Monetary stimulus: Through Wall Street or Main Street?

Diego E. Vacaflores[*]
Texas State University – San Marcos

* Contact: Department of Finance and Economics, Texas State University, San Marcos, Texas 78666 email: dv13@txstate.edu

ABSTRACT

In the last couple of years we have observed a variety of tools used to stimulate the economy, from the tax rebates of 2008 to the monetary infusion to the financial institutions in 2009. At the same time loud questioning of the perceived favoritism for the financial system has emerged, with suggestions that recoveries should also include infusions to "Main Street" to propel consumption bursts that promote economic activity and growth. A simple limited participation model is developed to examine the effect of alternative distributions of monetary injections, through the financial intermediaries or though consumers, on the main macroeconomic aggregates of the small open economy. It is found that the higher the proportion of monetary injection channeled through the consumers leads to a less vigorous recovery of output, but diminishes the negative effect on the utility of the representative household.

JEL Classification: *C63, E37, E42, E52, E63*

Keywords: *optimal monetary policy, monetary injections, recoveries, theoretical modeling, small open economies*.

I. Introduction.

The recent economic downturn has given rise to an increasing questioning of the way in which our governments choose to stimulate the economy. Starting from the Term Auction Facility of 2007 in the U.S., the following initiatives geared to promote economic growth – like the Economic Stimulus Act of 2008, the temporary cash infusion to taxpayers, the Troubled Asset Relief Program, and the new proposals in place – have generated a continuous debate on the more efficient options available to policymakers to jump-start the economic recovery, with people searching for a logic and clear explanation for the use of such methods.

The typical definition of monetary injection used for the study of economic fluctuations defines monetary injections as the increase in the amount of money circulating in the economy, which then increases the amount of funds available to financial intermediaries to be loaned out at lower interest rates. These additional funds at lower interest rates are typically conceived to facilitate productive and economic activity, which should further boost spending through a multiplier effect.This conventional interest rate/cost of capital channel augments a country's output by lowering the cost of capital, but suggests that countries that are more capital intensive will be more sensitive to monetary shocks. This is the predominant view on the impact of monetary injections by most economists and policymakers, and it is the way in which most of the stimulus resources have been used in the recent recession.

However, since the U.S. government used most of the stimulus funds to rescue the financial system, Wall Street, and in a way neglected initiatives to increment consumer spending to stimulate domestic demand, omitting Main Street, a lot of analysts have started to raise their voice in an attempt to call attention to policies geared to support consumers. They call for measures that will allow channeling monetary injections through households to stimulate demand and thus promote growth. While most economists argue that the usual monetary injections through financial intermediaries is the most appropriate and effective to jump-start the economy, most of this questioning to the usual channel to inject liquidity and create economic growth is in fact exacerbated by the lack of a clear answer of the optimality of each channel.

Perhaps in response to this criticism, an interesting case was implemented at the beginning of the recent economic recession, with the government choosing to target directly the households – consumers – by implementing a tax rebate in the amount of $600 dollars per tax-paying member, with an additional $300 dollars for every qualifying dependent. [Internal Revenue Service, 2008]. The total amount injected into the economy was approximately $100 billion. The theory behind these monetary injections is that they will increase the demand for consumption, stimulate aggregate demand, and thereby get the economy growing again. Critics, however, argue that according to the *Permanent Income Theory* of Milton Friedman or the *Life Cycle Theory* of Franco Modigliani, consumption will only respond marginally because such monetary injections through the consumers are only temporary, and thus would not change their wealth or consumption patterns.

This is why, through different arguments, many economists conclude that monetary injections channeled through the consumers are not a good policy tool to promote economic growth ([Taylor, 2008], [Eichenbaum, 1997], [Feldstein, 2002], and [Taylor, 2009] amongst others). They use case studies, empirical analysis, and observed correlations to push their arguments, but it seems that the theoretical modeling of economic fluctuations has not clarified yet the effectiveness of monetary stimulus channeled through financial intermediaries. This lack of a clear explanation is what is fueling the current debate on the effectiveness of monetary injections through alternative channels, creating the need for a rigorous theoretical examination of the optimal channel to get the economy going.

This study fills this gap. It evaluates the impact of "governmental" monetary injections on economic performance, allowing for alternative fractions of a monetary injection to go through financial intermediaries and through consumers. To this end, I extend a basic limited participation model that can be calibrated to allow for alternative distributions of monetary injections between these two sectors. The results show that monetary injections have a differential effect on output and on the utility of the representative household depending on the relative size of the monetary injection going through the alternative channels, with the specification of higher percentages of the monetary injections going through consumers producing a weaker and delayed recovery of output, but diminishing the negative impact of the monetary injection on the welfare of the representative household.

The remainder of this paper is organized as follows: section II presents a brief summary of the literature review, section III formulates a theoretical limited participation model, section IV presents the dynamic responses of the main macroeconomic aggregates, together with the corresponding utility and trade balance dynamics, and section V summarizes and concludes.

II. Literature review.

Stabilization policy is widely perceived to be achieved more efficiently through monetary policy (i.e. [Taylor, 2009], [Eichenbaum, 2008], [Elmendorf and Furman, 2008]). Central banks can normally use monetary policy to optimally influence the average inflation and unemployment rates. Monetary policy is in general able to provide a stable environment for agents to perform their economic activities and at the same time act as the optimal countercyclical policy to accommodate the economy to shocks, mainly demand shocks. In addition, its effectiveness to respond to non-policy shocks enhances its perception as the most attractive and optimal tool. Eichenbaum (1997) further points out other beneficial qualities like the short time that needs to affect the economy, its short term non-neutrality, and its ability to have a neutral effect in the long-run growth rate of output, making it preferred to fiscal policies.

The conceived qualitative effects of a monetary expansion have been extensively documented and range from the small increase in the price levels, the lowering of the nominal interest rate, the slight increase in real wages, and the short-run expansion of output. Of course, its impact on a particular aggregate depends on the specific circumstances affecting the economy, so the prevailing conditions should guide the decision on which type of monetary policy response is necessary. While the current slowdown was initially perceived to suffer from a liquidity problem, thus requiring a monetary expansion to bring capital to banks and financial institutions, the effectiveness of monetary policy is currently constrained by low interest rates. Alternative tools are currently emphasized, but others argue for greater focus on explicit principles for interventions and the improvement of risk management. [Taylor, 2009].

The alternative view, pushed by the Main Street view advocates, relies on directing the expansionary initiatives to the sector that performs most of the economic activity in a given country, the consumers. The logic propose directing the stimulus through consumers to create higher demand that will then provide the incentive to firms to increase production, which eventually will lead to higher employment levels and thus more income that can further fuel the economic recovery. Of course, targeting consumers that find it difficult to borrow will produce the largest effect on demand. Looking at the issue of which channel should be used to get the economy growing again is in fact a decision between using supply side or demand side economics.

