Macroeconomic and Welfare Implications of Capital Account Liberalization

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Abstract

It is well documented that since the mid-1980s there has been a surge in capital flows due to an increased integration of world financial markets. Absent limited commitment, the increase in financial linkages should improve risk-sharing opportunities. I use a small open economy model where foreign lending to households is constrained by a borrowing limit motivated by limited enforcement. Borrowing is secured by collateral in the form of durable investment whose accumulation is subject to adjustment costs. In this economy an increase in the degree of capital account liberalization increases consumption volatility as agents are unable to exploit risk-sharing opportunities. In presence of risk averse agents an increase in financial integration reduces welfare.

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1 Introduction

It is well documented that since the mid-1980s there has been a surge in capital flows due to the increased integration of world financial markets[1]. Such episodes naturally lead to question the macroeconomic and welfare implications of increased financial liberalization. Most of the theoretical literature so far has shown that increasing international financial linkages should help to improve consumption smoothing possibilities in face of country-specific shocks. This is the starting assumption motivating the works by Backus and Smith 1993, Mendoza 1994, Baxter and Crucini 1995 who study the business cycle implications of restricting international asset trading. This paper builds a small open economy model with borrowing limits to show that capital account liberalization coupled with limited enforcement in financial markets can increase consumption volatility and reduce welfare in presence of risk averse agents.

The model used in this paper is a small open economy model where risk averse agents consume durable and non-durable goods, supply labour services and finance consumption with foreign lending. The latter is constrained by a borrowing limit in which foreign lending is secured by collateral in the form of durable stock. The small open economy produces and trades non-durable consumption goods with the rest of the world as there is imperfect substitution between home and foreign consumption. As shown in Backus, Kehoe and Kydland 1992 imperfect substitution allows for a better characterization of the current account dynamic. Accumulable durables play the role of collateral and can be seized by foreign lenders in the event of default. The reason for introducing durable goods is twofold. First, they account for a large portion of measured consumption and for this reason the current account becomes more variable as agents tend to lump their purchases of durables. Second, given the size of the transactions agents borrow mostly to finance the purchase of durable rather than that of non-durable goods. In this paper we assume that durables play the role of collateralizable wealth but they also provide utility services (see Davis and Heatcote 2005, Miles 1992 and Iacoviello 2005). The latter assumption allows to account both for the welfare effects of fluctuations in durable goods and for the business cycle implications of imperfect substitutability

[1] See Lane and Milesi-Ferretti 2001, Kose, Prasad, Rogoff and Wei 2005, among others.

between durable and non-durable goods. Finally, I assume that agents face adjustment costs on durable consumption, an assumption that allows to reproduce persistence in response to various shocks (see Topel and Rosen 1988, Erceg and Levin 2005). The borrowing limit allows to model the assumption of imperfect financial linkages while the degree of financial liberalization is captured by the parameter characterizing the sensitivity of foreign lending to the value of collateral as a higher value of this parameter relaxes the constraint on foreign lending. The type of borrowing constraint considered is an ad hoc limit on the line of Kiyotaki and Moore 1997, Kocherlacota 2000, Chari, Kehoe and McGrattan 2005 among others.

I study the quantitative properties of this model economy in response to a set of demand and supply shocks which are the main driver of business cycle fluctuations, namely productivity, government expenditure and foreign demand shocks. Several results stand out.

First, the model is able to replicate some important stylized facts such the co-movements of durable and non-durable consumptions and the countercyclical behavior of the current account.

Secondly, I find that an increase in financial liberalization increases consumption volatility in response to shocks even relative to that of output. This is so since an increase in the sensitivity of foreign lending to the value of collateral has three effects: (i) a *wealth effect,* (ii) a *wedge/substitution effect*, (iii) a *valuation effect.* Consider a shock which boosts the economy and increases demand.

First, a higher degree of financial liberalization, by relaxing the borrowing limit, induces a positive *wealth effect*. For the borrower an exogenous increase in credit availability is akin to a positive income shock. Contrary to consumption-smoothing agents, borrowers are impatient and tend to increase borrowing in the face of such a positive income shock. Ultimately higher availability of foreign lending allows for an increase in the demand for both durable and non-durable goods, therefore increases collateralizable wealth. Overall this effect tends to increase non-durable consumption volatility.

Second, when an additional unit of collateral becomes available the shadow value of relaxing the liability constraint is higher the bigger the sensitivity of foreign lending to collateral. The shadow value represented by the lagrange multiplier on the collateral constraint acts as a tax on durable

goods. An increase in this wedge induce agents to substitute durable with non-durable consumption as the current value of the first decreases relative to the second. Such *wedge/substitution effect* induces a higher increase in (non-durable) consumption volatility, the bigger the sensitivity of the debt to collateral.

