, this type miss-perception may lead to a boom-bust cycle similar to the one described in section 2. In contrast to CIMR (2007), we show that in order to replicate the features of the boom-bust cycle in a small open economy, we need to consider shocks to productivity trends, very much in line with Aguiar and Gopinath (2007). Finally, we analyze the policy trade-offs faced by a monetary authority confronted with a boom-bust cycle induced by overoptimistic perceptions.<sup>8</sup>

In what follows, we define the real exchange rate in the model as the relative price of domestic tradable ( $H$ ) and non-tradable ( $N$ ) goods. The implied evolution of measured total factor productivity (TFP) is estimated in the model as an aggregate *Solow* residual (without adjusting for the capital utilization rate). We construct a similar measure using actual data for Chile.<sup>9</sup> The Tobin's  $Q$  is identified in the data with the stock market price, which in the case of Chile corresponds to an aggregate price index (*IPSA*). In the data, labor is measured as the ratio of

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<sup>8</sup>We do not analyze fiscal policy nor terms of trade shocks, which have also been relevant in the episodes described. We rather concentrate on expectation based boom-bust cycles and the role of conventional central bank policies.

<sup>9</sup>Formally,  $\ln(TFP_t) = \ln(Y_t) - \eta \ln(l_t) - (1 - \eta) \ln(K_t)$ , where  $\eta$  is the labor share in aggregate output.

formal employment to working age population and real wage corresponds an index of labor cost.<sup>10</sup>

#### 4.1 Foreign financial condition reversal

According to several authors, the boom-bust cycle in many emerging market economies during the 1990s was a consequence of changes in external financial conditions. This conclusion is based on the observation that periods of favorable external financial conditions are associated with economic expansions, while depressed economic activity coincides with periods of less beneficial foreign financial conditions (see e.g. Neumeyer and Perri, 2005; Uribe and Yue, 2006). Favorable external financial conditions at the beginning of the 1990s implied large capital flows to emerging market economies that produced an economic boom coupled with real exchange rate appreciations and current account deficits. The boom phase was then followed by an abrupt worsening in foreign financial conditions. Valdés (2007) describes a similar pattern around the period 1995-2001 for Chile, arguing that this behavior hinged partly on foreign financial factors.

To produce an initial boom in our model we assume an exogenous, highly persistent, decrease in the foreign interest rate ( $i^*$ ). The reversal in the favorable financial conditions is then modelled as an exogenous increase on the foreign interest rate back to its original level. We calibrate the size of the shock so that the boom in output roughly coincides with the data for Chile. Figure 4 presents the results of this exercise. The model produces expansions in output, labor, consumption and investment that are sharply reversed when the foreign interest rate returns back to its original level. During the expansion, the real exchange appreciates by 10% and the current account deficit (as GDP percentage) reaches a peak close to 6%. Contrary to what the data shows, the model predicts an initial fall in inflation and a subsequent rise in this variable as the exchange rate depreciates. The episode is accompanied by a rise in Tobin's Q for both types of capital. The boom in total output is driven by the evolution of output in the non-tradable goods sector. In fact, the real appreciation of the currency leads to an initial fall in output in the tradable goods sector. Overall, the story of a boom-bust cycle driven by changes in foreign financial conditions is able to satisfactorily account for the stylized facts for Chile.

#### 4.2 Overoptimistic perceptions

We explore now an alternative –though complementary– explanation for the boom-bust based on the idea that, rather than being caused by external factors, the cycle was triggered by the misperception of domestic private agents regarding future productivity prospects. As mentioned above, this idea has been recently formalized by CIMR in a fully specified closed economy model. We build on their approach to model overoptimistic news on future productivity improvements.

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<sup>10</sup>To construct the cyclical components for these series, we follow the same procedure described in footnote 3.

### 4.2.1 Transitory productivity shocks

We first assume that productivity in sector  $J = N, H$  is governed by the following stationary process,

$$a_{J,t} = \rho_{a_J} a_{J,t-1} + \zeta_{a_J,t-p} + \varepsilon_{a_J,t} \quad J = H, N \quad (12)$$

where  $a_{J,t} = \ln A_{J,t}$  and  $\varepsilon_{a_J,t} \sim N(0, \sigma_{a_J}^2)$  are *i.i.d.* innovations. The variable  $\zeta_{a_J,t-p}$  is a shock to the expected future productivity **level**  $p$ -periods ahead and is uncorrelated with  $\varepsilon_{a_J,t}$ . This shock captures the idea discussed in section 2, that structural reforms lead to expected changes in productivity. However, those changes take time to materialize and the agents do not exactly know the effective impact they have on productivity. Here, we assume that at time  $t$  private agents learn that a set of reforms were carried out and, given (12), they expected that productivity  $p$  period ahead will be given by

$$E_t [a_{J,t+p}] = \rho_{a_J}^p a_{J,t} + \zeta_{a_J,t}$$

where  $\zeta_{a_J,t} > 0$ . At time  $t + p$  agents learn that the productivity level did change by less than expected. For that, we introduce a shock  $\varepsilon_{a_J,t+p} < 0$  on productivity at  $t + p$ . Figure 5 presents the results of this exercise assuming  $p = 12$  and  $\rho_{a_J} = 0.999$  together with actual data for Chile.<sup>11</sup> We consider a case where news affect equally the expected productivity levels in both sectors ( $H$  and  $N$ ).<sup>12</sup>

As in CIMR the expected gain in productivity produces a boom in output. In our case, this is mainly due to the boom in the tradable goods sector. In fact, output in the non-tradable goods sector falls in the short run, and it increases afterwards. Consumption initially falls, but then it slowly expands in response to the expected increase in productivity. Labor rises during the boom phase due to the presence of sticky wages. When wages are flexible in our model, this expansion in labor does not longer hold.<sup>13</sup> This is coherent with Jaimovich and Rebelo (2007), who show that, under flexible wages, households preferences should exhibit a weak wealth effect on labor supply in order to generate a boom in labor in response to expected gains in productivity. In our case, preferences are standard, but the wealth effect on labor supply is muted due to sticky wages. Notice that total inflation falls along with the output boom. The reason is that expected future productivity gains mean lower future marginal costs. Since inflation is forward looking, firms respond by currently lowering their prices, despite of the rise in actual marginal cost associated to the expansion in labor and the rise in real wages.

