Modelling Sudden Stops: The non-trivial role of preference specifications

November 14, 2008

Abstract

Recent international macroeconomics literature on sudden stops faces a puzzling ambiguity. Using essentially the same basic small, open economy model with collateral constraints, some studies successfully predict the empirically observed link between sudden stops and output drops, while others get the opposite result where sudden stops lead to increases in output. In this paper we resolve this ambiguity and theoretically prove that the ambiguity results from choice of preference specifications. Specifically, using quasi-linear or GHH preferences allows a small, open economy model to yield observations consistent with data . In contrast, using standard Cobb-Douglas preferences as in business cycle literature leads to an increase in output in response to sudden stop.

Keywords: Sudden Stops, General Equilibrium, Borrowing Constraints, Preference Specifications, Wealth Effects

(JEL Classification Code: F41; F32; E44; D52)

1 Introduction

Recent emerging market crises are commonly characterized by the twin phenomenon of a sudden, sharp reversal of capital inflow, or a *sudden stop*, followed by a large drop in output. While empirical analysis across countries have shown these two phenomenon to be closely related, theoretically establishing this link has been more of a challenge. In current international macroeconomics literature, most studies that have attempted to establish this link have used the common framework of a small, open economy general equilibrium model (RBC-SOE) with collateral constraints on foreign borrowings where sudden stops are triggered by a sudden tightening of the collateral constraint. However, even using this common theoretical framework, the link between a sudden stop and a consequent output drop has not been unambiguously established. While some studies including Mendoza (2006) and Mendoza and Smith (2006) have been successful in establishing the link, a study of the Mexican crisis by Chari, Kehoe and McGrattan (CKM (2005)) have used the same model but have found quite the opposite result: sudden stops infact lead to output increases.

Can these opposing outcomes be reconciled? Under what conditions can RBC-SOE models yield outcomes consistent with data? Our study is motivated by the observation that though most studies that attempt to link sudden stops with output drops use the basic RBC-SOE model, they often vary in two important aspects: (1) presence or absence of other frictions in addition to collateral constraints and (2) preference specifications used, thus offering two potential sources to account for the anomaly. In this paper we theoretically establish that differences in preference specifications play a non-trivial role in determining the success or failure of an RBC-SOE model of sudden stops to reproduce facts from emerging markets and is sufficient to account for the apparent anomaly in literature. To test our conjecture, we take a model of a small, open economy embedded in the world economy populated by agents who face a consumption-leisure choice every period and production takes a labor-augmenting Cobb-Douglas form. The *only* friction in our model is a collateral constraint on foreign borrowing which reflects fluctuations in the economy's access to funds in the international market. Considering two alternative preference structures, GHH[1] and Cobb-Douglas (non-separable in consumption and leisure) we theoretically and quantitatively show that using GHH specification helps us generate an output drop in response to a sudden stop but using Cobb-Douglas preferences yield the opposite result.

The intuition follows from the equilibrium first order conditions. Under GHH preference specifications the marginal rate of substitution between consumption and leisure is independent of consumption implying labor is immune to wealth effects and is uniquely determined by the beginning of the period capital stock.

[1]GHH specification is termed after Jeremy Greenwood, Zvi Hercowitz and Gregory Huffman (1988).

Given this structure, a sudden stop has no effect on current labor hours and consequently on current output. However, the wealth effect of a sudden stop leads to a decline of current period private consumption raising its marginal utility and consequently leads to a reduction in investment, reflecting household's desire to smooth consumption[2] which leads to declines in future capital stock. A fall in future capital in turn reduces labor supply at future dates (given labor is determined by capital stock under GHH preferences) which leads to declines in future output, setting in motion the phenomenon of output drops due to sudden stops, albeit with a one period lag. In contrast, under Cobb-Douglas preferences, the marginal rate of substitution between consumption and leisure is not independent of consumption and thus labor supply decision is not immune to the wealth effects. Thus a sudden stop which can be interpreted as a sudden decline in the wealth of the economy causes a sharp decline in leisure (which is assumed to be a superior good). Decline in leisure, in turn, implies an increase in labor hours. Under standard Cobb-Douglas production functions, an increase in labor hours (given the predetermined capital stock) leads to an increase in output (since the marginal productivity of labor is positive), thus generating the result that sudden stops lead to output increases on impact.

