I. INTRODUCTION

Over the last 20 years, dynamic general equilibrium models have become one of the main tools in modern macroeconomic analysis. Since the seminal work of Kydland and Prescott (1982) many extensions to the baseline model have been made in order to assess many issues originally not analyzed in this model. Such extensions include the analysis of labour market, open economies, the introduction of money and, fiscal and monetary policy analysis (see Hansen (1985), Mendoza (1991), Cooley and Hansen (1989) and (1992) and Chari et al. (1991) and (1995)).

The final objective of this literature is to construct a framework to understand and predict the effects of alternative policies. Previously, it is necessary to check that the framework used to analyze these policies, is able to account for the stylized facts in the economies under study. This exercise has been done for a variety of real business cycle models to assess their ability to mimic the behaviour of the macroeconomic variables of USA. However, the efforts to assess the performance of these models in developing economies, such as Chile, are still insufficient[3]. An important question that remains unanswered is what the effect is of the money fluctuations over the volatility of the main macroeconomic series in a developing economy. In this context, this paper has two objectives. The first is to assess the ability of a cash-in-advance model to replicate the behaviour of the macroeconomic variables of the Chilean economy for quarterly data spanning between Q1:1986 and Q3:2005. The second objective is to assess the changes that arise in the behaviour of these variables, in the context of a cash-in-advance economy, when the monetary growth rate behaves as observed in the Chilean data.

To achieve the objectives of this paper, we generate artificial data from the Cooley and Hansen (1989) cash-in-advance model calibrated with the Chilean economy data. Then, we compare the statistical properties of this artificial data with those observed in real data. To achieve the second objective of this paper, it is necessary to compare the results of two versions of the theoretical model: one where the monetary growth rate is constant and other where the monetary growth rate is "erratic" or, in other words, has a random component.

The structure of the paper is the following. In the next section, we provide a brief description of the Chilean economy regarding its cyclical behaviour. In section III we describe the model that we will use to analyze the data. In section IV we report the results of the simulations and compare them with that observed in real data. Finally, in section V, we highlight the main findings

[3] The only papers that we know in this line are Chumacero (2000), Bergoeing and Soto (2005) and Quiroz et al. (1991). Previous work suggests that there are some differences between the business cycles of the Chilean and USA economies (see Bergoeing and Suárez (1998)).

II. CHARACTERIZING THE CHILEAN BUSINESS CYCLE

The objective of this section is to provide a description of the cyclical behaviour of the most important macroeconomic variables of the Chilean economy. The period of analysis spans between Q1:1986 and Q3:2005. In order to reach this objective, it is necessary to isolate the cyclical component (ct) of the series (yt), which is the sum of a growth component (tt) and a cyclical component, that is, $y_t = t_t + c_t$ for $t = 1, ..., T$. This is done using the Hodrick & Prescott (H-P) filter[4].

The general idea behind the H-P filter is to balance two opposing objectives: minimize the sum of the squared deviations of the actual series from the trend and, minimize the sum of the squares of the trend component's second differences. Therefore, the H-P filtering problem is to choose the growth component, tt, to minimize the following loss function:

$$\underset{\{T_t\}}{Min}\sum_{t=1}^{T}(y_t - t)^2 + \lambda\sum_{t=2}^{T-1}[(T_{t+1} - T_t) - (T_t - T_{t-1})] \tag{1}$$

where the parameter l reflects the weight of the second objective. When $\lambda \to \infty$, the growth component approaches a linear trend, and when $\lambda \to 0$, the growth component is simply the series[5]. For quarterly data it is usual to choose $\lambda = 1600$.

Once data is filtered, we study the statistics focused on by the literature (see Kydland and Prescott (1982, 1990)), i.e., standard deviation and cross correlation of different variables with real GDP[6].

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[4] For a comparison of alternative filters, see Bergoeing, R. and J. Suárez (1998).
[5] For more details of the H-P filter see Cooley, T. F. and E. C. Prescott (1995).
[6] Before data filtering, the series are expressed as natural logarithms in order to smooth the trend.

TABLE 1

CYCLICAL BEHAVIOR OF THE CHILEAN ECONOMY, Q1:1986-Q3:2005.