While research in temporary tax rebates is sparse, recent findings show that this type of temporary stimulus can be as effective as traditional monetary injections. Well designed monetary injections to households can provide an alternative tool to jump-start the economy. For example, Zandi (2008) shows that a one-time tax rebate could increase output by an additional 26 percent of the amount injected, providing a significant increase in spending within a year, particularly in the retail sector. He acknowledges that the full effect of the recent temporary cash infusion did not materialize, mainly because of high oil and food prices.

In the same line, Elmendorf and Furman (2008) examine cases when temporary tax rebates could be effective in stimulating the economy. They provide evidence that stimulus efforts focused on individuals add a larger effect on spending than skeptical economists might have expected, highlighting that more than 50 percent of targeted tax rebates are spent within a few quarters. This reinforces the estimates of Johnson et. al. (2007), which show that households spend 25 percent of the tax rebate during the first quarter, and an additional 33 percent of the following quarter. Agarwal et. al. (2007) also report that consumer spending rises in a comparable way, even if the tax rebate is initially used to reduce credit card debt. From a theoretical standpoint, Elmendorf and Reifschneider (2002) use the Federal Reserve Board's large-scale model to show that a 1 percent tax rebate will increase output for 2 consecutive quarters, producing an annualized increase in GDP growth rate of almost 4 percent.

However, when Taylor (2009) examines the causes of the current recession in the U.S., he concludes that the temporary cash infusions of the Economic Stimulus Act of 2008 did little to raise consumption and jump-start the economy. His argument is based in the permanent income theory of consumption, which explains why the jump in personal disposable income did not affect personal consumption expenditures. Temporary rebates would then lead to small increases in consumption, with only consumers having difficulty to borrow adding consumption temporarily [Taylor, 2008]. He goes to argue that policymakers should be wary of such short-term impulse. Critics would argue that this lack of response was due to the extraordinarily high oil and food prices and the observed deleveraging happening during this time, when consumers preferred to reduce their debt instead of increasing consumption.

Implicit in this discussion of the effectiveness of temporary stimulus programs is the potential effect on the welfare of these sectors. The sentiment is that current expansionary initiatives that are going through the financial system and the productive sector are favoring these last two sectors at the expense of the consumers, or Main Street. It is clear that the current decision lays in the idea that if we stimulate the financial system and the productive sector, we will be able to expand the supply side of our economy, and as firms start to increase production they will also increase the amount of workers needed for such expansion, and consequently provide the required income that consumers will need to be able to purchase the additional output produced. Which is not clear is the superiority of this way over the demand led recovery, and who should bear the cost of such effort.

To answer these questions we should abstract from the formal definition of monetary injections performed by the Central Banks and the fiscal policies that are performed by the executive branch, and concentrate in “governmental” monetary injections like the temporary tax rebate in the U.S. and the conditional cash transfer programs in Latin America (i.e. the *bono Juancito Pinto* in Bolivia). Many Latin American countries have expanded these safety net programs to alleviate the negative effect of the downturn on the most vulnerable, but also to inject liquidity into their economies (Guatemala increased the disbursements to *Mi familia progresa* from 0,1 percent of GDP in 2008 to 0,3 percent of GDP in 2010, the Dominican Republic increased the reach of *Solidaridad* by 70.000 families in 2009). [IMF,2011]. We also want to abstract from policies that have focus on broader economic fluctuations and only concentrate in monetary injections geared to get an economy out of a recession. This facilitates our focus on the current discussion of the optimal monetary injection to get our economies out of the recent downturn, being able to test the optimality of the alternative channels used to achieve this goal.

III. Methodological framework.

This section presents a simple limited participation model that is used to examine the alternative channels through which "governmental" monetary injections could be used to stimulate economic growth. This type of model requires money cash balances be held to finance certain types of purchases, with money cash balances (M_c^t) being determined on the previous period, and agents incur an adjustment cost when altering their money holdings. It thus assumes that any monetary shock occurs after households have decided on their money cash – and deposit – balances. This model has been used to rationalize a large and persistent liquidity effect ([Fuerst, 1992], [Lucas, 1990], and [Christiano, 1991]).

The cost of changing money holdings is modeled like in Hairault et. al. (2004), taking into account the time spent on reorganizing the flow of funds. The adjustment cost is a time cost – a reduction in leisure hours in order to spend time adjusting money balances. The adjustment cost equation is given by:

$$\Omega_t = \frac{\xi}{2}\left(\frac{M_{t+1}^c}{M_t^c} - \theta\right)^2 \qquad (1)$$

where the long run value of $\frac{M_{t+1}^c}{M_t^c}$ is in steady state equal to the growth rate of money, represented by the parameter θ. Note that both the level of Ω_t and its derivative with respect to $\frac{M_{t+1}^c}{M_t^c}$ are zero in steady state. The cost of changing M_t^c is an increasing function of the parameter ξ, and this parameter allows us to calibrate the size and persistence of the liquidity effect.

This cost of adjusting money holdings implies that banks deposits would not change significantly following a monetary shock, and consequently, the firm will have more funds to absorb as the decrease in the interest rate is stronger and more persistent. In addition, given uncovered interest rate parity (UIP), this large and persistent fall in the interest rate differential generates an overshooting in the exchange rate in accord with the stylized facts. The model is described in the following subsections.

III.1. Structure of the model

The goods market is characterized by perfect competition, with domestic firms and the rest of the world producing an identical good whose price in domestic currency is given by P_t (i.e. *pesos*). The law of one price holds. Letting S_t denote the price of foreign currency in terms of domestic currency (i.e. *pesos* per dollars), and keeping in mind that the small open economy assumption implies that the price of the good in foreign currency P^* (i.e. dollars) is exogenous, then purchasing power parity is given by:

$$P_t = e_t P^* \quad (2)$$

III.1.1. The household.

The representative agent's objective is to choose a path for consumption and asset holdings to maximize

$$\sum_{t=0}^{\infty} \beta^t U(C_t, L_t) \quad (3)$$

where C is real consumption and L is leisure hours. We normalize the time endowment to unity, so leisure is given by

$$L_t = 1 - H_t - \Omega_t$$

where H is worked hours and Ω is time spent adjusting money balances. We specify the following log-linear per-period utility function to facilitate calibration of the model:

$$U(C_t, L_t) = \log(C_t) + \gamma \log(L_t) \qquad (4)$$

Here γ is the relative weight of leisure in the above utility function, with $0 < \gamma < 1$.

When the goods market opens – in the fourth stage – the cash-in-advance (CIA) constraint takes the form:

$$P_t C_t \leq M_t^c + (1-\varphi)X_t \qquad (5)$$

where M_t^c denotes cash brought forward from period *t-1*, and X_t is the amount of money injected by the central bank. The parameters φ take values between 0 and 1. The parameter φ indicates the percentage of the monetary injection available for immediate consumption as opposed to being first channeled through the financial intermediary.[1] This parameter allows us to change the channel in which monetary injections enter the economy, and to see how the end use of the monetary injections matter.

Household can hold foreign bonds that yield a risk-free nominal interest rate i^*. In each period the household buys foreign assets B_{t+1} denominated in the foreign currency, so the nominal exchange rate becomes a key variable in the portfolio decision of the household.