The rest of the paper is organized as follows. In Section Two, we present the model. In Section Three, we present the theoretical analysis and in Section 4 we take a quantitative look at the implications of alternative preferences. Section 5 concludes the paper.

2 Model

We use a standard general equilibrium model of a small open economy that is embedded in the world economy. Time is discreet. The economy is populated by measure one of identical and infinitely lived agents or households, and a large number of identical firms that produce a single homogeneous good every period. The households can borrow from the rest of the world at a given world interest rate. However, the households face collateral constraints that limits their ability to borrow. The borrowing limit can be exogenously fixed by the lender (as we assume here[3]) or endogenously determined by the wealth of the household. In our analysis, a "sudden stop" is modelled as a sudden tightening of the collateral constraint which limits the household's ability to borrow from the international market.

At every time period t, the representative firm hires labor $l(t)$, and capital $k(t)$ from the households to produce the final good $y(t)$. The good $y(t)$ is produced using a constant-returns-to-scale labor augmenting technology that we assume to be of the Cobb-Douglas form:

[2] Note that this effect is similar to one observed when government spending increasing in an RBC model (see Aiyagari, Christiano and Eichenbaum (1992)).

[3] This assumption is to make our study consistent with CKM(2005) and relaxing the assumption does not affect our results.

$$y(t) \leq F(k(t),\ l(t),\ z(t)) = \left((k(t))^{\theta}\left(z(t)l(t)(1+\gamma)^{t}\right)^{1-\theta},\ 0 < \theta < 1\right) \quad (1)$$

where $z(t)$ represents the productivity shock at time t and γ is the long run rate of technical progress.

Assumption 1: Note that our neoclassical production function satisfies the following characteristics:

(1.1) F is homogenous of degree one i.e. for any $\xi > 0$, $F(\xi k(t),\ \xi l(t),\ z(t)$ $= \xi F(k(t),\ l(t),\ z(t))$.

(1.2) The production function is strictly increasing in inputs and the firms face decreasing returns to scale: $F_i() > 0$, $F_{ii}() < 0$, where $i = k,\ l$ and $F_{kk}F_{ll} - F_{kl}F_{lk} > 0$.

(1.3) Further both inputs are needed for production: $F(k, 0) = 0$ and $F(0, l) = 0$.

(1.4) In addition to the above, we also assume that the Inada conditions hold, i.e.: $\lim_{k\to 0} F_k(k,\ l) = \infty$ and $\lim_{k\to\infty} F_k(k,\ l) = 0$.

Thus the problem of the representative firm every period t is to choose labor $l(t)$ and capital $k(t)$ to maximize profits $\pi(t)$:

$$\pi(t) = y(t) - w(t)l(t) - r_k(t)k(t),\ \forall t \quad (2)$$

subject to the production constraint (equation (1)) where $w(t)$ is the wage rate and $r_k(t)$ is the rental rate of capital and they are expressed in terms of the numeraire, the final good y.

A household begins period t with a stock of capital $k(t)$ and borrowings $b(t)$. During the period, the households make consumption $c(t)$ and investment $x(t)$ decisions that is financed by wage income $w(t)l(t)$ and rental income from capital $r_k(t)k(t)$. The households make interest payments $R(t)b(t)$ to the rest of the world at an exogenously given gross world interest rate $R(t)$ and pays lumpsum taxes $T(t)$ to the government. In addition, the households can borrow $b(t+1)$ from the international capital market. The present discounted value of lifetime utility of the household is given by:

$$E_0\left[\sum_{t=0}^{\infty}\beta^t u(c(t), l(t))\right], \quad (3)$$

E is the conditional expectations operator and $\beta \in (0, 1)$ determines the rate of time preference.

Assumption 2: The assumptions on felicity (period utility function) u are as follows:

(2.1) u is a standard strictly increasing, continuously differentiable concave function where $u_j() > 0$,and $u_{jj}() < 0$, where $j = c, 1-l$ and $u_{cc}u_{ll} - u_{cl}u_{lc} > 0$.