Variable	Volatility %	Relative Volatility (a)	Cross Correlation of Real GDP with:										
			x(t-5)	x(t-4)	x(t-3)	x(t-2)	x(t-1)	x(t)	x(t+1)	x(t+2)	x(t+3)	x(t+4)	x(t+5)
Real Gross Domestic Product	1.89	1.00	-0.25	-0.05	0.21	0.47	0.75	1.00	0.75	0.47	0.21	-0.05	-0.25
NATIONAL ACCOUNTS													
Private Consumption	2.20	1.17	-0.21	-0.01	0.19	0.42	0.68	0.92	0.70	0.46	0.24	0.02	-0.14
Consumption of Durables Goods (b)	9.28	4.91	-0.39	-0.25	0.01	0.35	0.68	0.89	0.82	0.59	0.24	-0.13	-0.40
Consumption of Non Durables Goods (b)	1.77	0.94	-0.35	-0.27	0.03	0.39	0.73	0.85	0.71	0.47	0.17	-0.14	-0.29
Government Purchases	1.61	0.85	-0.24	-0.03	0.06	0.25	0.38	0.44	0.26	0.18	0.12	0.08	0.03
Investment	7.43	3.94	-0.33	-0.22	-0.05	0.24	0.54	0.80	0.79	0.70	0.45	0.20	-0.08
Exports of Goods and Services	3.30	1.74	-0.08	-0.04	0.11	0.22	0.22	0.45	0.30	0.10	0.00	0.03	-0.09
Imports of Goods and Services	5.92	3.14	-0.34	-0.16	0.08	0.34	0.58	0.83	0.78	0.61	0.35	0.05	-0.14
Net Exports (Balance of Trade/GDP ratio)	1.58	0.83	0.28	0.13	-0.04	-0.25	-0.49	-0.61	-0.63	-0.56	-0.36	-0.06	0.06
MONETARY AGGREGATES													
Currency	3.15	1.67	-0.01	0.13	0.32	0.51	0.64	0.63	0.43	0.18	-0.04	-0.15	-0.23
M1	4.78	2.53	0.13	0.31	0.51	0.67	0.72	0.62	0.36	0.07	-0.17	-0.27	-0.33
M2A	3.16	1.67	-0.22	-0.22	-0.09	0.10	0.28	0.42	0.48	0.41	0.39	0.31	0.14
M2A - M1	4.09	2.16	-0.27	-0.36	-0.33	-0.20	-0.02	0.18	0.36	0.41	0.49	0.45	0.29
M7	2.06	1.09	-0.15	-0.18	-0.14	-0.07	0.03	0.09	0.13	0.16	0.17	0.15	0.09
INTEREST RATES													
Short Term Interest Rate	0.33	0.18	-0.21	-0.39	-0.53	-0.52	-0.33	-0.05	0.26	0.45	0.57	0.49	0.33
Long Term Interest Rate	0.33	0.18	-0.25	-0.43	-0.53	-0.51	-0.31	0.00	0.31	0.50	0.60	0.51	0.35
PRBC 90 days (c)	0.30	0.16	-0.18	-0.33	-0.40	-0.36	-0.20	0.06	0.34	0.49	0.58	0.46	0.32
PBC 8 years (d)	0.12	0.06	-0.57	-0.58	-0.56	-0.40	-0.14	0.15	0.36	0.35	0.28	0.16	0.12
Monetary Policy Interest Rate	0.32	0.17	-0.14	-0.22	-0.28	-0.26	-0.17	-0.01	0.24	0.41	0.47	0.39	0.22
PRICES													
Consumer Price Index	1.83	0.97	0.25	0.08	-0.08	-0.19	-0.29	-0.34	-0.29	-0.21	-0.12	-0.07	-0.02
Inflation (CPI)	0.84	0.44	-0.25	-0.40	-0.40	-0.27	-0.22	-0.10	0.10	0.20	0.23	0.13	0.12
Producer Price Index	3.31	1.75	0.26	0.14	-0.01	-0.08	-0.10	-0.17	-0.24	-0.30	-0.32	-0.34	-0.31
Inflation (PPI)	1.93	1.02	-0.18	-0.21	-0.25	-0.11	-0.04	-0.15	-0.14	-0.11	-0.04	-0.04	0.04
Real Wage Index	0.99	0.53	0.27	0.43	0.48	0.37	0.33	0.19	-0.03	-0.11	-0.12	-0.05	-0.02
Real Exchange Rate	4.10	2.17	0.19	0.05	-0.20	-0.35	-0.39	-0.42	-0.46	-0.37	-0.24	-0.18	-0.05
OTHERS													
Terms of Trade (e)	5.37	2.84	0.39	0.46	0.43	0.37	0.19	0.05	-0.07	-0.20	-0.33	-0.34	-0.24
Unemployment	0.77	0.41	0.28	0.20	0.10	-0.09	-0.32	-0.61	-0.74	-0.66	-0.49	-0.25	0.00
Productivity (GDP/Hours)	1.95	1.03	-0.07	0.08	0.26	0.49	0.66	0.76	0.48	0.23	0.01	-0.18	-0.32
Average Weekly Hours	0.74	0.39	0.13	0.19	0.20	0.04	-0.08	-0.10	-0.22	-0.30	-0.28	-0.19	-0.05
Capital Stock	0.91	0.48	-0.21	-0.27	-0.25	-0.21	-0.11	-0.02	0.18	0.36	0.52	0.60	0.60

Source:Authors´ computations based on Central Bank of chile statitics.

(a) The Relative Volatility is defined as variable std. dev. / GDP std. dev. ratio.

(b) Sample period: Q1:1996 – Q3:2005.

(c) Sample period: Q1:1986 – Q4:2003.

(d) Sample period: Q1:1992 – Q3:2002.

(e) Sample period: Q1:1990 – Q3:2005.

Following Bergoeing and Suárez (1998); who compare the Chilean business cycle with those of Argentina, USA and a sample of OECD countries; we characterize the business cycle of the Chilean economy for quarterly time series (Q1:1986 – Q3:2005). In Table 1 we report the statistics of interest. In this table the first two columns show the series volatility (amplitude of fluctuations), whereas the other columns reflect the degree, direction and phase shift of the correlation between series and real GDP. Salient features of these figures are:

- Consumption of Durable Goods, Investment, Real Exchange Rate, Terms of Trade, Imports of Goods and Services present high volatility with respect to the real GDP. Exports and Imports are pro-cyclical.
- Private Consumption and Imports are highly pro-cyclical, and their cycle coincides with GDP cycle. Also, we can make a distinction between consumption of non-durable and durable goods. We found that durable consumption volatility is 9.28%, and non-durable consumption volatility is 1.77%.
- Short Term, Long Term, PRBC 90 days and Monetary Policy Interest Rates, Terms of Trade and Capital Stock are considered to be uncorrelated with GDP cyclical component because the contemporaneous correlation coefficient, x(t), is close to ± 0.10, the range usually used as the limit in the literature (e.g. Kydland and Prescott (1990)).
- There is a relatively important concurrence between GDP and M1 cyclical behaviour (see Figure 1), in fact M1 leads the real GDP cycle by a quarter[7]. However, notice that the monetary policy instrument is the interest rate, which leads GDP cycle in three quarters. M2A money definition is pro cyclical, but it lags the GDP cycle by a quarter. M7 is uncorrelated with GDP cycle but it lags GDP cycle by three quarters.
- Consumer Price Index and Producer Price Index are counter-cyclical; as are the inflation rates for these indices. Real Wage Index is pro cyclical and it leads GDP cycle by three quarters.
- Unemployment is counter cyclical and lags the GDP cycle by a quarter.

[7] After performing Granger causality tests, we conclude that M1 does Granger cause GDP, and GDP does not Granger cause M1.

FIGURE 1
GDP AND M1 CYCLICAL BEHAVIOR, Q1:1986 – Q3:2005.

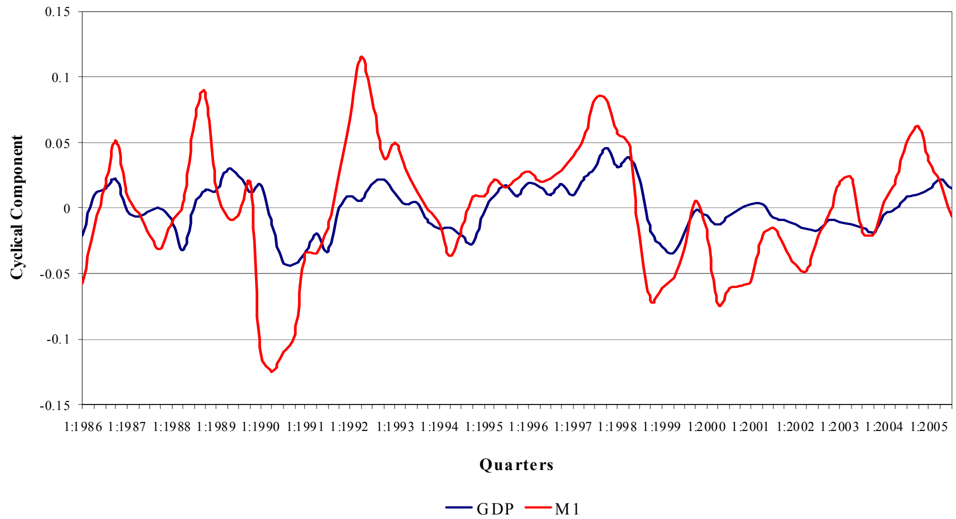

TABLE 2
CHILEAN BUSINESS CYCLE VERSUS U.S.A. AND CANADA BUSINESS CYCLES.