The household budget constraint is given by:

$$M_{t+1}^c + M_{t+1}^b + s_t B_{t+1} + P_t C_t \leq M_t^c + (1-\varphi)X_t + P_t w_t H_t + (1+i_t)M_t^b + s_t(1+i_t^*)B_t + D_t^f + D_t^b \qquad (6)$$

At time t the household determines consumption C_t and labor supply H_t, as well as the amount of money deposited in banks, M^b_{t+1}, the amount of

1 We introduce φ to allow for different channels through which money could be injected by the central bank, either *helicopter drops* on households or *helicopter drops* on banks. When equal to 0 all goes through the consumer, and is available for consumption in the current period. This is how we model the “governmental” monetary injection analyzed by Zandi (2008), Elmendorf and Furman (2008), Johnson et. al. (2007), and Agarwal et. al. (2007).

money kept as cash, M^c_{t+1}, and the foreign asset position B_{t+1}. Household income is determined by the real wage w_t and by profits (or dividends) received at the end of the period from the firm and the commercial bank, D^f_t and D^b_t, as well as interest on deposits and on foreign bonds. The household's maximization problem can be represented by the value function

$$V(M_t^c, M_t^b, B_t) = \underset{\{C_t, H_t, M_{t+1}^c, M_{t+1}^b, B_{t+1}\}}{Max} \left\{ U(C_t, 1 - H_t - \Omega_t) + \beta \underset{t}{E} V(M_{t+1}^c, M_{t+1}^b, B_{t+1}) \right\}$$

subject to the cash-in-advance constraint (5) and the budget constraint (6). Letting λ_t denote the Lagrangian multiplier associated with the budget constraint, the first order necessary conditions for the household's choice of consumption, labor, money deposits, money-cash holdings, and foreign assets provide the following relationships:

$$\lambda_t = \beta \underset{t}{E} \left[(1 + i_{t+1}) \lambda_{t+1} \right] \qquad (7)$$

$$\frac{\gamma}{1 - H_t - \Omega_t} = w_t P_t \lambda_t \qquad (8)$$

$$s_t \lambda_t = \beta E_t [s_{t+1} (1 + i^*_{t+1}) \lambda_{t+1}] \qquad (9)$$

$$P_t w_t \lambda_t \frac{\xi}{M_t^c} \left(\frac{M_{t+1}^c}{M_t^c} - \theta \right) + \lambda_t = \beta \underset{t}{E} \left[\frac{1}{P_{t+1} C_{t+1}} \right]$$

$$+ \beta \underset{t}{E} \left[P_{t+1} w_{t+1} \lambda_{t+1} \frac{\xi M_{t+2}^c}{(M_{t+1}^c)^2} \left(\frac{M_{t+2}^c}{M_{t+1}^c} - \theta \right) \right] \qquad (10)$$

Equation (7) requires equality between the costs and benefits of bank deposits, while equation (8) requires equality between the marginal disutility of working and the marginal benefit – the real wage multiplied by the Lagrange multiplier. Equation (9) requires equality of the current marginal cost of buying foreign assets (in terms of wealth) with the gains in the following period from holding such assets today, and equation (10) equates the costs and benefits related to the choice made at time *t* of money holdings available for consumption in the following period. It is clear that if the adjustment cost is set to zero ($\xi = 0$) then equation (10) will just equate the household's cost of holding money in the current period to the marginal utility of consumption in the following period, properly discounted. However, when adjustment costs exist ($\xi \neq 0$), the household will compare the cost of changing money holdings (cash) today to the benefits accrued in the next period with respect to the purchasing power of money holdings and the in-advance time saved rearranging the household portfolio.

III.1.2. The firm.

The firm's production technology is specified by a parametric, Cobb-Douglas functional form:

$$Y_t = e^{z_t} K_t^{\alpha} H_t^{1-\alpha} \quad (11)$$

Here $\alpha \in$ [1,0] and *K* is physical capital. The firm's objective is to maximize the discounted stream of dividend payments, namely the value of this discounted dividend stream to the owners, households. The firm receives its profits at the end of the period, so the firm borrows funds from the bank to invest in physical capital at the beginning of the period, with the cost of borrowing given by the nominal interest rate i^t. Consequently, the nominal profits of the firm are given by[2]

$$D_t^f = P_t Y_t - P_t w_t H_t - P_t (1+i_t) I_t - P_t \frac{\psi}{2} (K_{t+1} - K_t)^2 \quad (12)$$

with investment evolving according to the law of motion of the stock of physical capital,

$$I_t = K_{t+1} - (1-\delta) K_t \quad (13)$$

where δ is the (constant) depreciation rate. The last term in (12) accounts for the fact that physical capital is not freely adjusted but in

2 Note that we assume that firms can only borrow for incremental investments, which need to be paid off completely by the end of the period.

fact forces firms to incur in a capital adjustment cost when altered. Here the parameter ψ is chosen to calibrate such cost.

The decision about the use of dividends, either payments to households or reinvestment in the firm, is captured by the ratio of the multipliers associated with the budget constraint of the household in the value function (see equation (7)), as it reflects the consumer's variation in wealth. The value function of the firm is then

$$V(K_t) = \underset{\{H_t, K_{t+1}\}}{Max} \{D_t^f + E_t\left[\beta \frac{\lambda_{t+1}}{\lambda_t}\right] V(K_{t+1})\} \tag{14}$$

Note that the discount factor $\beta \frac{\lambda_{t+1}}{\lambda_t}$ can be written as $[E_t\ (1+i_{t+1})]^{-1}$, reflecting the fact that the appropriate discount rate is time varying and reflects the expected value of the market-determined interest rate.

The first order necessary conditions for the household's choice of labor and capital take the form:

$$w_t = (1-\alpha)\frac{Y_t}{H_t} \tag{15}$$

$$(1+i_t) + \psi(K_{t+1} - K_t) = \beta E_t\left[\frac{P_{t+1}\lambda_{t+1}}{P_t \lambda_t}\left(\alpha \frac{Y_{t+1}}{K_{t+1}} + (1-\delta)(1+i_{t+1}) + \psi(K_{t+2} - K_{t+1})\right)\right] \tag{16}$$

Equation (15) indicates that the cost of hiring an additional worker should equal that worker's marginal productivity, and equation (16) requires equality between the cost and benefit of the marginal investment.

III.1.3. The Central Bank.

The money stock evolves according to

$$M_{t+1} = M_t + X_t \tag{17}$$

where the Central Bank's money injection is defined as

$$X_t = (\theta_t - 1)M_t \tag{18}$$

and where θ_t represents the monetary growth factor. Equation (17) indicates that money growth in the economy depends on the existing stock of money M_t and the monetary injection implemented by the Central Bank X_t. The timing here is that M_t is the beginning-of-period t money stock, and the monetary injection, X_t, determines the money stock carried forward into period t+1.