In our analysis, we consider two alternative forms of the period utility function (we call it u_1 and u_2) where u_1 takes the quasi-linear or GHH form and u_2 takes the non-separable (Cobb-Douglas) form.

(1) u_1 is given by:

$$
\begin{aligned}
u_1(c(t), l(t)) &= \frac{\left(c(t) - \frac{\psi(l(t))^v(1+\gamma)^t}{v}\right)^{1-\sigma} - 1}{1-\sigma}, \ \sigma > 1 \qquad (4) \\
&= \log\left(c(t) - \frac{\psi\left(l(t)\right)^v\left(1+\gamma\right)^t}{v}\right), \ \sigma = 0
\end{aligned}
$$

where γ is the rate of technical progress. Note that to have these preferences be compatible with balanced growth path[4], we need technological progress to increase the utility of leisure.

(2) u_2 is given by:

$$
\begin{aligned}
u_2(c(t), l(t)) &= \frac{\left(c(t)^{\alpha}\left(1 - l(t)\right)^{1-\alpha}\right)^{1-\sigma} - 1}{1-\sigma}, \ \sigma > 1, \ 0 < \alpha < 1 \qquad (5) \\
&= \alpha \log c(t) + (1-\alpha)\log(1 - l(t)), \ \sigma = 0, \ 0 < \alpha < 1
\end{aligned}
$$

For u_2, in addition to (2.1), we also assume the following standard properties .

Let us define the marginal rate of substitution between leisure and consumption by $w(c,\, l) = -\frac{u_l(c,\, l)}{u_c(c,\, l)}$ for $c > 0$, and $0 \leq l < 1$.

(2.2) $w(c,\, l) \to \infty$ as $l \to 1$ for fixed $c > 0$ and $w(c,\, l) \to 0$ as $c \to 0$ for fixed $l < 1$.

(2.3) If $c \to 0$ and $w(c,\, l)$ is decreasing then $u_c(c,\, l) \to \infty$. This assumption is to accommodate situations when $c \to 0$ and $l \to 1$ simultaneously.

(2.4) $w_c(c,\, l) > 0$ for $c > 0$, and $0 \leq l < 1$. This assumption tells us that leisure is a superior good and we make use of this assumption in proposition 2[5]

Households maximize present discounted value of lifetime utility (Equation 3) subject to the period budget constraint:

$$
c(t) + x(t) \leq w(t)l(t) + r_k(t)k(t) + b(t+1) - R(t)b(t) - T(t), \ \forall t \qquad (6)
$$

Capital stock evolves according to the following:

$$
k(t+1) \leq x(t) + (1-\delta)\,k(t), \forall t \qquad (7)
$$

[4] We can conduct our theoretical analysis by setting $\gamma = 0$. This would not affect our propositions and proofs in any way. However, we assume $\gamma > 0$ for our numerical simulations so that we can better calibrate our model parameters.

[5] Check Aiyagari, Christiano and Eichenbaum (1992) for further details on this assumption.

In addition to the budget constraint, households face a collateral constraint which restricts their borrowing such that:

$$b(t+1) \leq B(t+1), \ \forall t \tag{8}$$

where $B(t+1)$ denotes the maximum amount that a household can borrow in period t. We assume $B(t+1)$ to be exogenously fixed. A decline in $B(t+1)$ corresponds to a sudden stop in our model. To avoid Ponzi scheme we assume that $B(t+1)$ is bounded from above. In addition to the above, the consumer's also face the following constraints:

$$c(t) \geq 0, \ \forall t \tag{9}$$

$$k(t+1) \geq 0, \ \forall t \tag{10}$$

$$0 \leq l(t) \leq 1, \ \forall t \tag{11}$$

where equations (9) and (10) are the non-negativity constraints and equation (11) specifies the constraint on labor supply. Further, $k_0 > 0$ is given.