Variable	Country					
	Chile		U.S.A. (a)		Canada (b)	
	Volatility %	Contemporaneous Correlation	Volatility %	Contemporaneous Correlation	Volatility %	Contemporaneous Correlation
Real Gross Domestic Product	1.89	1.00	1.72	1.00	2.81	1.00
Consumption of Non Durables	1.77	0.85	0.86	0.77	2.46	0.59
Investment	7.43	0.80	8.24	0.91	9.82	0.64
Exports of Goods and Services	3.30	0.45	5.53	0.37	-	-
Imports of Goods and Services	5.92	0.83	4.88	0.72	-	-
Net Exports	1.58	-0.61	-	-	1.87	-0.13
Capital Stock	0.91	-0.02	0.38	0.28	1.38	-0.38
Hours	0.74	-0.10	1.59	0.86	2.02	0.80
Productivity	1.76	0.79	0.90	0.41	1.71	0.70
Consumer Price Index	1.83	-0.34	1.43	-0.52	-	-
Inflation (CPI)	0.84	-0.10	0.57	0.34	-	-
M1	4.78	0.62	1.52	0.33	-	-
M2A	3.16	0.42	1.46	0.33	-	-
Interest Rate	0.33	-0.05	1.29	0.40	-	-

Source: (a) Cooley and Hansen (1989, 1995); Cooley and Prescott (1995), (b) Mendoza (1991).

Table 2 shows an additional analysis comparing the cyclical behaviour of the Chilean economy with those of Canada and USA. From this table, we can see that the Chilean business cycle does not differ greatly from those of the mentioned countries. In all of these countries, investment is highly volatile; price level is counter cyclical in Chile as in USA, but in this last country the inflation rate is pro-cyclical. Monetary aggregates and productivity are less volatile in USA. In Canada, non-durable consumption is more volatile than in the other two countries. In regard to foreign trade, exports are more volatile in USA than in Chile, and US imports are less volatile than Chilean imports. In Chile and Canada the net exports are counter cyclical.

Given this characterization of the data, we present, in the next section, a brief revision of the theory that we will use to study it.

III. A Monetary Model

The model that we use to analyze the data was introduced by Cooley and Hansen (1989). In order to isolate the effect of money fluctuations on the dynamics of the economy, we study simulations of two alternative rules for the monetary growth rate: a constant rate and an "erratic" (random) rate. Now, we proceed to describe the model in detail.

A Cash-in-Advance Model

The cash-in-advance model was first studied by Lucas and Stokey (1983, 1987). This theory makes a distinction between cash goods and credit goods. To get "cash intensive" goods (cash goods) it is necessary to hold monetary balances, leading to a cash-in-advance constraint.

The economy we study is populated with a large number of identical agents who live infinitely. All of them have identical preferences described by the following utility function:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left(\log c_t + A \log l_t \right) \qquad 0<\text{b}<1 \tag{2}$$

where c_t represents consumption and lt is leisure in period t. E_0 is the expectation operator subject to all information available at time zero. β is the subjective discount factor and parameter A is the substitution elasticity between leisure and consumption. In each period the representative agent is endowed with one unit of time, which can be allocated between leisure, lt, and work hours, l_t, i.e., $h_t + l_t = 1$.

In this model labour is assumed to be indivisible[8], which means that the representative agent only can work some given positive time fraction, ho. The agent sells

[8] For details, see Hansen (1985).

contracts which specify a probability of working in a given period, π_t. Given that all agents are identical, they will choose the same π_t. Therefore, a fraction π_t of the agents will work ho hours, and the remaining $(1 - \pi_t)$ agents will be unemployed during period t. A lottery determines which of the agents work and which do not. Thus, per capita work hours in period t are given by:

$$h_t = \pi_t h_0 \tag{3}$$

The expected utility of the representative agent is:

$$\begin{aligned} u(c_t, h_t) &= \log c_t + \pi_t A \log(1 - h_0) + (1 - \pi_t) A \log(1) \\ &= \log c_t + h_t A (\log(1 - h_0))/h_0 \end{aligned} \tag{4}$$

We can rewrite (4) as:

$$u(c_t, h_t) = \log c_t - B h_t, \qquad \text{where } B = -A \log(1 - h_0)/h_0 \tag{4.1}$$

The representative agent must choose consumption (c_t), investment (i_t) and nominal money holdings (m_t) subject to the following budget constraint:

$$c_t + i_t + \frac{m_t}{p_t} \leq w_t h_t + r_t k_t + \frac{(m_{t-1} + (g_t - 1)M_{t-1})}{p_t} \tag{5}$$

The capital letters denote per capita quantities that are determined in equilibrium but are not influenced by the actions of any individual agent, and lower-case letters denote quantities associated with a particular agent. At equilibrium they will be the same.

Equation (5) tells us that agent expenditure must satisfy a budget constraint. The budget includes income from capital and labour, currency carried from the previous period and a transfer equals to $(g_t - 1)\ M_{t-1}/p_t$, where $(g_t - 1)$ is the monetary growth rate and pt is the price level.

The consumption choice must satisfy the following cash-in-advance constraint:

$$p_t c_t \leq m_{t-1} + (g_t - 1)M_{t-1}) \tag{6}$$

The law of motion for the capital stock is:

$$k_{t+1} = (1 - \delta)k_t + i_t, 0 \leq \delta \leq 1 \tag{7}$$

where δ is the depreciation rate.

The law of motion for the monetary stock is:

$$M_t = g_t M_{t-1} \tag{8}$$

where M_t is the per capita money supply in period t, and g_t is the monetary growth factor, which is decided by the monetary authority.

In order to reach the objectives of this paper we study two versions for the money growth factor: firstly, g_t is assumed to be constant and, secondly, g_t evolves according to an AR(1) process:

$$\log(g_{t+1}) = \alpha \log(g_t) + \xi_{t+1} \tag{9}$$

where ξ is an i.i.d. random variable with expected value $(1-a)\log(\hat{g})$ and variance σ_ξ^2. Note that $\log(\hat{g})$ is the unconditional expectation of the logarithm of the growth rate g_t. Finally, it is assumed that g_t is revealed to all the agents at the beginning of period t. As in Cooley and Hansen (1989), the motivation behind the selection of an AR(1) process for the money growth rate is simplicity.

Equation (9) is very important for the objective of the paper because it reflects the erratic behaviour of monetary growth. That equation is estimated from Chilean data.