The monetary growth factor θ_t is specified as:

$$\log(\theta_{t+1}) = (1-\rho_\theta)\log(\overline{\theta}) + \rho_\theta \log(\theta_t) + \varepsilon_{\theta,t+1} \qquad (19)$$

and to confirm stable behavior of the model we also specify the technological innovation Z_t as:

$$\log(z_{t+1}) = (1-\rho_z)\log(\overline{z}) + \rho_z \log(z_t) + \varepsilon_{z,t+1} \qquad (20)$$

where we let $\varepsilon_{\theta,t+1}$ and $\varepsilon_{z,t+1}$ be white noise innovations with variance σ^2_θ and σ^2_z, respectively.

III.1.4. The financial intermediary.

At the beginning of the period, the financial intermediary or 'commercial bank' receives deposits from the household, M_t^b, and potentially a monetary injection from the Central Bank, φX_t [3]. These funds are then available for lending to the firm to pay for the firm's investment in physical capital. At the end of the period, the firm repays its loans, and the bank returns deposits to the household along with the appropriate interest payment.

To make this clearer, the bank's nominal asset balance is given by

$$P_t I_t = M_t^b + \varphi X_t \qquad (21)$$

[3] The monetary injection X_t is a *helicopter drop* that can be split between households and banks. When dropped on banks, it can lend out in the current period t, earning interest that is then distributed back to the households at the end of the period.

Here $P_t I_t$ are the loans made to firms and the right hand side lists sources of funds, the household's deposits and the portion of the monetary injection.

The per-period profits of the commercial bank are equal to the interest on loans minus interest paid on deposits in the bank. Note that the monetary injection directly into banks, is a subsidy to the bank in that there is no interest expense incurred by the bank on the use of those funds. Note also that we have equality between the loan rate and the deposit rate. Absent monetary injections, the bank earns zero economic profits.

$$D_t^b = (1+i_t)P_t I_t - (1+i_t)M_t^b \qquad (22)$$

Putting both expressions together, results in profits of the intermediary depending only on the money injection provided by the monetary authority

$$D_t^b = (1+i_t)\varphi X_t \qquad (23)$$

III.1.5. Closing the model.

To complete the model specification it is worth to note that there is an uncovered interest rate parity condition (UIP) from combining equations (7) and (9):

$$\underset{t}{E}\left[P_{t+1}\lambda_{t+1}\frac{(1+i_{t+1})}{(1+\pi_{t+1})}\right] = \underset{t}{E}\left[P_{t+1}\lambda_{t+1}\frac{e_{t+1}}{e_t}\frac{(1+i_{t+1}^*)}{(1+\pi_{t+1})}\right] \qquad (24)$$

Here π is the net inflation rate at time t+1. Since we are modeling a small open economy with international assets freely traded, the no-arbitrage condition leads to UIP.

Note also that the household can, in principle, hold any quantity of foreign assets that it finds optimal, subject only to its budget constraint. From equation (6) and market equilibrium we can infer that foreign asset holdings evolve according to:

$$s_t B_{t+1} - s_t(1+i^*)B_t = P_t(Y_t - C_t - I_t - \frac{\psi}{2}(K_{t+1} - K_t)^2) \qquad (25)$$

Equation (25) relates domestic production and absorption to an economy's foreign asset position, giving the balance of payments equilibrium. If a country's production is greater than its absorption, that country has a balance of trade surplus and a negative capital account, so its foreign asset holdings will increase.

We also introduce the interest rate differential on bond holdings as

$$i_t^* = i^W - \tau \frac{s_{t-1} B_t}{P_{t-1}} \qquad (26)$$

where the interest in bonds is determined by the world interest rate and the net real foreign asset position, with τ calibrating the asset position. This assumption leads to a lower bond interest rate as the country's net asset position improves. That is, the more foreign bonds held (valued in local currency), the lower is the interest rate on those bonds. The reason for this assumption is to avoid an instability problem with non-stationary behavior on bonds ([Karamé et. al., 2008], [Kollman, 2002], [Ghironi, 2006]).

The set of equations given by the first order conditions, the market equilibriums, and the laws of motion for physical capital, domestic money supply, foreign assets, and the monetary growth factor, constitute a non-linear dynamic stochastic system. The system of equations is presented in the appendix (A.1) together with the log-linearized system following Uhlig's methodology. [Uhlig, 1997]. To solve this system we calibrate certain basic parameters and find the steady state values of the relevant variables to characterize the long-run equilibrium of the economy.

III.2. Calibration and steady state equilibrium.

The calibration for the small open economy uses quarterly data. Table 1 lists the values we assign to the basic parameters. The first three parameters have a standard calibration. The capital share, α, is set to 0,36. The subjective discount factor β is set at 0,988, implying a real interest rate equal to 1,2% per quarter. The depreciation rate on capital is set at 2,5% per quarter. We set the parameter H to 0,2, which implies that the representative household devotes 80% of its time endowment to non-working activities, roughly a 34-hour work week. The parameter ν represents the average of the trade balance to GDP, and is used to determine the long-run real debt-to-GDP ratio in our steady state calculation. The long run gross inflation factor is given by Π, and is based on the average inflation factor. We set the average money growth rate parameter, θ, to 0,014, or 1,4% per quarter. These last two parameters are calibrated to be representative of Latin American economies, currently experiencing a trade surplus and relatively moderate inflation. The persistence coefficient of the monetary and technology shocks, ρ_θ and ρ_z, and the standard deviation of the monetary innovation and technological improvements, σ_θ and σ_z, are calibrated to intermediate values.

Table 1: MODEL CALIBRATION VALUES

$\alpha = 0{,}36$	$H = 0{,}2$	$\varphi = 1$	$\xi = 2$	$\psi = 0{,}1$
$\beta = 0{,}988$	$\delta = 0{,}025$	$\theta = 1{,}014$	$\tau = 0{,}00019$	$\nu = 0{,}00061$
$\rho_\theta = 0{,}14$	$\sigma_\theta = 0{,}000782$		$\rho_z = 0{,}95$	$\sigma_z = 0{,}00816$

Source: Hairault et. al. (2004) and Karamé et. al. (2008), with small adjustments to reflect Latin American economies.

We assume the existence of positive adjustment costs to allow for the liquidity effect, and consider the case of a small but positive adjustment cost parameter, $\xi=2$. This positive adjustment costs represent lost time rearranging money cash balances of almost 2 minutes per week. Nominal variables are made stationary by dividing them by the lagged domestic price level. The main variables are:

$$m_t = M_t / P_{t-1}; m_t^c = M_t^c / P_{t-1}; m_t^b = M_t^b / P_{t-1}; \pi_t = P_t / P_{t-1}; b_t = s_{t-1} B_t / P_{t-1}$$

Obviously adjustment costs disappear in the steady state, and steady state values do not need time subscripts. In the long-run equilibrium we assume the domestic gross inflation rate is given by the gross money growth rate so that $\Pi=\theta$. This also leads to our steady state value for our definition of changes in money cash, equation (17), to be $\Delta M^c=\theta$. The calculations of steady state equilibrium for the remaining variables are straightforward, and are available from the author upon request.

We look at a steady state in which the domestic and foreign inflation levels are the same, so purchasing power parity implies that the change in the nominal exchange rate is constant[4]. Consequently the uncovered interest rate parity condition implies that the domestic interest rate and the interest rate on foreign bonds are equal ($i=i^*$). The steady state values presented in Table 2 examine the allocation of resources in the small open economy.