Government maintains a balanced budget such that $g(t) = T(t)$ every period and the resource constraint in this economy takes the form:

$$c(t) + x(t) + g(t) - b(t+1) + R(t)b(t) \leq y(t), \ \forall t \tag{12}$$

Definition of Equilibrium

Given initial conditions $k(0)$ and $b(0)$, a sequence of exogenous variables $\{B(t+1),\, R(t),\, z(t),\, g(t)\}_{t=0}^{\infty}$, an equilibrium in this economy is given by a set of prices $\{w(t),\, r_k(t)\}_{t=0}^{\infty}$ and a set of allocations $\{c(t),\, l(t),\, k(t+1),\, b(t+1),$ $y(t)\}_{t=0}^{\infty}$ such that (i) at the equilibrium prices the goods and factor markets clear and (ii) given the equilibrium prices, the allocations solve the firm's profit maximization and household's utility maximization problem.

3 Sudden stops & the non-trivial role of preferences: Theoretical analysis

The central question of this paper is how does output respond to sudden declines in the external borrowing limit? We propose that the answer depends on what type of preference specifications were used. Stating our propositions formally:

Proposition 1 *In any period* t*, all other things remaining constant, a decline in the external borrowing limit* $B(t+1)$ *has no effect on current output* $y(t)$ *i.e.* $\frac{dy(t)}{dB(t+1)} = 0$ *but leads to a decline in future output* $y(t+j)$*,* $j = 1,\ 2, 3...$*i.e.* $\frac{dy(t+j)}{dB(t+1)} < 0$*,* $j = 1, 2, 3...$*when utility takes the quasi-linear (GHH) form outlined in equation (4).*

Proof. To theoretically establish the result consider the first order conditions (F.O.Cs) of the benchmark model:

$$\frac{u_l(c(t), l(t))}{u_c(c(t), l(t))} = F_l(t),\ \forall t \tag{13}$$

$$\beta E_t \tfrac{u_c(c(t+1), l(t+1))}{u_c(c(t), l(t))} \left(F_k(k(t+1),\ l(t+1),\ z(t+1)) + 1 - \delta\right) = 1,\ \forall t \tag{14}$$

$$u_c(c(t), l(t)) - \beta E_t u_c(c(t+1), l(t+1)) R(t+1) = \mu(t),\ \forall t \tag{15}$$

$$c(t) + x(t) + g(t) - b(t+1) + R(t)b(t) = y(t),\ \forall t \tag{16}$$

$$F(k(t),\ l(t),\ z(t)) = y(t),\ \forall t \tag{17}$$

$$\left(b(t+1) - B(t+1)\right)\mu(t) = 0,\ \forall t \tag{18}$$

$$\lim_{t\to\infty} \beta^t \lambda(t) k(t+1) = 0 \tag{19}$$

$$\lim_{t\to\infty} \beta^t \lambda(t) b(t+1) = 0 \tag{20}$$

Equation (13) shows that in equilibrium, the marginal rate of substitution between leisure and consumption is equal to the marginal product of labor. Equation (14) is the intertemporal optimization condition determining investment in capital stock. Equation (15) is the corresponding condition for international borrowing where $\mu(t)$ represents the lagrange multiplier on the borrowing constraint. Equation (16), (17) and (18) represent the resource constraint, production constraint and the collateral constraint respectively. Note that $\mu(t) > 0$ is the sufficient condition for the borrowing constraint to hold with equality such that $b(t+1) = B(t+1)$[6]. Equations (19) and (20) are the transversality conditions where $\lambda(t)$ is the lagrange multiplier associated with period t budget constraint.

[6] One can prove that the borrowing constraint holds with equality in the steady state provided $\beta R < 1$ where R is the steady state world interest rate. By extension, literature usually assumes that borrowing constraint also binds in the neighbourhood of the steady state. Interested readers can contact the author for the proof.