There is a firm that produces output, Y_t, using a constant returns-to-scale technology on capital (K_t) and work (H_t):

$$Y_t = \exp(z_t) K_t^\theta H_t^{1-\theta}, 0 \leq \theta \leq 1 \tag{10}$$

where z_t is an exogenous technology shock that follows a law of motion given by:

$$z_{t+1} = \gamma z_t + \varepsilon_{t+1}, 0 \leq \gamma \leq 1 \tag{11}$$

where ε_t is an i.i.d. random variable with mean zero and variance σ_ε^2. We assume that z_t, like g_t, is revealed to all agents at the beginning of period t.

The firm seeks to maximize profit, which is equal to $Y_t - w_t H_t - r_t K_t$. The necessary first order conditions for the firm's problem yield the following functions for the wage rate and rental rate of capital:

$$w(z_t, K_t, H_t) = (1-\theta)\exp(z_t) K_t^\theta H_t^{-\theta} \tag{12}$$

$$r(z_t, K_t, H_t) = \theta \exp(z_t) K_t^{\theta-1} H_t^{1-\theta} \tag{13}$$

If g is greater than 1, both M and p will growth without limit. Because the solution method requires that all variables fluctuate around a constant mean (steady state), it is necessary to introduce the following change of variables: $\widetilde{m}_t = m_t/M_t$ and $\widetilde{p}_t = p_t/M_t$.

From here on, Model 1 will refer to the model with constant monetary growth rate, and Model 2 to the model with an "erratic" monetary growth rate.

Let $V(z, g, \widetilde{m}, K, k)$ be the value function of the representative agent problem.

We can write the individual's problem as the solution of the following Bellman's equation:

$$V(z,g,\widetilde{m},K,k) = \max\left\{u\left(c,h\right) + \beta E\left[V\left(z\prime,g\prime,\widetilde{m}\prime,K\prime,k\prime\right)|z,g,\widetilde{m},K,k\right]\right\} \qquad (14)$$

subject to:

$$\begin{aligned}
c+i+\frac{\widetilde{m}\prime}{\widetilde{p}} &\leq w(z,K,H)h + r(z,K,H)k + \frac{\widetilde{m}+g-1}{\widetilde{p}g} && * \quad (14.1)\\
C &\leq \frac{\widetilde{m}+g-1}{\widetilde{p}g} && ** \quad (14.2)\\
z\prime &= \gamma z + \varepsilon\prime && (14.3)\\
g\prime &= g = \hat{g} \qquad \text{(model 1)} && (14.4)\\
\log(g\prime) &= \alpha \log(g) + \xi\prime \qquad \text{(model 1)} && (14.5)\\
k\prime &= (1-\delta)k + i && (14.6)\\
K\prime &= (1-\delta)K + i && (14.7)
\end{aligned}$$

* This constraint is obtained from equation (5) using $\widetilde{m}_t = m_t/M$ and $\widetilde{p}_t = p_t/M_t$. Multiply both sides by $M_t/(p_t * M_t)$: $c_t + i_t + (m_t M_t/M_t p_t) \leq w_t h_t + r_t k_t + (M_t m_{t-1} + (g_t - 1)M_t M_{t-1})/M_t p_t$

Next using a change of variables and equation (8):

$c_t + i_t + \widetilde{m}_t/\widetilde{p}_t \leq w_t h_t + r_t k_t + (\widetilde{m}_{t-1} + g_t - 1)/g_t \widetilde{p}_t$

** This constraint is obtained from equation (6) using $\widetilde{m}_t = m_t/M$ and $\widetilde{p}_t = p_t/M_t$. Multiply both sides by $M_t/(p_t * M_t)$:

$p_t c_t M_t/p_t M_t \leq m_{t-1} + (g_t - 1)M_{t-1} M_t/p_t M_t$

Next using a change of variables and equation (8):

$c_t \leq (\widetilde{m}_{t-1} + g_t - 1)/\widetilde{p}_t g_t$

And subject to $c, i, \widetilde{m}$ being non-negative, and $0 \leq h \leq 1$. Primes denote next period values.

A Stationary Competitive Equilibrium for this economy consists of a set of the decision rules $c(s), i(s), \widetilde{m}\prime(s)$ and $h(s)$,where $s = (z, g, \widetilde{m}, K, k)$ are the state variables of the dynamic programming problem; a set of aggregate decision rules, $I(S)$ and $H(S)$, where $S = (z, g, K)$; a pricing function $\widetilde{p}(s)$, and a value function $V(s)$ such that:

i) The functions V, I, H and satisfy (14)-(14.7) and $c, i, \widetilde{m}\prime$, and h are the associated set of decision rules;

ii) $i = I, h = H$ and $\widetilde{m}\prime = 1$ when $k = K$ and $\widetilde{m}\prime = 1$; and

iii) The functions $c(s)$ and $i(s)$ satisfy: $c(s) + i(s) = Y(S)$, for all s.

All these conditions characterize an economy where agents, both households and firms, behave optimally and all markets are in zero net-supply.

Parameterisation of the Model

Now we describe the procedures that we used to assign values to the deep parameters of the model, $i.e. \beta, \gamma, \sigma_\varepsilon, \log(\hat{g}), \sigma_\xi, \alpha, \theta, h_0, \delta, A$.

We apply the Generalized Method of Moments approach in order to obtain the discount factor β. We obtained as result β=0.9841[9] with a standard deviation of 0.00063.

Since the technology shock, zt, is not directly observed in the data, it is obtained in an indirect way using the production function given by equation (10), and solving for z:

$$z_t = \log Y_t - \theta \log K_t - (1-\theta) \log H_t \tag{15}$$

Once the values for z are obtained, we estimate equation (11). We obtain a value for γ of 0.97 and a value for the standard deviation for residuals, σ_ϵ 0.03472.

In order to obtain the parameters associated to the law of motion of log(g) we run the following regression:

$$\triangle \log M_t = \gamma_0 + \gamma_1 \triangle \log M_{t-1} + \eta_t \tag{16}$$

to obtain the following result:

$$\triangle \log M_t = \underset{(0.006029)}{0.02547503} + \underset{(0.10268)}{0.42243418} \triangle \log M_{t-1} \tag{17}$$

where γ_0 represents $(1-a)\log(\hat{g})$ and γ_1 represents α. The standard deviation associated to the residuals of equation (16) is 0.032567. Here we use the $M1$ aggregate for M_t.

To obtain q we use the Euler equation:

$$\theta = \frac{[1-\beta(1-\delta)]}{\beta\delta} \frac{i_t}{y_t} \tag{18}$$

where i_t/y_t is the investment output ratio. The compute of θ is made using a quarterly depreciation rate, δ, equal to 1.7% based on National Accounts statistics. We obtained an average capital share equal to 0.44.