Notice also that despite of the expected increase in future productivity, investment and the Tobin's  $Q$  in both sectors fall initially when the signal about future productivity arrives. Then,

<sup>11</sup>These productivity news shocks are highly persistent, but they are still transitory.

<sup>12</sup>Real quantities in figures below correspond to the normalized effects of the productivity shock, i.e., our simulations remove the effects of the actual improvement in productivity associated to the economic reforms.

<sup>13</sup>The simulation under flexible wages is available upon request.

these variables monotonically increase over time until the moment when agents learn that productivity is lower than expected. These predictions regarding the behavior of investment and the Tobin's Q during the news-induced boom-bust cycle are different than the one obtained by CIMR. In their monetary closed economy model the boom-bust cycle in output also coincides with a boom-bust cycle for investment and the Tobin's Q. The reason for such behavior of investment in response to news about future productivity in CIMR is the presence of low wage indexation to past inflation and an aggressive inflation-targeting policy rule for the central bank. In their case, given the fall of inflation below target, monetary policy follows a loose stance in response to the news shock. That helps rising the Tobin's Q and induces firms to increase investment. Low indexation to past inflation, in turn, helps to keep real wages rigid in the short run, amplifying the effects of overoptimistic shocks. In our calibration, we allow for a larger fraction of wages to be indexed to past inflation, and a less *hawkish* inflation targeting regime –more in line with standard parametrization for the monetary policy rule. In figure 5, we also present an alternative calibration of the model where we reduce the fraction of wages being indexed to past inflation (we set  $\chi_L = 0.1$ ) and increase the reaction of the interest rate to deviations of inflation from target in the policy rule (we set  $\psi_\pi = 2.0$ ). Under this alternative parametrization, the results of our simulation are in line with CIMR: Output, labor, consumption, investment and Tobin's Q simultaneously feature a boom-bust cycle.

While the qualitative results of this last exercise resemble some features of the stylized fact discussed in section 2, they fall short in comparison to the observed size of the boom-bust in investment and consumption in Chile. More importantly, the simulation misses two prominent features of the boom-bust cycles in emerging economies during the 1990s, namely, the real appreciation of the exchange rate and the current account deficit. Despite of the boom in consumption and investment –which tends to produce a deficit in the current account– the exchange rate depreciation leads to an improvement in net exports that offsets the negative impact on this variable associated with the expansion in consumption and investment. In other words, the expenditure switching effect induced by the depreciation of the currency dominates the intertemporal effect of the shock. The counterfactual behavior of the real exchange rate and the current account are even worse under the baseline calibration.

There are at least two reasons for why in a small open economy a loose monetary policy is not able to amplify boom-bust cycles as in CIMR (2007). First, in a closed economy, the policy interest rate determines the equilibrium between domestic investment and savings. In a open economy, investment can differ from domestic saving. Moreover, in an open economy both the domestic and the foreign interest rates are relevant to determine the cost of financing. If the foreign interest rate is constant –and the country does not face external borrowing constraints– the domestic monetary policy is less powerful to affect the relevant cost of financing. As a result,

the response of investment to a signal shock is less intense. Second, the increase in private consumption in response to a future expected increase in productivity depends on the expected present value of private income. In a closed economy, the sequence of interest rates relevant to discount future incomes is determined by the monetary policy. Thus, if monetary policy is expansive in response to a signal shock, the perceived increase in the present value of income is amplified. In a small open economy facing a constant foreign interest rate, the monetary policy does not determine alone the relevant interest rate to discount expected future incomes. Hence, a loose monetary policy has limited impact in amplifying the boom in consumption.

As mentioned, the model fails at producing a real appreciation of the currency along the boom phase of the cycle. In a two sector small open economy, with tradable and non-tradable goods, a real appreciation of the currency requires an increase in real wages. In the case of CIMR, part of the mechanism that produces the boom is the combination of rigid nominal wages with a strict inflation targeting that prevents an upward adjustment in real wages. Therefore, if we rely on more rigid real wages to produce a sizable boom-bust cycle we will not be able to produce a significant real appreciation of the currency along the cycle.

#### 4.2.2 Permanent productivity shocks

Aguiar and Gopinath (2007) have argued that in the case of emerging market economies, rather than productivity level shocks, stochastic productivity trends are a major source of business cycle fluctuations. Moreover, these types of shocks are able to explain the observed co-movement in major aggregate variables in these economies. In particular, shocks to the trend are better equipped to produce strongly counter-cyclical current accounts as observed in emerging economies. Interestingly, trend shocks can generate these co-movement without relying on household preferences that remove wealth effects in the labor supply.<sup>14</sup>

In what follows, we analyze the case of news shocks about future productivity trends. To that end, we assume that the natural logarithm of the stochastic trend of labor productivity,  $T_t$ , evolves according to the following expression:

$$\tau_{T,t} = \tau_{T,t-1} + (1 - \rho_T) \ln(1 + g_y) + \rho_T \Delta \tau_{T,t-1} + \zeta_{T,t-p} + \varepsilon_{T,t} \quad (13)$$

where  $\tau_{T,t} = \ln(T_t)$  and  $\varepsilon_{T,t} \sim N(0, \sigma_T^2)$  are *i.i.d.* innovations. A shock  $\zeta_{T,t-p}$  leads to an increase in the labor productivity **trend**  $p$ -periods ahead. We assume that this shock is uncorrelated with  $\varepsilon_{T,t}$ . If agents receive a signal  $\zeta_{T,t} > 0$  at time  $t$  they expect that  $p$ -periods ahead productivity will grow faster:

$$E_t [\Delta \tau_{T,t+p}] = \rho_T^p [\Delta \tau_{T,t} + (1 - \rho_T) \ln(1 + g_y)] + \zeta_{T,t}$$

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<sup>14</sup>See Correia *et al.* (1995) for an analysis of the aggregate dynamics in a small open economy without wealth effects in the labor supply.

As in the case of news about productivity **levels**, we consider a shock  $\varepsilon_{T,t+p} < 0$  in period  $t + p$  to capture the idea that the news about expected productivity growth turns out to be overoptimistic ex-post.