Consider a "sudden stop" in a small open economy with binding collateral constraint that manifests itself as a drop in $B(t+1)$. Under GHH preferences equation (13) reduces to:

$$\frac{u_l(c(t),l(t))}{u_c(c(t),l(t))} = \psi l(t)^{v-1}(1+\gamma)^t = F_l(k(t),\ l(t),\ z(t)) \tag{21}$$

which implies that labor at time t or $l(t)$ is a function of the predetermined capital stock $k(t)$ and exogenous shock $z(t)$ only. For example, with Cobb-Douglas production function, equation (21) reduces to:

$$l(t) = \left(\frac{(1-\theta)}{\psi}\left(\frac{k(t)}{(1+\gamma)^t}\right)^{\theta}(z(t))^{1-\theta}\right)^{\frac{1}{v+\theta-1}} \tag{22}$$

which is predetermined given capital stock $k(t)$ and exogenous productivity shock $z(t)$. Therefore, any change in $B(t+1)$ has no effect on labor in period t or $\frac{dl(t)}{dB(t+1)} = 0$.

Given the structure of our production function (equation (1)) period t output $y(t)$ is given by

$$y(t) = \left((k(t))^{\theta}\left(z(t)l(t)(1+\gamma)^t\right)^{1-\theta},\ 0<\theta<1\right) \tag{23}$$

Hence, given predetermined capital stock $k(t)$ and equation (22), output is unchanged or $\frac{dy(t)}{dB(t+1)} = 0$.

While a sudden decline in $B(t+1)$ has no effect on current output $y(t)$, how does it affect future output?

A decline in $B(t+1)$ leads to a fall in disposable income of the household. Given consumption smoothing behavior of the households, a fall in disposable income leads to a fall in investment $x(t)$ and consequently causes a fall in future capital stock $k(t+1)$ (equation 8). Under GHH preferences, future labor supply $l(t+1)$ is given by:

$$l(t+1) = \left(\frac{(1-\theta)}{\psi}\left(\frac{k(t+1)}{(1+\gamma)^{t+1}}\right)^{\theta}(z(t+1))^{1-\theta}\right)^{\frac{1}{v+\theta-1}} \tag{24}$$

Thus a fall in $k(t+1)$, assuming that $z(t+1)$ has not changed, reduces $l(t+1)$. Future output $y(t+1)$ is given by:

$$y(t+1) = (k(t+1))^{\theta}\left(z(t+1)(1+\gamma)^{t+1}l(t+1)\right)^{1-\theta} \tag{25}$$

Therefore a drop in $k(t+1)$ and a drop in $l(t+1)$ results in a drop in $y(t+1)$. A decline in $y(t+1)$ reduces the disposable income of the household in period $t+1$ leading to further declines in investment $x(t+1)$ and future capital stock $k(t+2)$ that in turn reduces future labor supply $l(t+2)$ and output $y(t+2)$. A decline in $y(t+2)$ and consumption smoothing behavior ensures drop in $k(t+3)$and the steps are repeated thus resulting in an "output drop" due to a "sudden stop". ■

Proposition 2 *In any period* t*, all other things remaining constant, a decline in the external borrowing limit* $B(t+1)$ *increases current output* $y(t)$ *i.e.* $\frac{dy(t)}{dB(t+1)} < 0$ *when utility takes the non-separable (Cobb-Douglas) form outlined in equation (5).*

Proof. Under non-separable preferences and Cobb-Douglas production function, equation (13) can be written as:

$$\frac{(1-\alpha)}{\alpha}\frac{c(t)}{(1-l(t))} = (1-\theta)\frac{y(t)}{l(t)} \tag{26}$$

Substituting the value of $y(t)$ from the production function:

$$\frac{(1-\alpha)}{\alpha}c(t) = (1-\theta)\left(\frac{k(t)}{l(t)}\right)^{\theta}(z(t)(1+\gamma)^t)^{1-\theta}(1-l(t)) \tag{27}$$

which implicitly gives the relation between labor and consumption in period t.

Note that taking the first derivation of $c(t)$ with respect to $l(t)$ yields:

$$\begin{array}{c} \frac{\partial c(t)}{\partial l(t)} = (1-\theta)\frac{\alpha}{1-\alpha}k^{\theta}(t)(z(t)(1+\gamma)^t)^{1-\theta}\left(\frac{-\theta}{l(t)^{\theta-1}} + \frac{\theta-1}{l(t)^{\theta-2}}\right) < 0 \\ \text{given that } \theta \in (0,\ 1),\ \alpha \in (0,\ 1) \end{array} \tag{28}$$

which equivalently implies:

$$\frac{\partial l(t)}{\partial c(t)} < 0, \text{(as opposed to zero in the GHH case)} \tag{29}$$

Thus unlike in the GHH case, under non-separable preferences, labor supply is not immune to wealth effects.