The parameter associated to indivisible labour, ho, is obtained assuming that total available hours per week are 112 (16 daily hours, 7 days a week). Also, if we consider

9 Also Bravo and Oyarzún (2001) estimate preference parameters (discount factor and the risk aversion coefficient) for the Chilean economy applying the Generalized Method of Moments approach to financial market data. They obtained estimates for quarterly discount factor in the range (0.860, 0.985).

that any worker must work 48 hours per week, ho, is the weekly work-hour to leisure-hour ratio.

To obtain A, we follow Hansen (1985), who calibrates this parameter in such a way that ht gives the leisure share in steady state. To be able to do this, we first obtain the share of leisure from the occupation data taken from the INE (National Statistics Institute), which gives an average leisure share of 60.01%. Thus, the value of A that allows h to replicate the steady state leisure share is 1.383. Table 3 contains a summary of the parameter values.

TABLE 3
PARAMETER VALUES

Preferences			Technology				Money		
β	A	h_o	θ	γ	σ_ε	δ	$\hat{g}$	α	σ_ξ
0.9841	1.383	0.43	0.44	0.97	0.013472	0.017	1.0451	0.4224	0.032567

Source: Authors´ computations.

Solving the Model

To solve the model we use an algorithm developed by Hansen and Prescott (1995). Once the algorithm converges we are able to obtain policy functions for our decision variables, namely, investment and price level. The arguments of these functions are state variables. The optimal policy rules associated to the decision variables for Model 1 are the following:

$$I = 1.5198 + 4.1405z - 0.0229K \quad (19.1)$$
$$\widetilde{p} = 0.7020 - 0.1893z - 0.0067K \quad (19.2)$$

for Model 2, the policy rules are:

$$I = 1.4847 + 4.1393z + 0.7945 \log g - 0.0229K \quad (20.1)$$
$$\widetilde{p} = 0.6950 - 0.1893z + 0.1586 \log g - 0.0067K \quad (20.2)$$

IV. RESULTS

In this section we provide the results obtained from the simulation of the model under alternative monetary growth rules. Also, we include a sensitivity analysis describing how much parameters affect results.

Simulation Results[10]

We ran 3200 simulations and obtained the statistics of interest for each of them. The results are reported in tables 4 and 5. A comparison regarding the volatility of both models with volatility in the real data is provided in Table 6. Both models fail to replicate GDP, investment, average work hours, price level, unemployment and productivity volatility. However, Model 2 performs better than Model 1 replicating non-durable consumption volatility. A result, which was also found by Cooley and Hansen (1989), is that when money grows at an erratic rate, consumption becomes more variable relative to income and price level becomes quite volatile. Also, the correlations between these variables and output become smaller in absolute value. The direction and phase shift of the simulated variables is summarized in Table 7. In this table we can see that both models replicate direction and phase shift of almost all the variables: only failing to do so for average work hours and money. The simulation results reported in tables 4 and 5 correspond to the average value through all the simulations of the statistics of interest. We construct confidence intervals[11] for the statistics as well as reporting the median and a p-value corresponding to the rate at which the simulated statistics are greater than the statistic obtained from real data. These results are reported in tables 8 and 9. In Table 8, we can see that output volatility in Model 1 is outside of the 95% confidence interval, as are consumption, work hours, money, price level, unemployment and productivity. This result tells us that it is very unlikely that Model 1 is able to generate the volatility observed in the data. On the other hand, in Table 9 we can see that Model 2 also fails in replicating output, hours, price level and productivity volatility.

However, Model 2 improves the mimic of consumption. Even though Model 2 successfully replicates M1 volatility, it fails to replicate the direction and phase shift of this monetary aggregate.

[10] We solve and simulate the model using GAUSS software. The code is available for colleagues.

[11] The confidence intervals are constructed ordering the observations in ascendant order and eliminating the first eighty and the last eighty observations, thus giving 95% of the observations.

TABLE 4

CYCLICAL BEHAVIOUR MODEL 1.

Variable	Volatility %	Relative Volatility	Cross Correlation of Output with:										
			x(t-5)	x(t-4)	x(t-3)	x(t-2)	x(t-1)	x(t)	x(t+1)	x(t+2)	x(t+3)	x(t+4)	x(t+5)
Output	2.97	1.00	-0.08	0.04	0.19	0.40	0.66	1.00	0.66	0.40	0.19	0.04	-0.08
Standard Deviation	0.4696		0.145	0.149	0.145	0.129	0.087	0.000	0.087	0.129	0.145	0.149	0.145
Consumption	0.81	0.27	-0.27	-0.16	-0.01	0.22	0.51	0.89	0.73	0.57	0.42	0.29	0.17
Standard Deviation	0.1518		0.113	0.114	0.114	0.105	0.073	0.026	0.075	0.124	0.154	0.173	0.180
Investment	11.78	3.97	-0.03	0.08	0.23	0.43	0.67	0.97	0.62	0.34	0.13	-0.03	-0.14
Standard Deviation	3.0211		0.156	0.159	0.152	0.132	0.088	0.014	0.085	0.123	0.136	0.138	0.132
Capital Stock	0.63	0.21	-0.47	-0.47	-0.44	-0.35	-0.20	0.02	0.32	0.50	0.60	0.62	0.59
Standard Deviation	0.1679		0.131	0.118	0.112	0.110	0.106	0.093	0.065	0.060	0.068	0.086	0.112
Hours	2.34	0.79	0.00	0.11	0.26	0.45	0.69	0.97	0.60	0.31	0.09	-0.07	-0.18
Standard Deviation	0.4604		0.161	0.163	0.155	0.134	0.088	0.008	0.085	0.122	0.132	0.132	0.126
Money	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Standard Deviation	0.0000		0.074	0.068	0.062	0.057	0.053	0.050	0.071	0.093	0.110	0.121	0.130
Price Level	0.81	0.27	0.27	0.16	0.01	-0.22	-0.51	-0.89	-0.73	-0.57	-0.42	-0.29	-0.17
Standard Deviation	0.1518		0.113	0.114	0.114	0.105	0.073	0.026	0.075	0.124	0.154	0.173	0.180
Unemployment	2.04	0.69	0.00	-0.11	-0.26	-0.45	-0.69	-0.97	-0.60	-0.31	-0.09	0.07	0.18
Standard Deviation	0.3842		0.161	0.163	0.155	0.134	0.088	0.007	0.085	0.122	0.132	0.132	0.126
Inflation	0.56	0.19	-0.10	-0.16	-0.23	-0.32	-0.42	-0.54	0.24	0.22	0.21	0.19	0.17
Standard Deviation	0.0579		0.111	0.112	0.105	0.097	0.076	0.033	0.081	0.080	0.087	0.094	0.104
Productivity	0.80	0.27	-0.31	-0.21	-0.06	0.15	0.44	0.81	0.70	0.57	0.45	0.33	0.23
Standard Deviation	0.1679		0.130	0.136	0.141	0.139	0.123	0.108	0.080	0.117	0.154	0.182	0.195

Source: Authors´ computations.