The parameters used for the initial calibration produce an economy where the households consume 76 percent of output, and where firms invest in capital 23 percent of output. The remaining of output

Table 2: STEADY STATE VALUES

	100% Investment
Nominal Interest Rate	0,0263
Investment	0,1669
Capital	6,6779
Output	0,7072
D. Hours of Work	0,2
Real Wages	2,2630
Consumption	0,5398
Real Money Balances	0,7067
Real Money Cash	0,5474
Real Money Deposits	0,1594
Inflation	1,0140
Bonds	-0,0355
Trade Balance	0,00043
Utility	-1,3457

Source: Author's own calculations

constitutes the net exports of the small open economy, given by the trade balance. These steady state values also determine the per period utility of the representative household to be -1,3457, with increments towards zero, representing improvements in utility – values used in the logarithmic transformation smaller than unity turns them negative. Lastly, the only steady states that are affected by the alternative distribution on the monetary injection between the

4 Note that this assumption sets the steady-state nominal exchange rate to be constant, allowing a different steady-state foreign inflation rate will make the steady-state exchange rate grow at a constant rate.

financial intermediary and the consumers is the allocation of money cash and money deposits, which is determined by the parameter φ.

IV. Dynamic response.

Given the steady states values from the previous section, we now examine the dynamics of the main macroeconomic aggregates of our small open economy following an expansionary monetary shock, to then examine the overall effect of alternative distributions of the monetary injection, the welfare of the representative household, and the behavior of the trade balance. We first present results under the baseline calibration of Table 1, when all the monetary injection goes through the financial intermediary.

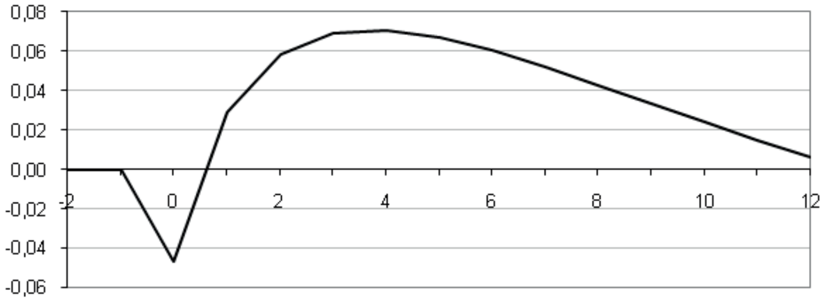
The model behaves according to established facts. A positive 1% shock to the rate of money growth in our baseline calibration slightly lowers the impact on interest rate. It raises inflation momentarily, which reduces the value of real money balances and induces households to increase their holdings of money cash the next period to satisfy a given level of consumption. However, since the monetary expansion goes completely through the financial intermediary and the households cannot withdraw their deposits within the period without incurring adjustment costs rearranging real money balances, it creates an excess supply of funds that outweighs the inflationary pressure to lower the nominal interest rate. This is the typical liquidity effect, and its persistence depends on the ability to rearrange money balances. It is only in the following period that the household will start to reduce its money deposits (M^b_{t+1}) to satisfy consumption, and thus exert an upward pressure on the interest rate.

This instantaneous fall in the nominal interest rate reduces the return on domestic savings, and since the households cannot immediately reallocate their funds towards foreign assets it leads to an instantaneous depreciation of the nominal exchange rate on impact. This depreciation arises from the jump in inflation, but its subsequent appreciation results from the uncovered interest rate parity, which requires the interest rate differential to be equal to the expected rate of appreciation, leading to the subsequent appreciation until it returns to its steady state, as the liquidity effect dissipates.

The consumption dynamics following the monetary injection are mainly generated by inflationary pressures during the period of the shock. Given that the consumption level is determined by the cash-in-advance constraint, and since the amount on money-cash available for consumption is predetermined, inflation generated by the larger money supply reduces consumption instantaneously. The consumption dynamics from the second period onwards arises from the rearrangement between money-cash and money-deposits. Since agents anticipate inflation, and in order to preserve their consumption in the future, households increase their future amount of nominal money-cash in the period of the shock (M^c_{t+1}). Because it is costly to change the ratio $\frac{M^c_{t+1}}{M^c_t}$ when there are positive adjustment costs, this ratio would be adjusted smoothly and thus induce persistence in the adjustment of consumption.

As it is typically found in the literature, an expansionary monetary shock generates a positive wealth effect, which is allocated to increases in leisure in the first period because of the cash-in-advance constraint and adjustment cost of money holdings. Since output is determined by labor and capital levels, and since capital is fixed for the period, this decline in work effort leads to the slight initial drop in output observed in Figure 1 below. However, from the second period onwards we observe an improvement in investment per worker, with its consequent effect on capital, as the interest rate remains below its steady state level due to the liquidity effect and an improvement in work effort due to the real wage remaining at above-steady-levels, both pushing output upwards. Output returns to its original steady state level in a half of a quarter after the monetary shock and peeks after 4 quarters before starting to decline. Note that this hump-shaped response of output is similar to those found in the economic literature (i.e. [Christiano and Eichenbaum, 1992]).

Figure 1: OUTPUT DYNAMICS

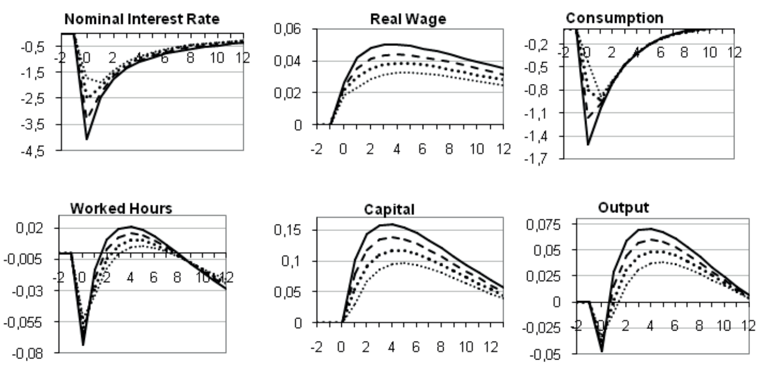


Source: Author's simulated impulse response function
Percent deviations from steady state in vertical axis and quarters in horizontal axis

These dynamic responses to an expansionary monetary shock are typically found in the literature, but our interest is in the potentially differential effects from alternative ways to inject liquidity into the system, through Wall Street or through Main Street. To this end, the parameter φ is allowed to vary away from 1, when the full monetary injection was going through the financial intermediary. The following analysis examines the behavior of the main macroeconomic aggregates to alternative distributions of the monetary injection. The three alternative distributions set the parameter φ equal to 0,75, indicating that 75 percent of the monetary injection goes through the financial intermediaries and the remaining 25 percent goes through the consumer; the parameter φ set equal to 0,5 indicates that 50 percent of the monetary injection goes through the financial intermediary, and the remaining 50 percent goes through the consumers, and the parameter φ set equal to 0,25 indicating that 25 percent of the monetary injection goes through the financial intermediary and the remaining 75 percent goes through the consumers.