Now, a decline in $B(t+1)$ reduces the wealth of private households. Given assumption 2.4 that leisure is a superior good, a decline in wealth implies a decline in leisure $(1-l(t))$ that in turn implies an increase in labor supply $l(t)$.*i.e.* $\frac{dl(t)}{dB(t+1)} < 0$.

With Cobb-Douglas production function:

$$y(t) = (k(t))^{\theta}\left(z(t)l(t)(1+\gamma)^t)\right)^{1-\theta},\ 0 < \theta < 1 \tag{30}$$

the marginal product of labor is positive:

$$\frac{\partial y(t)}{\partial l(t)} = (1-\theta)\,(k(t))^{\theta}\left(z(t)(1+\gamma)^t)\right)^{1-\theta} l(t)^{-\theta} > 0 \tag{31}$$

Hence an increase in labor supply $l(t)$ leads to an increase in output $y(t)$. Thus in case of non-separable Cobb-Douglas preferences, sudden stops cause an increase in output at impact or $\frac{dy(t)}{dB(t+1)} < 0$. ■

4 Sudden stops & non-trivial preferences: Quantitative look

In the previous section, we theoretically study the role of preference specifications in determining the effect of a Sudden Stop on output. Is this effect quantitatively significant[7]? To solve our model, we use the CKM (2005) technique of studying a prototype closed economy growth model with exogenous government consumption (referred to as a "government consumption wedge") that is numerically equivalent to our benchmark model of a small open economy with exogenous borrowing constraint. Sudden Stop in the small open economy is equivalent to an increase in government consumption in the closed economy. Given this proposition, it is enough for our analysis to look at the closed economy model outcomes when the economy faces a sudden increase in government consumption. We state the equivalence result formally in Proposition Three.

4.1 Equivalence results

Consider a closed economy with an exogenous stochastic variable $\widehat{g}(t)$ which we call government consumption that is financed by lumpsum taxes $\widehat{t}(t)$

Then the utility-maximization problem of the representative consumer is given by:

$$Max\ E_0\left[\sum_{t=0}^{\infty}\beta^t u(c(t),l(t))\right]$$
$$s.t.$$
$$1.c(t)+x(t)\leq w(t)l(t)+r_k(t)k(t)-\widehat{t}_t\ \forall t$$
$$2.k(t+1)\leq(1-\delta)k(t)+x(t)\ \forall t$$
$$3.c(t)\geq 0,\ k(t+1)\geq 0,\ 0\leq l(t)\leq 1\ \forall t$$
$$4.k(0)\ given$$

The profit-maximization problem of the representative firm is given by:

$$Max\ \pi(t)=y(t)-w(t)l(t)-r^k(t)k(t)$$
$$s.t.$$
$$y(t)\leq F(k(t),\ l(t),\ z(t))$$

The government balances budget such that $\widehat{g}(t)=\widehat{t}(t)$

[7] In this section, we provide a snapshot of the quantitative implications using impulse responses. For detailed implications including comparisons with data, please refer to an extended version in Chakraborty (2008)

The aggregate resource constraint is given by:

$$c(t) + x(t) + g(t) \leq y(t)\ \forall t$$

The standard assumptions specified in Section 2 holds.

Definition of Equilibrium

Given initial condition $k(0)$, and a sequence of productivity shocks and government expenditure $\{z(t), \widehat{g}(t)\}_{t=0}^{\infty}$, an equilibrium in this economy is given by a set of prices $\{w(t), r_k(t)\}_{t=0}^{\infty}$ and a set of allocations$\{c(t), l(t), k(t+1), y(t)\}_{t=0}^{\infty}$ such that the allocations solve the consumer's utility maximization problem, the firm's profit maximization problem and the resource constraint is met.