TABLE 5
CYCLICAL BEHAVIOUR MODEL 2.

Variable	Volatility %	Relative Volatility	Cross Correlation of Output with:										
			x(t-5)	x(t-4)	x(t-3)	x(t-2)	x(t-1)	x(t)	x(t+1)	x(t+2)	x(t+3)	x(t+4)	x(t+5)
Output	2.97	1.00	-0.08	0.03	0.19	0.40	0.66	0.99	0.66	0.40	0.19	0.03	-0.08
Standard Deviation	0.4665		0.145	0.149	0.145	0.129	0.087	0.000	0.087	0.129	0.145	0.149	0.145
Consumption	1.43	0.48	-0.15	-0.09	0.00	0.12	0.29	0.50	0.41	0.32	0.24	0.17	0.10
Standard Deviation	0.1849		0.128	0.130	0.135	0.135	0.129	0.113	0.130	0.147	0.156	0.163	0.163
Investment	12.63	4.26	-0.03	0.08	0.22	0.40	0.63	0.90	0.57	0.32	0.12	-0.03	-0.13
Standard Deviation	3.2737		0.156	0.159	0.153	0.136	0.097	0.032	0.098	0.129	0.140	0.139	0.134
Capital Stock	0.64	0.22	-0.46	-0.46	-0.42	-0.34	-0.20	0.02	0.31	0.49	0.58	0.61	0.58
Standard Deviation	0.1693		0.135	0.122	0.117	0.117	0.115	0.104	0.079	0.072	0.077	0.093	0.117
Hours	2.35	0.79	0.00	0.11	0.26	0.45	0.68	0.97	0.60	0.31	0.09	-0.07	-0.18
Standard Deviation	0.4544		0.161	0.163	0.155	0.135	0.089	0.008	0.086	0.122	0.132	0.132	0.126
Money	5.91	1.99	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
Standard Deviation	1.0720		0.229	0.230	0.232	0.234	0.233	0.229	0.227	0.226	0.224	0.224	0.225
Price Level	6.33	2.14	0.04	0.02	0.00	-0.02	-0.06	-0.11	-0.09	-0.07	-0.05	-0.04	-0.02
Standard Deviation	1.0419		0.219	0.219	0.222	0.223	0.220	0.217	0.215	0.214	0.212	0.213	0.216
Unemployment	2.05	0.69	0.00	-0.11	-0.26	-0.45	-0.68	-0.97	-0.60	-0.31	-0.09	0.07	0.18
Standard Deviation	0.3786		0.161	0.163	0.155	0.135	0.089	0.008	0.086	0.122	0.132	0.131	0.126
Inflation	4.45	1.50	-0.01	-0.02	-0.03	-0.04	-0.05	-0.08	0.03	0.03	0.02	0.02	0.02
Standard Deviation	0.3831		0.120	0.122	0.122	0.120	0.121	0.127	0.124	0.123	0.123	0.124	0.123
Productivity	0.81	0.27	-0.30	-0.20	-0.06	0.15	0.43	0.79	0.68	0.56	0.44	0.33	0.22
Standard Deviation	0.1679		0.131	0.137	0.142	0.142	0.128	0.112	0.086	0.120	0.155	0.182	0.195

Source: Authors´ computations.

TABLE 6

DATA AND MODEL COMPARISON.

Variable	Data		Model 1		Model 2	
	Volatility %	Contemporaneous Correlation	Volatility %	Contemporaneous Correlation	Volatility %	Contemporaneous Correlation
Output	1.89	1.00	2.97	1.00	2.97	1.00
Consumption	1.77	0.85	0.81	0.89	1.43	0.50
Investment	7.43	0.80	11.78	0.97	12.63	0.90
Capital Stock	0.91	-0.02	0.63	0.02	0.64	0.02
Hours	0.74	-0.10	2.34	0.97	2.35	0.97
Money (M1)	4.78	0.62	0.00	0.00	5.91	0.00
Price Level	1.83	-0.34	0.81	-0.89	6.33	-0.11
Unemployment	0.77	-0.61	2.04	-0.97	2.05	-0.97
Inflation (CPI)	0.84	-0.10	0.56	-0.54	4.45	-0.08
Productivity	1.76	0.79	0.80	0.81	0.81	0.79

Source: Authors´ computations.

TABLE 7

CO-MOVEMENT AND PHASE SHIFT OF SIMULATED VARIABLES

Variable	Data		Model 1		Model 2	
	Degree of Comovement	Phase Shift	Degree of Comovement	Phase Shift	Degree of Comovement	Phase Shift
Consumption	Procyclical	Coincides	Procyclical	Coincides	Procyclical	Coincides
Investment	Procyclical	Lags 1 period	Procyclical	Coincides	Procyclical	Coincides
Capital Stock	Uncorrelated	Leads 4 periods	Uncorrelated	Leads 4 periods	Uncorrelated	Lags 4 periods
Hours	Uncorrelated	Lags 2 periods	Procyclical	Coincides	Procyclical	Coincides
Money (M1)	Procyclical	Leads 1 period	Uncorrelated	Coincides	Uncorrelated	Coincides
Price Level	Countercyclical	Coincides	Countercyclical	Coincides	Countercyclical	Coincides
Unemployment	Countercyclical	Lags 1 period	Countercyclical	Coincides	Countercyclical	Coincides
Inflation (CPI.)	Uncorrelated	Leads 4 periods	Countercyclical	Coincides	Uncorrelated	Coincides
Productivity	Procyclical	Coincides	Procyclical	Coincides	Procyclical	Coincides

Source: Authors´ computations.

TABLE 8

CONFIDENCE INTERVAL AND STATISTICS SUMMARY FOR MODEL 1.

Variable	Data	Model 1				
	Volatility %	Mean	Median	P-value	Confidence Interval Lower Limit	Confidence Interval Upper Limit
Output	1.89	2.97	2.93	0.996	2.15	3.98
Consumption	1.77	0.81	0.79	0.000	0.56	1.14
Investment	7.43	11.78	11.30	0.979	7.56	18.85
Capital Stock	0.91	0.63	0.61	0.063	0.34	1.00
Hours	0.74	2.34	2.30	1.000	1.57	3.37
Money (M1)	4.78	0.00	0.00	0.000	0.00	0.00
Price Level	1.83	0.81	0.79	0.000	0.56	1.14
Unemployment	0.77	2.04	2.01	1.000	1.40	2.90
Inflation (CPI.)	0.84	0.56	0.56	0.000	0.46	0.68
Productivity	1.76	0.80	0.79	0.000	0.51	1.17

Source: Authors´ computations.