Figure 6 presents the trajectories of the endogenous variables to an expected shock to the trend in the future that does not materialize when  $p = 12$  and  $\rho_T = 0.999$ . These trajectories were obtained using the baseline calibration of the model.<sup>15</sup> The qualitative results of this shock are similar to the one obtain with a positive signal to the productivity level in the future. We observe a boom-bust episode in output, labor, investment and consumption. Interestingly, the quantitative pattern followed by the last three variables resembles more closely the data than in the previous case. Notice also that a positive news regarding future productivity **trend** generates a real appreciation of the exchange rate as in the stylized facts reported above. The deficit of the current account reaches almost 7% which is also very similar to what happened in Chile in the late 1990s, previous to the Asian crisis. In our model, the real appreciation also explains why the boom in output is mainly focussed in the non-tradable goods sector. This is completely different to the case of productivity **level** signal, where the boom is explained by the expansion of the tradable goods sector. In the bust phase, as the expected increase in productivity growth does not materialize, the real exchange rate depreciates and the current account deficit reverses. Also, there is a recession in output, and aggregate demand falls.

Despite the fact that productivity does not change, the measured TFP in the model rises above trend during the boom phase and falls during the bust phase. This pattern resembles the observed evolution of TFP constructed with actual Chilean data, highlighting the strong procyclicly of this variable. The model also predicts an increase in the Tobin's Q during the boom and a subsequent fall in this variable during the recession. However, the size of the cycle of this variable is smaller than the observed in stock prices for Chile during the 1990s. The model is also not able to closely replicate the behavior of the inflation in Chile.

Notice that in our model, the boom-bust cycle episode does not arise as a consequence of a loosening in the monetary policy in response to a fall in inflation, as in CIMR. Notice also that the dynamics of several variables in response to an overoptimistic signal regarding future productivity trends are observational equivalent to the ones obtained from a reversal in foreign financial conditions. Thus, overconfidence in productivity prospects is able to satisfactorily generate the boom-bust episode observed in emerging economies without any actual change in the economic fundamentals.

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<sup>15</sup>As with the productivity **level** news, we normalize the effects removing actual effect in the productivity **trend**.

### 4.3 Monetary Policy Trade-offs

To discuss the different trade-offs faced by the monetary policy in a boom-bust episode such as the one described, we analyze the implication of alternative policy rules. First, we consider two alternative rules, one that react strongly to inflation and another that responds strongly to output. Second, we consider a rule where the monetary policy responds not only to output and inflation but also to real exchange rate fluctuations. In all simulations below, we consider the responses after a signal to productivity **trend**.

Figure 7 presents the baseline scenario altogether with a rule that is more aggressive to inflation and a rule that is more aggressive to output fluctuations. If the monetary policy focuses on following a more strict inflation targeting ( $\psi_\pi = 3$ ), the boom in output, consumption and investment would be larger because monetary policy takes a more expansive stance. As a result, the deficit in the current account would also be larger and the real appreciation would be slightly smaller. On the other hand, if the monetary policy tries to stabilize more aggressive output ( $\psi_y = 0.8$ ), then it would induce a larger negative deviation of inflation from target, and also a larger appreciation of the currency. Given this currency appreciation, output stabilization rests proportionally more on tradable output than on non-tradable output. The higher interest rate implied by this policy reduces the boom in the Tobin's Q in both sectors and the current account deficit.

In the case of a central bank that responds to exchange rate fluctuations, we modify the policy rule as follows:

$$\frac{1 + i_t}{1 + i} = \left( \frac{1 + i_{t-1}}{1 + i} \right)^{\psi_i} \left( \frac{Y_t}{\bar{Y}_t} \right)^{(1-\psi_i)\psi_y} \left( \frac{1 + \pi_t}{1 + \bar{\pi}} \right)^{(1-\psi_i)\psi_\pi} \left( \frac{RER_t}{\overline{RER}} \right)^{(1-\psi_i)\psi_{rer}}$$

where  $RER_t$  is the real exchange rate and  $\overline{RER}$  is its steady state value. We calibrate  $\psi_{rer}$  to 0.2. The rest of the parameters of the rule are same as in the baseline calibration. This policy rule is motivated by the Chilean experience during the 1990s when the Central Bank had simultaneously a target for inflation and a target zone for the exchange rate as a way of avoiding excessive fluctuation in this last variable. Figure 8 presents the results. Under this policy, the monetary policy tends to be more expansive in response to the expected gain in productivity. As a result, the increases in output, consumption, investment and labor are larger than in the baseline case. The alternative rule reduces the volatility of the exchange rate, but the current account deficit, due to the investment and consumption booms, is more acute in response to the shock than in the baseline case. Notice also that initially inflation rises and falls after the bust. Inflation falls because the reduction in marginal cost dominates the inflationary effects of the subsequent currency depreciation. Finally, by stabilizing the real exchange rate, the monetary policy exacerbates the boom-bust in the Tobin's Q and makes the predictions of the model

quantitatively closer to the stock prices evolution in Chile during the 1990s.

## 5 Conclusions

Using a small open economy DSGE model we show that expected future gains in productivity that are not materialized ex-post –new shocks– can generate a boom-bust cycle in output as the one observed in several emerging market economies during the 1990s. However, when people expect that future productivity gains are transitory level changes, then the model predictions regarding the current account and the real exchange rate are not coherent with the observed pattern in those episodes. Moreover, the quantitative predictions for investment and consumption fall short respect to what we observe in the data. That is the case even if we assume a strong monetary policy response to inflation and a low degree of wage indexation to past inflation. The reason is that in an open economy setup the amplifying mechanism of the monetary policy is unable to induce large consumption and investment booms.

When the expected future improvement in productivity corresponds to a trend shock, for which the rate of growth of productivity is expected to increase above its steady-state level during some periods, the predictions of the model match satisfactorily the stylized facts observed in the data. Also, the boom generated by a productivity trend new shock affects more intensively the non-tradable goods sector. In fact, the the real appreciation of the currency induced by the shock leads to a fall in output in the tradable goods sector to fall. These results resemble almost exactly the results that can be obtained under a exogenous reversal in the foreign financial conditions faced by the country.

We show that monetary policy faces relevant trade-offs in a boom-bust cycle episode driven by overoptimistic perceptions about productivity improvements. In one hand, if the central bank tries to stabilize output, the fall in inflation and contraction in output in the tradable goods sector would be larger. On the other hand, if the central bank targets inflation more strictly, then the boom in activity, the current account deterioration and the exchange rate appreciation will be larger, and the subsequent recession more severe.