Proposition 3 *Given a set of initial allocations* $k(0)$ *and* $b(0)$ *and a set of exogenous variables* $\{B(t),\ R(t),\ z(t),\ g(t)\}$ *consider an equilibrium of the small open economy with exogenous borrowing constraint given by a set of allocations* $\{c(t),\ l(t),\ k(t+1),\ b(t+1),\ y(t)\}$ *and a set of prices* $\{w(t),\ r_k(t)\}$*. Let us define the government consumption* $\widehat{g}(t)$ *in the corresponding prototype closed economy as* $\widehat{g}(t) = g(t) - b(t+1) + R(t)b(t)$*. Then the allocations* $\{c(t),\ l(t),\ k(t+1),\ y(t)\}$ *and prices* $\{w(t),\ r_k(t)\}$ *also form an equilibrium of the prototype economy*

Proof. The proof follows by comparing the first order conditions of the original economy with that of the associated prototype economy.

The equations are the same if we specify $\widehat{g}(t) = g(t) - b(t+1) + R(t)b(t)$. Please check CKM (2005) or Chakraborty (2008) for the detailed proof. ■

4.2 Calibration and Results

Note that in our benchmark model borrowing constraint of the consumer binds in the steady state as long as $\beta R < 1$ where R denotes the steady state world interest rate and β is the constant rate of time preference[8].Given this proposition, we assume that borrowing constraint binds in the neighborhood of the steady state which allows us to solve the model using the usual log-linearization techniques[9]. The solution algorithm requires specification of values of preference and technology parameters $(\theta, \sigma, \upsilon, \gamma, \psi, \delta)$. For specifying the parameters we follow the standard calibration technique used in Real Business Cycle (RBC) literature such that the deterministic steady state moments of the model economy match the moments of the Mexican data. We begin by setting the growth

[8] Interested readers can get the proof from Chakraborty (2008).

[9] This approach has been used by other researchers studying dynamic models with credit constraints like Iacoviello (2005).

rate γ to be $(.04)^{.25}$ to match the long-term quarterly growth rate of the Mexican economy. The quarterly rate of depreciation δ is set to match the average GDP shares of investment and capital where the ratios are .217 and 2.5 where the investment to GDP ratio is taken from World Development Indicators and the capital-output ratio is from Mendoza (2006). As in Mendoza (2006) and Mendoza and Smith (2006), we assume that $\sigma = 2$ and $v = 2$ that yields the value of labor to .65. This results in a labor supply function with elasticity $\psi = 1.54$. In case of Cobb-Douglas preferences, α the weight of consumption in utility is calculated as .6434 There is a lot of controversy surrounding the labor share in Mexico as discussed in Kehoe et. al. (2000) who take the value closer to .7. We consider $1 - \theta$ to be .65, a value used by Mendoza (2004) and close to Kehoe's estimate. The steady state gross world rate of interest is 1.065 which yields a per quarter figure of 1.0159. The external debt to GDP ratio is taken as .2425. This is set to match the market value of debt to capital of 9.7%. We further assume that log deviations of productivity and government expenditure from their respective steady states follows a vector autoregressive process of order one. For estimating the parameters of the VAR process, we consider the TFP series as measured by Solow residuals. The parameters governing the VAR process for government expenditure is measured from the external debt series[10]. The persistence of TFP shocks is calculated at 91% (standard deviation of .04) while that of shocks to government expenditure is estimated to be 86% (standard deviation of .05).

Figure 1 shows the result of a 1% positive shock to government expenditure in a prototype growth model with GHH preferences. The results confirm our theoretical findings that on impact there is no effect on labor $l(t)$ and output $y(t)$, while next period capital $k(t+1)$ registers a decline by .03%. In the next period $t+1$, labor and output both drop and the economy goes into a decline that continues for three periods after the initial impact of the shock before gradually recovering.

[FIGURE 1 HERE]

Figure 2 plots the impulse response of a 1% positive shock to government expenditure in a model with non-separable preferences. On impact, labor and output registers an increase by .05%and .03% respectively while future capital investment falls by .02%. Thus a neoclassical growth model with non-separable preferences generates an output increase as opposed to an output drop when faced with a sudden stop, which is contrary to data.

[10] Chari, Kehoe and McGrattan (2005) take net export series to represent government consumption wedge where a decline in net exports due to a sudden stop correspond to a rise in government wedge.