TABLE 9

CONFIDENCE INTERVAL AND STATISTICS SUMMARY FOR MODEL 2.

Variable	Data	Model 2				
	Volatility %	Mean	Median	P-value	Confidence Interval Lower Limit	Confidence Interval Upper Limit
Output	1.89	2.97	2.93	0.997	2.16	3.97
Consumption	1.77	1.43	1.42	0.044	1.11	1.84
Investment	7.43	12.63	12.09	0.991	8.10	20.14
Capital Stock	0.91	0.64	0.62	0.068	0.35	1.02
Hours	0.74	2.35	2.31	1.000	1.60	3.37
Money (M1)	4.78	5.91	5.82	0.858	4.06	8.25
Price Level	1.83	6.33	6.26	1.000	4.53	8.63
Unemployment	0.77	2.05	2.02	1.000	1.43	2.90
Inflation (CPI.)	0.84	4.45	4.44	1.000	3.71	5.21
Productivity	1.76	0.81	0.80	0.000	0.52	1.18

Source: Authors´ computations.

Sensitivity Analysis

Here we assess how these results change when the values assigned to the deep parameters of the model are modified. We examine these parameters constructing confidence intervals using the same data that we used to assign values in the baseline simulations. The parameters that we consider in the analysis are compiled in Table 10.

In our first analysis we vary only the shock standard deviation while keeping constant the rest of the parameters. That is, we first simulate the model using lower limits for standard deviation of shocks, then we use upper limits, and finally we study combinations of both limits. When we use only the lower limit of the shocks standard deviation, volatility for most of the variables falls compared to the baseline simulation, specially output volatility. Analogously, when we use only the upper limit of the shock's standard deviation, volatility for most of the variables rises. Reductions in the volatility of shocks decrease the uncertainty regarding the states of nature. In fact, the economic agents can achieve smoother paths for the variables they control such as consumption and monetary balances. It follows that the economy, as a whole, exhibits smaller fluctuations. In tables 11 to 14 we summarize the statistics that we obtained.

TABLE 10

DEEP PARAMETERS CONFIDENCE INTERVALS.

Parameter	***Mean***	**Std. Deviation**	**Lower Limit ***	**Upper Limit ***
β	0.9841	0.00063938 (a)	0.9828	0.9854
θ	0.44	0.07218924 (b)	0.30	0.58
A (c)	1.383	-	1.352	1.416
σ_ε	0.013472	0.00002832 (d)	0.011174	0.015432
σ_ξ	0.032567	0.00016650 (d)	0.026975	0.037331

Source: Authors´ computations.

* The confidence intervals are computed using the parameter mean ± two times standard deviation.

(a) The standard deviation for b is obtained from a GMM estimation using PRBC 90 days and consumption data.

(b) Standard deviation is computed using the regular formula: $\sigma^2 = \sum_{i=1}^{N} \left(\frac{X_i - \mu}{N-1}\right)^2$, where $\mu = \sum_{i=1}^{N} \frac{X_i}{N}$.

(c) The confidence interval for the parameter A is obtained indirectly from the construction of a confidence interval for leisure share that is equal to (0.5908, 0.6094).

(d) The standard deviation for technology and monetary shocks is obtained using the variance-covariance matrix, which is computed using maximum likelihood method.

TABLE 11

SIMULATION WITH LOWER LIMIT OF BOTH SHOCKS MODEL 1.

Variable	Data	Model 1				
	Volatility %	Mean	Median	P-value	Confidence Interval Lower Limit	Upper Limit
Output	1.89	2.47	2.44	0.950	1.80	3.31
Consumption	1.77	0.67	0.66	0.000	0.46	0.94
Investment	7.43	9.54	9.25	0.867	6.34	14.41
Capital Stock	0.91	0.53	0.52	0.011	0.29	0.85
Hours	0.74	1.95	1.92	1.000	1.34	2.77
Money (M1)	4.78	0.00	0.00	0.000	0.00	0.00
Price Level	1.83	0.67	0.66	0.000	0.46	0.94
Unemployment	0.77	1.71	1.69	1.000	1.19	2.39
Inflation (CPI.)	0.84	0.46	0.46	0.000	0.38	0.56
Productivity	1.76	0.67	0.66	0.000	0.43	0.97

Source: Authors computations.

TABLE 12

SIMULATION WITH LOWER LIMIT OF BOTH SHOCKS MODEL 2.

Variable	Data	Model 2				
	Volatility %	Mean	Median	P-value	Confidence Interval Lower Limit	Upper Limit
Output	1.89	2.47	2.45	0.951	1.79	3.32
Consumption	1.77	1.18	1.17	0.001	0.93	1.50
Investment	7.43	10.21	9.91	0.933	6.84	15.22
Capital Stock	0.91	0.54	0.53	0.012	0.30	0.86
Hours	0.74	1.96	1.93	1.000	1.36	2.77
Money (M1)	4.78	4.90	4.82	0.517	3.36	6.85
Price Level	1.83	5.24	5.17	1.000	3.73	7.17
Unemployment	0.77	1.72	1.69	1.000	1.21	2.41
Inflation (CPI.)	0.84	3.67	3.67	1.000	3.07	4.30
Productivity	1.76	0.68	0.67	0.000	0.44	0.98

Source: Authors´ computations.

TABLE 13

SIMULATION WITH UPPER LIMIT OF BOTH SHOCKS MODEL 1.

Variable	Data	Model 1				
	Volatility %	Mean	Median	P-value	Confidence Interval Lower Limit	Confidence Interval Upper Limit
Output	1.89	3.37	3.33	1.000	2.45	4.53
Consumption	1.77	0.92	0.91	0.000	0.63	1.32
Investment	7.43	13.88	13.04	0.995	8.50	23.99
Capital Stock	0.91	0.70	0.68	0.140	0.39	1.11
Hours	0.74	2.66	2.61	1.000	1.75	3.85
Money (M1)	4.78	0.00	0.00	0.000	0.00	0.00
Price Level	1.83	0.92	0.91	0.000	0.63	1.32
Unemployment	0.77	2.31	2.27	1.000	1.55	3.29
Inflation (CPI.)	0.84	0.65	0.64	0.008	0.52	0.80
Productivity	1.76	0.91	0.90	0.000	0.58	1.33

Source: Authors´ computations.

TABLE 14

SIMULATION WITH UPPER LIMIT OF BOTH SHOCKS MODEL 2.