If we modify the policy rule to include an endogenous response of the interest rate to exchange rate fluctuation (this is intended to capture the behavior of the CBC during the period, during which a target zone for the exchange rate coexisted with a target for inflation) then we observe that the model does a better job at fitting some of the variables. This type of policy only prevents the perverse effects on the domestic tradable goods sector in the short run, but it amplifies the boom-bust cycle in the other aggregate variables.

## References

- [1] Aguiar, M. and G. Gopinath (2007) "Emerging Market Business Cycles: The Cycle is the Trend," *Journal of Political Economy* 115(1): 69-102.
- [2] Banerjee, A. (1992) "A Sample Model of Herd Behavior," *Quarterly Journal of Economics* 107: 797-817.
- [3] Beaudry, P. and F. Portier (2004) "An Exploration into Pigou's Theory of Cycles," *Journal of Monetary Economics* 51(6): 1183-1216
- [4] \_\_\_\_\_ (2007) "When can Changes in Expectations Cause Business Cycle Fluctuations in Neo-classical Settings?" *Journal of Economic Theory* 127(1): 458-477.
- [5] Calvo, G. (1983), "Staggered Prices in Utility-Maximizing Framework," *Journal of Monetary Economics* 12: 383-98.
- [6] Caplin, A. and J. Leahy (1993) "Sectoral Shocks, Learning and Aggregate Fluctuations," *Review of Economic Studies* 60: 1065-1085.
- [7] Chamley, C. and D. Gale (1994) "Information Revelation and Strategic Delay in a Model of Investment," *Econometrica* 62: 1065-1085.
- [8] Christiano, L., Eichenbaum, M. and C. Evans (2005), "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy* 113: 1-45.
- [9] Christiano, L., C. Ilut, R. Motto and M. Rostagno (2007) "Monetary Policy and Stock Market Boom-Bust Cycle," mimeo, Northwestern University.
- [10] Christiano, L., Eichenbaum, M. and C. Evans (2005) "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy* 113: 1-45.
- [11] Correia, I., J. Neves, and S. Rebelo (1995) "Business Cycles in a Small Open Economy," *European Economic Review* 39: 1089-1113.
- [12] Erceg, Ch., D. W. Henderson and A. T. Levin (2000) "Optimal monetary policy with staggered wage and price contracts," *Journal of Monetary Economics*, 46: 281-313.
- [13] Farmer, R. (1993) *The Macroeconomics of Self-fulfilling Prophecies* Cambridge, MA: MIT Press.
- [14] Jadresic, E. and R. Zahler (2000) "Chile's Rapid Growth in the 1990s Good Policies, Good Luck, or Political Change?," IMF Working Paper No. 00/153

- [15] Jaimovich, N. and S. Rebelo (2006) “Can News About the Future Drive the Business Cycle?” NBER Working Paper No. 12537.
- [16] Jaimovich, N. and S. Rebelo (2007) “News and Business Cycles in Open Economies,” NBER Working Paper No. 13444.
- [17] Marfán, M. (2005) “Fiscal Policy Efficacy and Private Deficits: A Macroeconomic Approach.” In J. A. Ocampo (ed.) *Beyond Reforms Structural Dynamic and Macroeconomic Vulnerability*. Stanford and The World Bank.
- [18] Mertens, K. (2007) “The Rol of Expectations in Sudden Stops,” EUI Working Paper ECO 2007/16.
- [19] Neumeyer, P. and F. Perri (2005) “Business cycles in emerging economies: the role of interest rates,” *Journal of Monetary Economics* 52(2): 345-380.
- [20] Pigou, A. (1926) *Industrial Fluctuations*. MacMillan, London.
- [21] Uhlig, H. (1997) “A Toolkit for Analyzing Nonlinear Dynamic Stochastic Models Easily ”, mimeo, University of Tilburg.
- [22] Uribe, M. and V. Yue (2006) “Country Spreads and Emerging Countries: Who Drives Whom?” *Journal of International Economics* 69(1):6–36.
- [23] Valdés, R. (2007) “Policy Responses to Sudden Stops in Capital Flows: The Case of Chile in 1998,” Central Bank of Chile, WP 430.
- [24] Zeira, J. (1994) “Informational Cycles,” *Review of Economic Studies* 61: 3144.

**Table 1: Base Calibration**

<b>Name</b>	<b>Description</b>	<b>Value</b>
$\beta$	Subjective discount factor (quarterly)	0.999
$\sigma_L$	Inverse of the elasticity of the labor supply	1
$h$	Habit formation coefficient	0.9
$\alpha_C$	Share of tradable goods in the consumption basket	0.4
$\gamma_C$	Share of $H$ goods in the tradable consumption basket	0.5
$\eta_C$	Elasticity of substitution b/w tradable and non-tradable goods in the consumption basket	0.5
$\omega_C$	Elasticity of substitution b/w Home and Foreign goods in the tradable consumption basket	1
$\epsilon_L$	Elasticity of substitution among labor varieties	11
$\phi_L$	Calvo probb in nominal wages	0.9
$\chi_L$	Wage indexation to past inflation	0.9
$\alpha_I$	Share of tradable goods in the investment basket [in $I(H)$ and $I(N)$ ]	0.6
$\gamma_I$	Share of $H$ goods in the tradable investment basket [in $I(H)$ and $I(N)$ ]	0.5
$\eta_I$	Elasticity of substitution b/w tradable and non-tradable goods in the investment basket [in $I(H)$ and $I(N)$ ]	0.5
$\omega_I$	Elasticity of substitution b/w Home and Foreign goods in the tradable investment basket [in $I(H)$ and $I(N)$ ]	1
$\delta(1)$	Depreciation rate (annual) of capital [in $I(H)$ and $I(N)$ ]	5.0%
$\mu_S$	Elasticity of the adjustment cost in the flow of investment [in $I(H)$ and $I(N)$ ]	15
$\sigma_I$	Elasticity of the cost of capital utilization rate [ $\delta''(1)/\delta'(1)$ ]	0.05
$\eta_H$	Labor share in the domestic tradable goods sector	0.65
$\eta_N$	Labor share in the non-tradable goods sector	0.65