As it can be observed below in Figure 2, when one reduces the percentage of the monetary injection going through the financial intermediary the drop in the nominal interest rate will be reduced. The interest rate drops by more than 4 percent when the whole monetary injection goes through the financial intermediary but by only 1 percent when only 25 percent of the monetary injection goes through the financial intermediary. This is expected since the addition of funds injected through the financial intermediary will be reduced, and consequently the pressure to reduce the interest rate from the additional funds would be ameliorated. Since the positive wealth effect arising from the expansionary monetary is allocated to increases in leisure, the decline in labor supply pushes the real wage upwards, with the effect on the real wage being enhanced with the highest proportion of the monetary injection going through the financial intermediary. Even if the inflationary effect is identical under the different distributions of the monetary injection, this suggests a similar drop in consumption due to the predetermined allocation of money cash. Higher levels of the monetary injection going through the consumer loosen the cash-in-advance constraint neutralizes to a certain extent the initial inflationary pressure. This is shown in the top-right corner by the smaller drop in consumption.

Figure 2: DYNAMIC RESPONSE TO A 1% MONETARY SHOCK



Source: Author's simulated impulse response functions
Percent deviations from steady state in vertical axis and quarters in horizontal axis
φ = 1 ____ φ = 0,75 ----- φ = 0,5 …… φ = 0,25 ……

The three graphs at the bottom of Figure 2 explain the behavior of output. In the left hand side we observe the behavior of employment, and it shows that the decline in worked hours ameliorates when the monetary injection is channeled increasingly through the consumers, but it also shows that the subsequent recovery of work effort is diminished as higher proportions of the monetary injection goes through the consumers. The initial drop in employment reflects the household's response to the positive wealth effect, while the subsequent dynamics arise in response to the behavior of real wages, and since real wages increase at lower rates when higher proportions of the monetary injection goes through the consumers, its stimulative effect is also reduced.

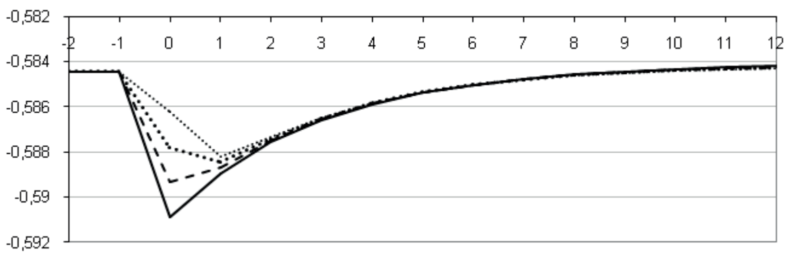
The other factor of production responds in a similar way. The analysis of the nominal interest rate shows that the liquidity effect will be enhanced when higher percentages of the monetary injection goes through the financial intermediaries, and this behavior then affects the investment decisions of the firm. Investment reacts positively to the monetary injection, but its rise is reduced by the smaller declines in the interest rate arising from the higher allocation of the monetary injection through the consumers. This, of course, has an effect on capital accumulation, with capital increasing more slowly and peaking almost 60 percent lower when the percentage of the monetary injection channeled through the financial intermediary is reduced to 25 percent.

Taking these last two dynamics together we can see that the initial decline in output is reduced as we increase the proportion of the monetary injection channeled through the consumers, but the subsequent recovery will also be reduced. The smaller reduction in employment achieved by redirecting a higher fraction of the monetary injection through the consumers, given that capital is fixed during that period, ameliorates the initial drop in output, but it is only a one-period improvement. However, the subsequent smaller recuperation in worked hours and smaller capital accumulation has long lasting effects on the economic recovery when the monetary injection is channeled at higher rates through the consumers. These results clearly indicate that the most effective way in which the Central Bank should inject money into the economy to create economic recoveries is in fact by channeling such injections through the financial intermediaries. To be sure, the distribution of monetary injection does not affect the dynamics of the main macroeconomic aggregates but it does affect their magnitudes.

This alternative distribution of the positive monetary shock will also affect the per-period utility of the representative household. As it is observed below in Figure 3, the expansionary monetary shock will reduce the utility of the representative household, irrespective of the way in which the Central Bank channels the monetary injection. However, when the percentage of the monetary injection being channeled through the consumers increases, this negative effect on the utility will be ameliorated, particularly in the first two periods.

There are three effects generating these dynamics: the first one has to do with deprivation of time available for leisure as the agents spent time rearranging money balances to protect consumption levels from the inflation generated by the monetary injection, which is exacerbated by higher percentages of the monetary injection going through the financial intermediaries; the second one has to do with the larger decline in consumption arising from higher percentages of the monetary injection going through the financial intermediary; and the third one arises from the larger decline in worked hours from higher percentages of the monetary injection going through the financial intermediaries. Note that while the third effect improves utility in all cases, its positive contribution is outweighed by the first two.

Figure 3: UTILITY DYNAMICS FOLLOWING A 1% MONETARY SHOCK

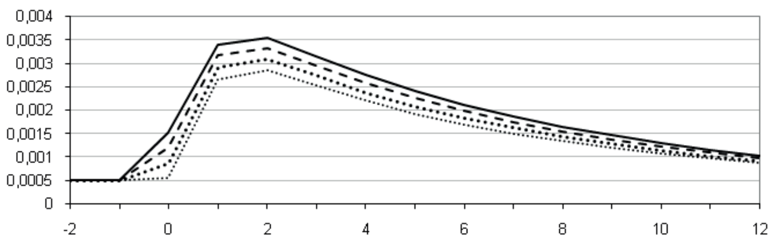


Source: Author's estimates
Changes in Utility in vertical axis and quarters in horizontal axis
φ = 1 ____ φ = 0,75 ----- φ = 0,5 **……** φ = 0,25 ……

These results suggest that the representative household would be better off by having the monetary injection directed through the consumers instead of through the financial intermediaries. Such additional funds help the household protect their consumption pattern and preclude deeper drops in work effort. By pushing for higher proportions of the recovery funds to be channeled through the consumers, Main Street view advocates, in a way are protecting the consumption pattern of the population, and thus this result should not be surprising.

With respect to the trade balance of the small open economy, these alternative distributions of the expansionary monetary shock will affect only the magnitude of the improvement in the trade balance. As it is observed below in Figure 4, the expansionary monetary shock generates a similar pattern except in the first period. This initial difference arises from the behavior of consumption and investment, since the decline in output is somewhat similar under the four alternative distributions of the monetary injection. When only 25 percent of the monetary injection is channeled through the financial intermediary, the decline in output is smaller than the decline in domestic absorption – smaller decline in consumption but also smaller improvement in investment – and thus results in a small improvement in the trade balance. As the percentage of the monetary injection channeled through the financial intermediary increases, the drop in consumption is exacerbated at a higher rate than the enhancement of investment, and thus results in a reduction of domestic absorption that results in a more pronounced improvement of the trade balance with the higher proportion of the monetary injection going through the financial intermediary.