Variable	Data	Model 2				
	Volatility %	Mean	Median	P-value	Confidence Interval Lower Limit	Confidence Interval Upper Limit
Output	1.89	3.38	3.34	1.000	2.46	4.52
Consumption	1.77	1.65	1.64	0.278	1.27	2.13
Investment	7.43	14.86	14.02	0.999	9.19	25.86
Capital Stock	0.91	0.72	0.70	0.159	0.40	1.13
Hours	0.74	2.68	2.62	1.000	1.80	3.84
Money (M1)	4.78	6.77	6.67	0.964	4.63	9.46
Price Level	1.83	7.27	7.18	1.000	5.19	9.91
Unemployment	0.77	2.33	2.29	1.000	1.60	3.26
Inflation (CPI.)	0.84	5.11	5.11	1.000	4.27	6.00
Productivity	1.76	0.93	0.92	0.000	0.60	1.35

Source: Authors computations.

When we run simulations combining different limit values for the rest of the parameters, we do not obtain results that differ significantly from those of the baseline model. However, we could establish that the technology shock standard deviation is the main parameter in the determination of output volatility. On the other hand, the monetary shock only plays a role in the determination of money holdings, price level, inflation and consumption. Therefore, "erratic" monetary growth in this model does not have an impact on output volatility, but it does have an impact on price level and consumption. This is because in the model that we study there are not channels by which monetary shocks can (directly) affect output levels. A solution for this shortcoming would be including a credit or liquidity constraint; it would help the model to generate an impact of money over investment decisions.

We also do a similar exercise mixing the parameters values for b, q and A. Changes in the values of the parameters affect the solution of the model. In fact, there are 26 different combinations, but the solution algorithm converges for only seven of them[12]. However, as can be seen in tables 15 and 16, the results are not significantly different from the baseline results. However, we can see that investment volatility falls dramatically in the 21st variant. The artificial volatility for model 1 is quite near to what is observed in the data; in this variant we highlight the greater value of capital share q = 0.58. Moreover, unemployment volatility exhibits a considerable fall in the 10th variant, which assumes greater capital share and substitution elasticity between leisure and consumption. However, this fall in the simulated volatility is not enough to replicate what is observed in Chilean data.

TABLE 15

SIMULATIONS MIXING* PARAMETERS VALUES MODEL 1.

Variable	Data Volatility %	Model 1 Varying 9	10	12	17	20	21	26
Output	1.89	2.97	2.62	2.93	2.97	2.93	2.63	2.99
Consumption	1.77	0.82	0.61	0.80	0.81	0.78	0.59	0.79
Investment	7.43	12.31	8.44	11.67	11.79	11.26	7.81	11.44
Capital Stock	0.91	0.66	0.48	0.61	0.63	0.58	0.44	0.62
Hours	0.74	2.34	2.28	2.31	2.34	2.32	2.30	2.38
Money (M1)	4.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Price Level	1.83	0.82	0.61	0.80	0.81	0.78	0.59	0.79
Unemployment	0.77	1.97	1.58	2.06	1.99	2.08	1.72	2.05
Inflation (CPI.)	0.84	0.57	0.41	0.56	0.57	0.56	0.40	0.55
Productivity	1.76	0.83	0.65	0.79	0.82	0.76	0.62	0.79

Source: Authors´ computations.

[12] For the other 19 combinations of parameter values the solution algorithm does not converge because the second order conditions are violated. For details see Hansen and Prescott (1995).

TABLE 16

SIMULATIONS MIXING* PARAMETERS VALUES MODEL 2.

Variable	Data Volatility %	Model 2 Varying 9	10	12	17	20	21	26
Output	1.89	2.97	2.62	2.94	2.97	2.93	2.63	2.99
Consumption	1.77	1.43	1.34	1.43	1.43	1.42	1.34	1.43
Investment	7.43	13.23	9.09	12.53	12.64	12.04	8.36	12.26
Capital Stock	0.91	0.67	0.49	0.62	0.65	0.59	0.45	0.63
Hours	0.74	2.35	2.32	2.33	2.35	2.33	2.33	2.39
Money (M1)	4.78	5.91	5.90	5.92	5.91	5.91	5.90	5.91
Price Level	1.83	6.33	6.31	6.34	6.33	6.34	6.32	6.33
Unemployment	0.77	1.99	1.60	2.07	2.01	2.09	1.75	2.07
Inflation (CPI.)	0.84	4.43	4.43	4.45	4.44	4.45	4.44	4.45
Productivity	1.76	0.84	0.69	0.80	0.83	0.76	0.66	0.80

Source: Authors´ computations.
* The changing parameters are: 9: b=0.9828, A=1.416; 10: b=0.9828, A=1.416, q=0.58; 12: A=1.352; 17: A=1.416; 20: b=0.9854, A=1.352; 21: b=0.9854, A=1.352, q=0.58; 26: b=0.9854, A=1.416.

V. Concluding Remarks

In this section we highlight the main findings of this paper which can be summarized as follows.

- The Chilean business cycle is not significantly different to those of other economies, i.e., Canada and USA. It may be worth to highlight that even when developing economies short run dynamics are highly influenced by the dynamics of the terms of trade, the basic observed regularities of business cycles are still very similar to those of developed countries.
- The monetary models that we studied are able to replicate the phase shift and correlation with GDP of many macroeconomic variables, i.e., consumption, price level, and productivity. However, there are some of them for which the models fail, such as money and work hours.
- Introducing an "erratic" monetary growth rate improves the ability of the model to replicate the behaviour of consumption. As in Cooley and Hansen (1989), consumption and price level become more volatile and, the contemporaneous correlation between these variables and GDP falls in absolute value, getting closer to what

is observed in data. This is a direct consequence of the cash-in-advance condition stated in equation (6). Introducing a random rate of growth of money leads to a random version of this restriction. Since this restriction is binding in equilibrium; it helps to generate a higher volatility in both consumption and price levels.

- Both versions of the model fail to replicate the volatility of many variables under study. For example, Model 1 fails to replicate work hours, money, price level, unemployment and productivity. In particular, the introduction of a random rate of growth of money has a very little effect on the cyclical properties of the real variables of the economy. It is a basic feature of this class of models that technology (productivity) shocks are the ones leading the dynamics of the real variables. Money, in these models, only affects prices; and consumption via the cash-in-advance constraint.
- Accordingly, the sensitivity analysis shows that the main variable in the determination of output volatility is the standard deviation of technology shock. The other deep parameters, such as discount factor (b), capital share (q) and substitution elasticity between leisure and consumption (A), do not have an important effect on the cyclical behaviour of the macroeconomic variables.
- The cash-in-advance economy that we have studied does not consider many arguments usually argued for giving to money a role in the determination of the economic activity. An example is the role of liquidity in the determination of interest rates and therefore, in the determination of investment. Further research along the lines of this paper should try to assess the quantitative impact of these other channels in the context of a dynamic general equilibrium model.

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