Table 1 cont.: Base Calibration

Name	Description	Value
$\epsilon_N$	Elasticity of substitution among non-tradable varieties	11
$\epsilon_H$	Elasticity of substitution among domestic tradable varieties	11
$\epsilon_F$	Elasticity of substitution among imported varieties	11
$\phi_{HD}$	Calvo probb in prices of domestic tradable goods sold domestically	0.75
$\chi_{HD}$	Indexation to past inflation of domestic tradable goods sold domestically	0.5
$\phi_{HF}$	Calvo probb in foreign currency prices of domestic tradable goods sold abroad	0.75
$\chi_{HF}$	Indexation to past inflation of domestic tradable goods sold abroad	0.5
$\phi_N$	Calvo probb in prices of non-tradable goods	0.75
$\chi_N$	Indexation to past inflation of non-tradable goods	0.5
$\phi_F$	Calvo probb in prices of imported goods	0.75
$\chi_F$	Indexation to past inflation of imported goods	0.5
$\psi_i$	Smoothing coefficient in the Taylor-type rule	0.8
$\psi_\pi$	Inflation coefficient in the Taylor-type rule	1.75
$\psi_y$	Output coefficient in the Taylor-type rule	0.2
$\eta_F$	Elasticity of the foreign demand for domestic tradable goods	0.5
$\rho$	Elasticity of the external premium to the Debt-to-GDP ratio	0.00001
$NX/Y$	Steady state Net export-to-GDP ratio	2%
$CA/Y$	Steady state Current Account-to-GDP ratio	-2%
$g_y$	Steady state GDP growth	5%
$\rho_{a_H}$	Persistence of productivity <b>level</b> shock in sector $H$	0.999
$\rho_{a_N}$	Persistence of productivity <b>level</b> shock in sector $N$	0.999
$\rho_T$	Persistence of productivity <b>trend</b> shock	0.999
$\rho_{i^*}$	Persistence of productivity foreign financial condition shock	0.999

Figure 1: Reforms and its impact on productivity

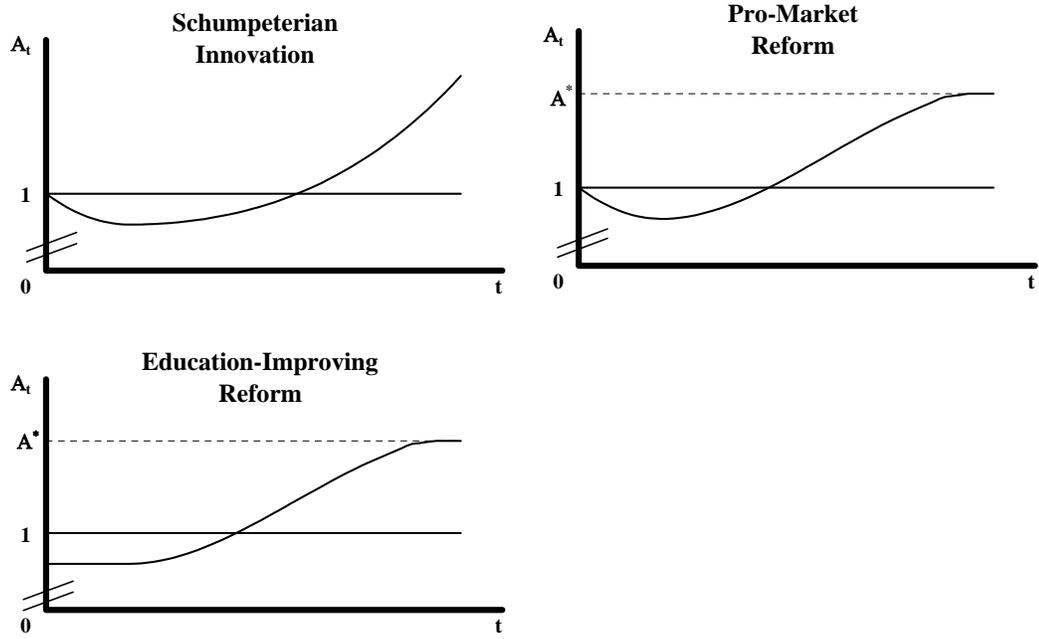
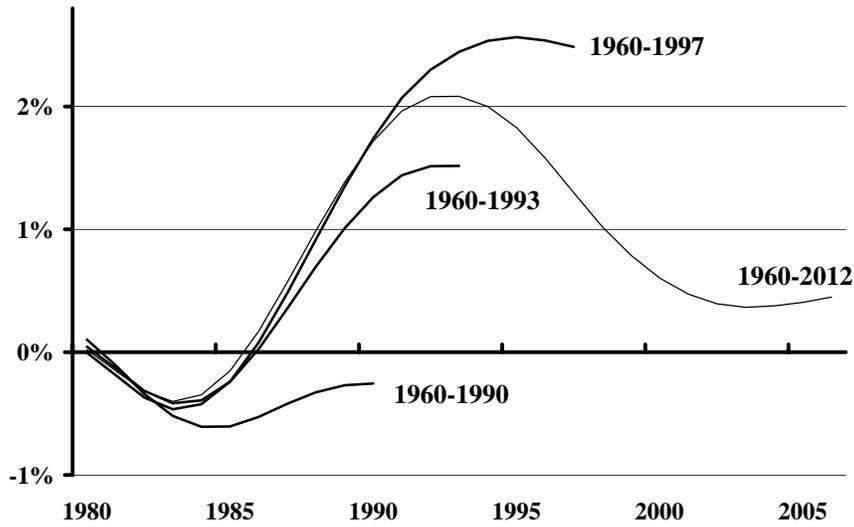


Figure 2: Measuring total factor productivity



Source: Authors estimates based on annual TFP growth rates series (using HP filter). The data source is the Ministry of Finance of Chile (1960-2006) and the TFP forecasted by the Group of Experts on Trend GDP (2007-2012).