Figure 4: TRADE BALANCE DYNAMICS FOLLOWING A 1% MONETARY SHOCK



Source: Author's estimates
Changes in the Trade Balance in vertical axis and quarters in horizontal axis
φ = 1 ____ φ = 0,75 ----- φ = 0,5 …… φ = 0,25 ……

After the first period the behavior of the trade balance becomes more homogeneous. As it can be observed above, alternative distributions of the monetary injections continue to improve the trade balance for two more periods before starting to deteriorate, with the dynamics of output, consumption and investment becoming more monotonic. In fact, only the behavior of output remains different for the alternative distributions of the monetary injection, while the dynamics of consumption and investment become very similar from the second period onwards.

V. Conclusions.

The main contribution of this study to the economic literature is the explicit modeling of alternative channels through which monetary injections can affect a small open economy. It allows understanding the mechanisms behind monetary injections to be channeled through financial intermediaries or through the consumers. This allows an explicit examination of differential responses from alternative channels and will contribute to the understanding of the optimality of each channel, both in terms of its impact on the economy's output and on the household's utility. This should help clarify the properties of temporary tax rebates and other policies that transfer liquidity to the consumers, and can then be used by policymakers to appropriately design monetary policy to stabilize economic fluctuations.

These results clearly indicate that the most effective way in which the Central Bank injects money into the economy to create economic recoveries is in fact by channeling such injections through the financial intermediaries. It was shown that the initial decline in output resulting from a monetary injection is reduced as we increase the proportion of the monetary injection channeled through the consumers, but the subsequent recovery will also be reduced and delayed. Consequently, if the main goal is GDP recovery, then Wall Street view advocates are correct.

However, since the expansionary monetary shock reduces the utility of the representative household, irrespective of the way in which the Central Bank channels the monetary injection, an increase in the percentage of the monetary injection being channeled through the consumers will lead to a reduced negative effect on the utility. It thus suggests that the representative household would be better off by having the monetary injection directed through the consumers instead of through the financial intermediaries. Such additional funds help households to protect their consumption patterns and preclude deeper drops in work effort.

The results of this paper provide a better understanding of the effectiveness of alternative channels through which the Central Bank could inject money into the system, but by no means argue that its effect is symmetric. In fact, it is unrealistic to imagine that the government could abruptly take cash from the consumers or financial intermediaries without a political cost. Further research should explore its robustness by examining alternative utility specifications, interest rate targeting, and exchange rate regimes.

References

Agarwal, S., Ch. Liu, and N. S. Souleles, (2007). "The reaction of consumer spending and debt to tax rebates – evidence from consumer credit data", Working Paper 13694, National Bureau of Economic Research, December.

Christiano, L., (1991). " Modelling the liquidity effect of a money shock", *Federal Reserve Bank of Minneapolis, Quarterly Review*, 15, pp.3-34.

Christiano, L., and M.Eichenbaum, (1992). "Identification and the liquidity effect of a monetary policy shock" in Cukierman, A., Z. Hercowitz, and L.Leiderman (Eds.), *Political Economy, Growth and Business Cycle*, MIT Press, Cambridge, M.A., pp. 335-368.

Congressional Budget Office, (2008). "Options for responding to short-term economic weakness", CBOPaper, January.

Eichenbaum, M., (1997). "Some thoughts on practical stabilization policy", *The American Economic Review*, 87(2), pp. 236-239.

Elmendorf, D. W., and J. Furman, (2008). "If, when, how: A primer on fiscal stimulus", Strategy Paper, The Hamilton Project, *Brookings Institution,* January.

Feldstein, M., (2002). "The role for discretionary fiscal policy in a low interest rate environment", Working Paper 9203, National Bureau of Economic Research, September.

Fuerst, T., (1992). "Liquidity, loanable funds, and real activity", *Journal of Monetary Economics*, 29, pp.3-24.

Ghironi, F., (2006). "Macroeconomic interdependence under incomplete markets", *Journal of International Economics*, 70(2), pp. 428-450.

Hairault, J.-O., L. Patureau, and T. Sopraseuth,(2004). "Overshooting and the exchange rate disconnect puzzle: A reappraisal", *Journal of International Money and Finance*, 23, pp. 615-643.

Johnson, D., J. A. Parker, and N. S. Souleles, (2006). "Household expenditure and the income tax rebates of 2001", *The American Economic Review,* 96(5)*,* pp. 1589-1610.

Internal Revenue Service, (2008). "Facts about the 2008 tax rebate checks". Available in http://www.irs.gov/newsroom/article/0,id=179095,00.html, (Retrieved on August 10th 2011).

International Monetary Fund, (2011). "The IMF's role in helping protect the most vulnerable in the global crisis". Available in http://www.imf.org/external/np/exr/facts/protect.htm, (Retrieved on August 10th 2011).

Karamé, F., L. Patureau, and T. Sopraseuth, (2008). "Limited participation and exchange rate dynamics: Does theory meet the data?", *Journal of Economic Dynamics & Control*, 32, pp. 1041-1087.

Kollman, R., (2002). "Monetary policy rules in the open economy: Effects on welfare and business cycles", *Journal of Monetary Economics*, 49(5), pp. 989-1015.

Lucas, R., (1990). "Liquidity and interest rate", *Journal of Economic Theory*, 50, pp. 237-264.

Taylor, J. B., (2008). "The state of the economy and principles for fiscal stimulus", *Testimony before the Committee on the Budget, United States Senate,* November.

Taylor, J. B., (2009). "The financial crisis and the policy responses: An empirical analysis of what went wrong", Working Paper 14631, National Bureau of Economic Research*,* January.

Uhlig, H., (1997). "A toolkit for analyzing nonlinear dynamic stochastic models easily", CentER Discussion Paper 97, University of Tilburg and CEPR.

Zandi, M., (2008). Written testimony before the House Committee on Small Business hearing on "Economic stimulus for small business: A look back and assessing need for additional relief". Available in http://www.scribd.com/doc/12002123/Written-Testimony-of-Mark-Zandi-Chief-Economist-and-CoFounder (Retrieved on August 10th 2011).

APPENDIX A.1. System of Equations in real terms

$$\pi_t = \frac{s_t}{s_{t-1}} \pi_t^* \qquad \text{(A.1.2)}$$

$$\pi_t C_t = m_t^c + (1-\varphi)(\theta_t - 1) m_t \qquad \text{(A.1.5)}$$

$$\Lambda_t = \beta \underset{t}{E} \left[\frac{\Lambda_{t+1}}{\pi_{t+1}} (1 + i_{t+1}) \right] \qquad \text{(A.1.7)}$$

$$\Lambda_t w_t = \frac{\gamma}{1 - H_t - \Omega_t} \qquad \text{(A.1.8)}$$

$$\Lambda_t = \beta \underset{t}{E} \left[(1 + i_{t+1}^*) \frac{s_{t+1}}{s_t} \frac{\Lambda_{t+1}}{\pi_{t+1}} \right] \qquad \text{(A.1.9)}$$