For our purposes, it would result in an alternative specification of parameters governing the stochastic process for govt. wedge. We check our results given this alternative specification and do not find significant differences. The results are not presented in this paper, but is available on request.

[FIGURE 2 HERE]

5 Conclusion

While empirical studies on sudden stops overwhelmingly link sudden stops to drops in real macro variables, theoretically establishing this link in a general equilibrium framework has been more of a challenge with literature giving us quite opposite results. In this paper, we investigate the reasons behind this anomaly in general equilibrium literature. Using theoretical analysis we establish that the difference in preference specifications is a non-trivial one and is the key element that determines the success or failure of a small open economy general equilibrium model of sudden stops to generate outcomes consistent with data. In other words, to successfully generate an output drop due to a sudden stop in a standard, small open economy general equilibrium model, one has to use preferences such that labor drops in response to a sudden stop. The simple solution would be to use quasi-linear or GHH preferences. The results of our quantitative analysis are consistent with our theoretical findings. Our results thus provide a simple framework for replicating the output drops due to a sudden stop.

References

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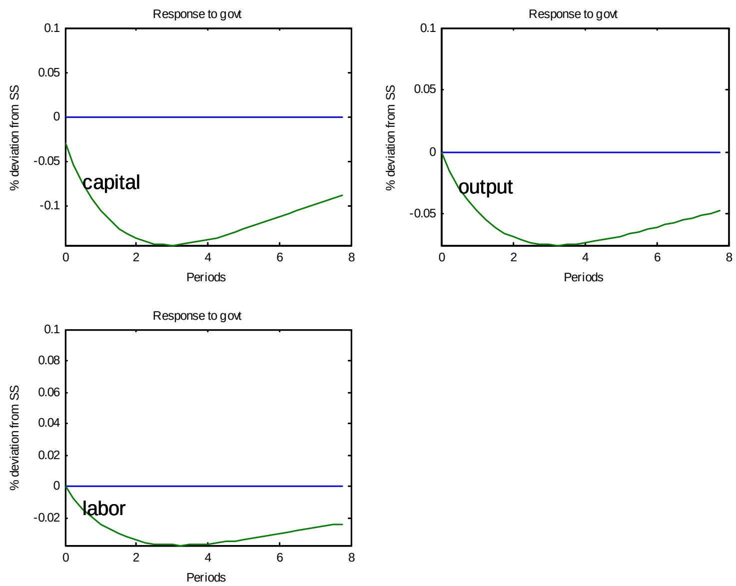
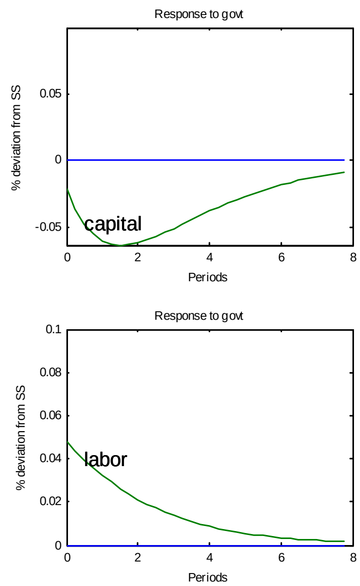
EFFECT OF A CAPITAL FLOW REVERSAL
Impulse responses

Figure 1: Quasi-Linear (GHH) preferences



Note: Proposition 3 outlined the numerical equivalence of the effect of a Sudden Stop occurring in a small, open economy and an increase in tax-financed government expenditure in a prototype closed economy. Therefore to ascertain the effect of a Sudden Stop, we numerically solve the prototype closed economy model and plot the impulse responses of aggregate macro variables (in particular, per capita capital stock, output and labor) to a 1% increase in government expenditure (that corresponds to a 1% decline in external borrowing limit). In Figure 1, the preference specification is quasi-linear, popularly known as GHH.

Figure 2: Non-Separable (Cobb-Douglas) preferences



Note: In Figure 2, the preference specification is Cobb-Douglas and the impulse responses are a result of 1% increase in government expenditure, a similar exercise as in Figure 1.