Figure 3: Stylized facts

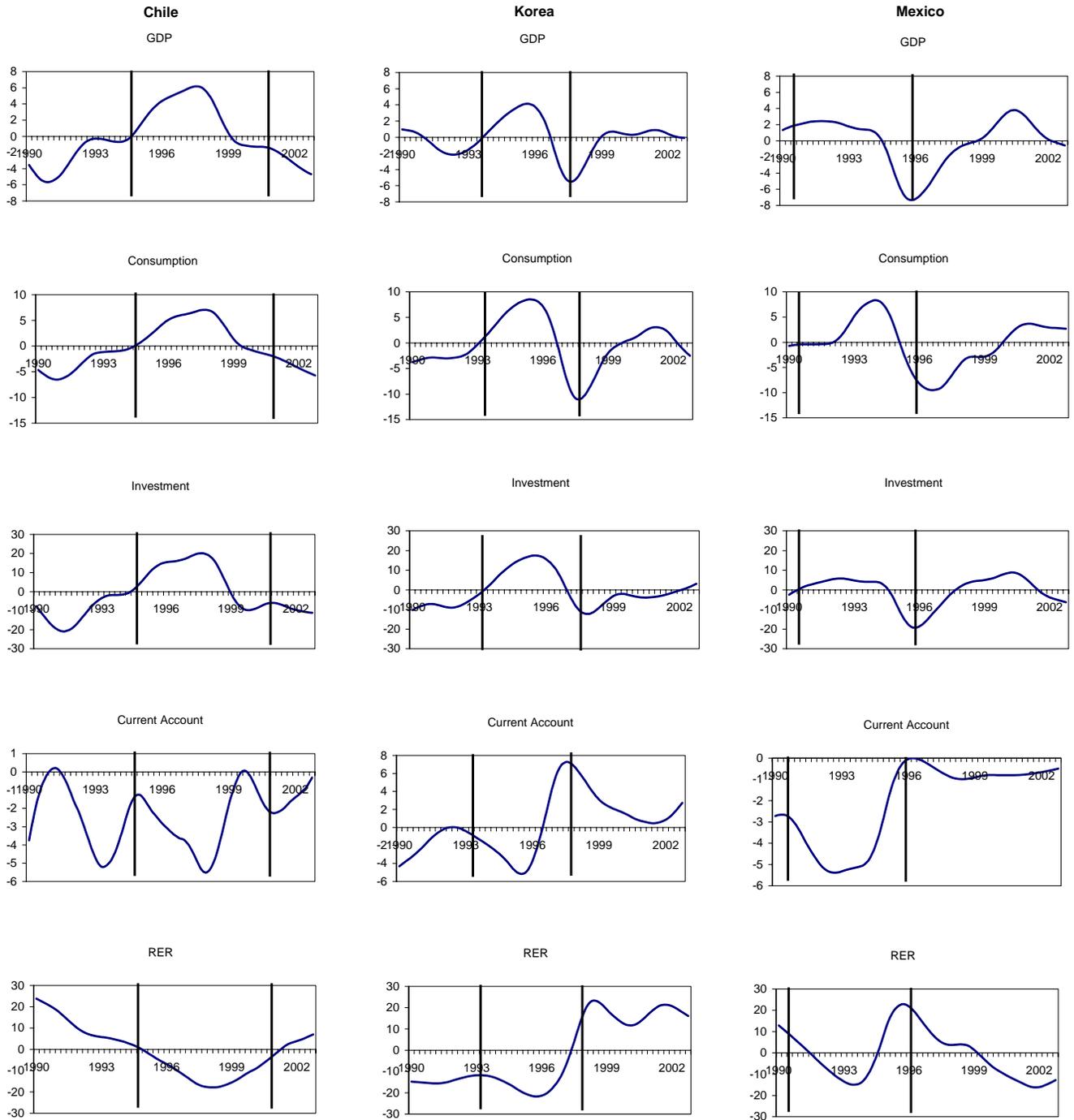


Figure 4: Foreign financial condition reversal

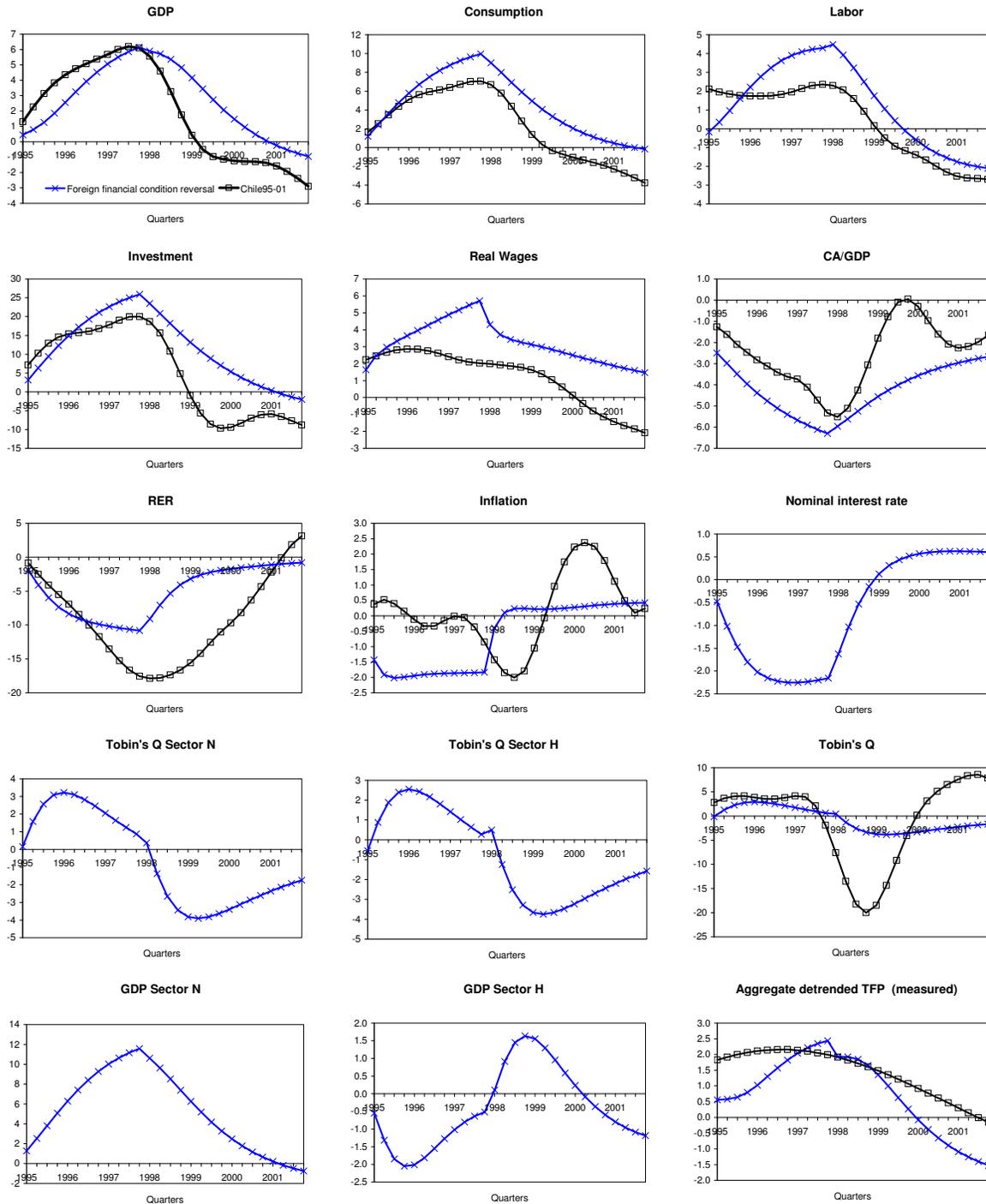