$$\Lambda_t w_t \frac{\xi}{m_t^c} \pi_t \left(\Delta M_t^c - \theta \right) + \Lambda_t = \beta \underset{t}{E} \Big[\frac{1}{\pi_{t+1} C_{t+1}} + \Lambda_{t+1} w_{t+1} \frac{\xi}{m_{t+1}^c} \Delta M_{t+1}^c \big(\Delta M_{t+1}^c - \theta \qquad \text{(A.1.10)}$$

$$Y_t = e^{z_t} K_t^{\alpha} H_t^{1-\alpha} \qquad \text{(A.1.11)}$$

$$I_t = K_{t+1} - (1-\delta) K_t \qquad \text{(A.1.13)}$$

$$w_t = (1-\alpha) \frac{Y_t}{H_t} \qquad \text{(A.1.15)}$$

$$(1 + i_t) + \psi \left(K_{t+1} - K_t \right) = \beta E_t \Big[\frac{\Lambda_{t+1}}{\Lambda_t} \Big(\alpha \frac{Y_{t+1}}{K_{t+1}} + (1-\delta)(1 + i_{t+1}) + \psi \left(K_{t+2} - K_{t+1} \right) \qquad \text{(A.1.16)}$$

$$m_{t+1} = \theta_t \frac{m_t}{\pi_t} \qquad \text{(A.1.17)}$$

$$\pi_t I_t = m_t^b + \varphi(\theta_t - 1) m_t \qquad \text{(A.1.21)}$$

$$b_{t+1} - \frac{s_t}{s_{t-1}} (1 + i_t^*) \frac{b_t}{\pi_t} = Y_t - c_t - I_t - \frac{\psi}{2} (K_{t+1} - K_t)^2 \qquad \text{(A.1.25)}$$

$$i_t^* = i^W - \tau b_t \qquad \text{(A.1.26)}$$

To avoid clutter we define changes in money cash balances as

$$\Delta M_t^c = \frac{m_{t+1}^c \pi_t}{m_t^c} \tag{A.1.28}$$

By definition on money balances we have that

$$m_t = m_t^b + m_t^c \tag{A.1.29}$$

$$\log(\theta_{t+1}) = (1-\rho_\theta)\log(\overline{\theta}) + \rho_\theta \log(\theta_t) + \varepsilon_{\theta t+1} \tag{A.1.19}$$

$$\log(z_{t+1}) = (1-\rho_z)\log(\overline{z}) + \rho_z \log(z_t) + \varepsilon_{zt+1} \tag{A.1.20}$$

APPENDIX A.2. The log-linearized system of equations is given by

$$0 = -\hat{\pi}_t + \hat{s}_t - \hat{s}_{t-1} \tag{A.2.2}$$

$$0 = -\hat{\pi}_t - \hat{C}_t + \frac{m^c}{\pi C}\hat{m}_t^c + \frac{(1-\varphi)(\theta-1)m}{\pi C}\hat{m}_t + \frac{(1-\varphi)m}{C}\hat{\theta}_t \tag{A.2.5}$$

$$0 = \underset{t}{E}\left[-\hat{\Lambda}_t + \frac{i}{1+i}\hat{i}_{t+1} + \hat{\Lambda}_{t+1} - \hat{\pi}_{t+1}\right] \tag{A.2.7}$$

$$0 = -\hat{w}_t - \hat{\Lambda}_t + \frac{H}{1-H}\hat{H}_t \tag{A.2.8}$$

$$0 = \underset{t}{E}\left[-\hat{\Lambda}_t + \hat{\Lambda}_{t+1} + \hat{s}_{t+1} - \hat{s}_t - \hat{\pi}_{t+1} + \frac{i^*}{1+i^*}\hat{i}_{t+1}^*\right] \tag{A.2.9}$$

$$0 = \underset{t}{E}\left[-\Lambda\hat{\Lambda}_t - \frac{\beta}{\pi C}\hat{\pi}_{t+1} - \frac{\beta}{\pi C}\hat{C}_{t+1} + \beta w\Lambda\frac{\xi}{m^c}(\Delta M^c)^2\,\Delta\hat{M}^c_{t+1} - \pi w\Lambda\frac{\xi}{m^c}\Delta M^c\,\Delta\hat{M}^c_t\right] \tag{A.2.10}$$

$$0 = -\hat{Y}_t + \alpha\hat{K}_t + (1-\alpha)\hat{H}_t + \hat{z}_t \tag{A.2.11}$$

$$0 = \frac{I}{K}\hat{I}_t - \hat{K}_{t+1} + (1-\delta)\hat{K}_t \tag{A.2.13}$$

$$0 = -\hat{w}_t + \hat{Y}_t - \hat{H}_t \tag{A.2.15}$$

$$\begin{aligned}0 = \underset{t}{E}\Big[&\beta\upsilon K\hat{K}_{t+2} - \left(\upsilon K(1+\beta) + \alpha\beta\frac{Y}{K}\right)\hat{K}_{t+1} + \upsilon K\hat{K}_t - i\hat{i}_t + \beta(1-\delta)i\hat{i}_{t+1} + \frac{\alpha\beta Y}{K}\hat{Y}_{t+} \\ &+\left(\frac{\alpha\beta Y}{K} + \beta(1-\delta)(1+i)\right)\hat{\Lambda}_{t+1} - \left(\frac{\alpha\beta Y}{K} + \beta(1-\delta)(1+i)\right)\hat{\Lambda}_t\end{aligned} \tag{A.2.16}$$

$$0 = -\hat{m}_{t+1} + \hat{m}_t - \hat{\pi}_t + \hat{\theta}_t \tag{A.2.17}$$

$$0 = -\hat{\pi}_t - \hat{I}_t + \frac{m^b}{I\pi}\hat{m}_t^b + \frac{\varphi m(\theta-1)}{I\pi}\hat{m}_t + \frac{\varphi m}{I}\hat{\theta}_t \tag{A.2.21}$$

$$0 = -\hat{b}_{t+1} + \frac{(1+i^*)}{\pi}\hat{s}_t - \frac{(1+i^*)}{\pi}\hat{s}_{t-1} + \frac{(1+i^*)}{\pi}\hat{b}_t - \frac{(1+i^*)}{\pi}\hat{\pi}_t + \frac{i^*}{\pi}\hat{i}_t^* + \frac{Y}{b}\hat{Y}_t - \frac{C}{b}\hat{C}_t - \frac{I}{b}\hat{I}_t \tag{A.2.25}$$

$$0 = \hat{i}_t^* + \frac{\tau b}{i^*}\hat{b}_t \qquad \text{(A.2.26)}$$

$$0 = -\Delta\hat{M}{}^c_t + \hat{m}^c_{t+1} + \hat{\pi}_t - \hat{m}^c_t \qquad \text{(A.2.28)}$$

$$0 = -(m)\hat{m}_t + (m^b)\hat{m}^b_t + (m^c)\hat{m}^c_t \qquad \text{(A.2.29)}$$

$$\hat{\theta}_{t+1} = \rho_\theta \hat{\theta}_t + \varepsilon_{\theta t+1} \qquad \text{(A.2.19)}$$

$$\hat{z}_{t+1} = \rho_z \hat{z}_t + \varepsilon_{zt+1} \qquad \text{(A.2.20)}$$