Figure 5: Productivity level signal

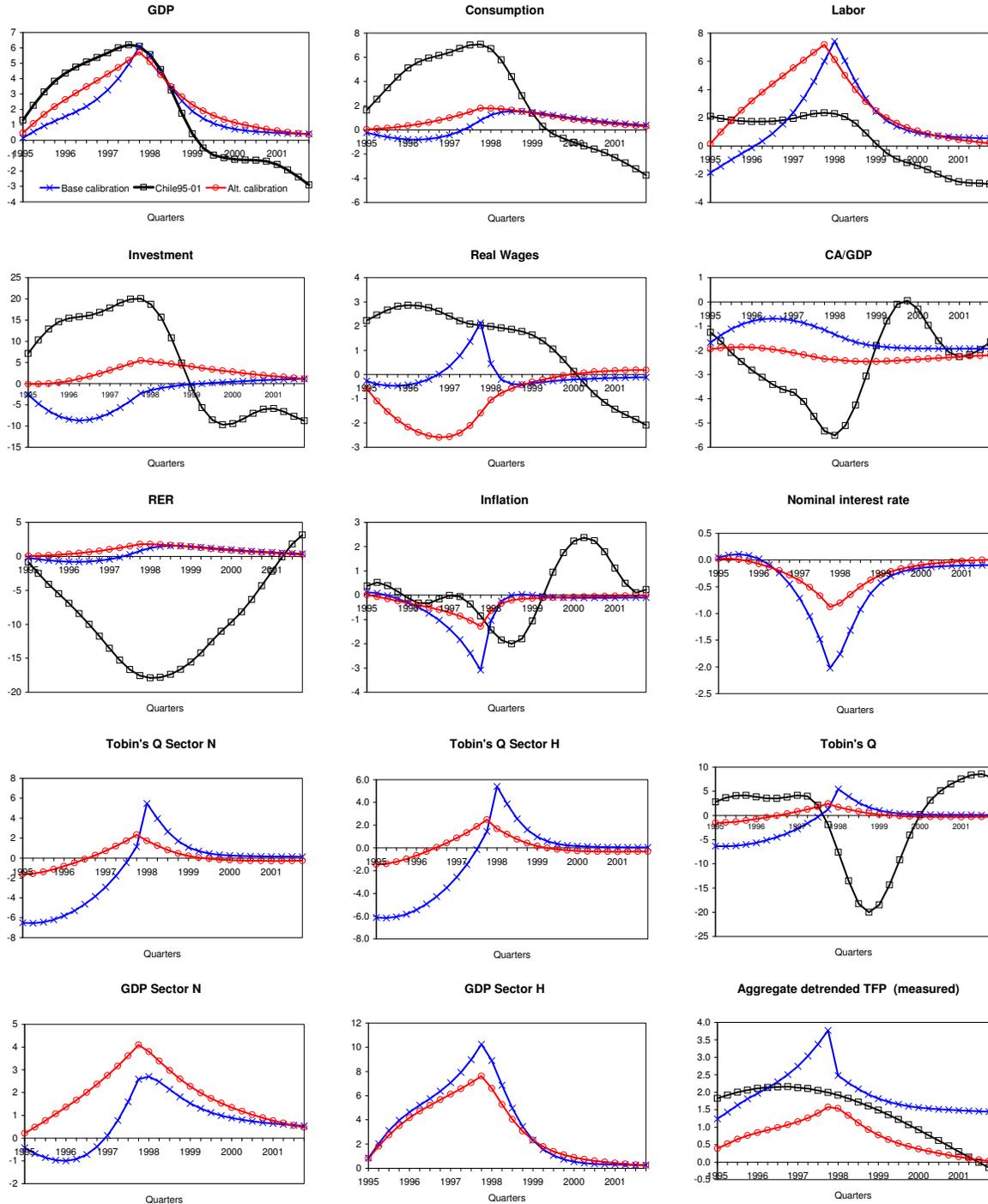


Figure 6: Productivity trend signal

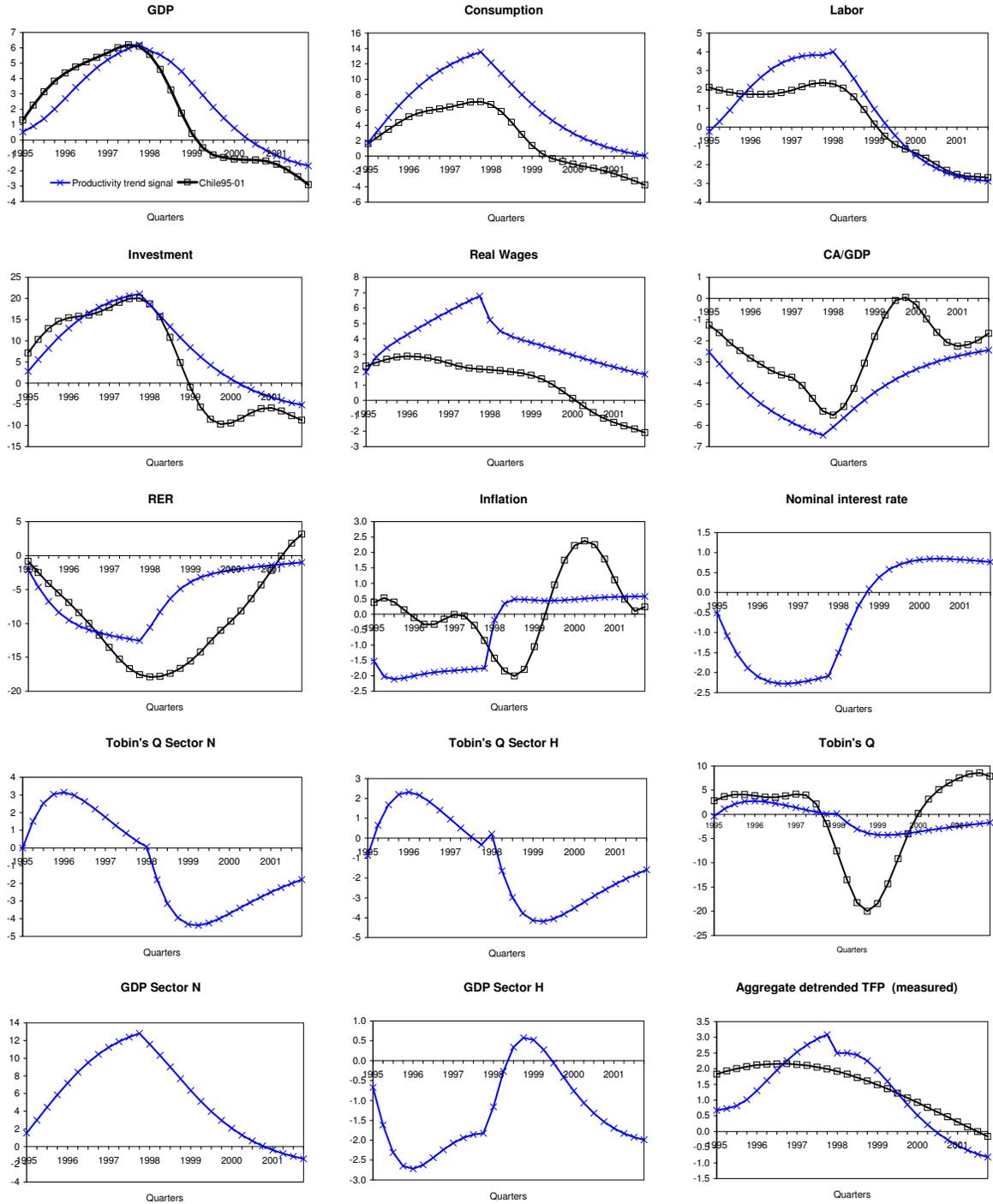


Figure 7: Stabilization of inflation vs. output

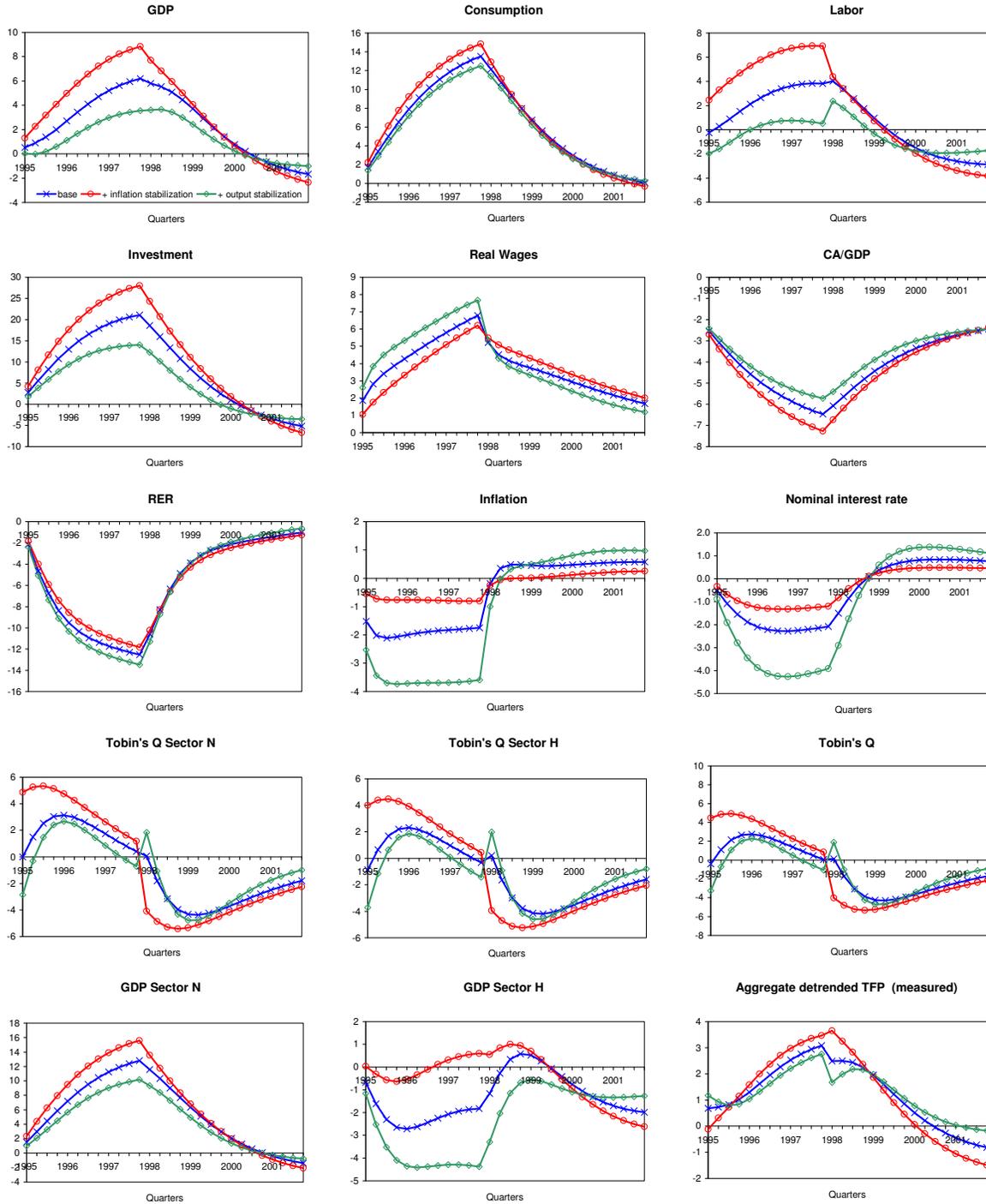


Figure 8: Stabilization of the real exchange rate