Finally, a shock that increases the price of durable also increases the collateral value of the durable good, thereby increasing the borrowing capability at the extensive margin. Such *valuation effects* work in the same direction as the *wealth effect.*

I finally consider the welfare consequences of financial liberalization and find that it is welfare detrimental in an economy with imperfect risk sharing. This is so since financial liberalization increases volatility of all variables producing utility services, namely durable and non-durable consumption and employment, thereby reducing the welfare of risk averse agents. A crucial feature of the welfare analysis is the use of second order approximated solutions which allow [2] to account for the effects of stochastic volatility both on first and second moments of the variables that enter agents' utility.

The current paper is related to several strands of the literature. On the empirical side several studies document that an increase in financial openness coupled with less developed financial markets tend to increase both output and consumption volatility (even in terms of that of output). By inspecting countries with high degree of informational asymmetries and less developed financial markets Gavin and Hausmann 1996 find a positive link between capital flows and output volatility, while Bekaert, Harvey and Lundblad 2002, Kose, Prasad and Terrones 2003 and Kose, Prasad, Rogoff and Wei 2004 find that an increase in financial openness tends to increase consumption volatility (even relative to that of output). All those studies stress the role of limited international risk sharing for economies whose financial markets are characterized by strong informational asymmetries and poor financial development.

Most of the theoretical studies focusing on the role of financial integration for business cycle fluctuations (see Cole and Obstfeld 1989, Kollmann 1990, Mendoza 1994, Baxter and Crucini 1995,

[2] See Kim and Kim 2003 for an analysis of the inaccuracy of welfare calculations based on log-linear approximations in dynamic open economies.

Chari, Kehoe and McGrattan 2001, Schmitt-Grohe and Uribe 2003, Heatcote and Perri 2004 among many others) have compared financial scenarios that can be broadly summarized in the following three cases: a) international trade in state contingent securities, b) international trade in non-state contingent securities, c) full financial autarky. Most of the analysis found that restricting asset trading does not alter significantly the business cycle implications of the standard RBC model, both for the case of a small open economy and for the case of a two country model. Some theoretical studies have shown that the impact of financial openness on macroeconomic volatility depends the source of shocks, fiscal versus monetary shocks (see Obstfeld and Rogoff 1995, Sutherland 1996).

More recently some authors have introduced other forms of international financial market incompleteness. Levchenko 2005 uses a framework with limited commitment as in Kocherlacota 1996 and shows that domestic risk sharing arrangements might deteriorate in face of financial integration. He finds that in this case individual consumption might become more volatile but aggregate consumption volatility will nevertheless decrease. Finally Mendoza and Smith 2006 - MS 2006 hereafter - study the quantitative implications of introducing a collateral constraint that limits external debt. They find that when the constraint does not bind standard productivity shocks cause typical real-business-cycle effects, while a binding constraint can increase consumption and current account volatility in presence of high leverage. Using a calibration for emerging market economies they find that collateral constraints do not bind very often in the long run due to the precautionary saving motive. This paper differs from MS 2006 in that we assume that the borrowing limit is binding at all states (see Kiyotaki and Moore 1998 and Kocherlacota 2000). We are allowed to do so as in our economy agents do not face uninsurable idiosyncratic risk (as in Aiyagari 1994, Krusell and Smith 1998, Aiyagari and Gertler 1991) and aggregate stochastic driving forces are bounded above. Although this assumption might restrict the analysis as the precautionary saving channel is shut-off, it nevertheless carries some advantages. First, it allows to work with a tractable framework while maintaining the ability of the model to explore the role of collateralizable wealth and the impact that capital liberalization has on relaxing the borrowing limit at the margin. Second, occasionally binding constraints are more suitable to analyze wealth distribution issues in

presence of uninsurable aggregate risk[3]. The goal in this paper is to keep the analysis at a more general level and to show that business cycle implications of capital liberalizations are modified in presence of limited enforcement. Third, several recent papers have shown that those type of binding collateral constraints can be used successfully in closed economy models to replicate several business cycle stylized facts. For instance Campbell and Hercowitz 2006 show that the observed historical softening of the equity requirements associated with collateralizable household borrowing can explain the increased macroeconomic stabilization experienced in the U.S. (the so-called Great Moderation), while Carlstrom and Fuerst 2006 show that collateral constraints help to explain co-movements in durable and non-durable sectors.

The rest of the paper is divided as follows. Section 2 presents related literature and empirical evidence. Section 3 presents the model and calibration. Section 4 presents the results. Section 5 concludes.

2 A Small Open Economy with Borrowing Limits

The economy is populated by infinitely lived and risk averse agents who consume, work and invest in durable goods. Consumption in durable and non-durable goods is financed through foreign lending which takes the form of non–state contingent securities and is bounded above by a fraction of the future value of the collateral - i.e. durable goods. Hence the capital flow dynamic of the small open economy is directly linked to the tightness of the borrowing limit. Demand for durables is justified since they enter the utility function of the consumers. The assumption of a financially constrained small open economy is justified by the inability of foreign lenders to implement perfect monitoring of the investment activity. Under those circumstances the tightness of the borrowing limit depends on the degree of information asymmetry, of financial market integration and of debt repossession ability which in turn depends upon legal and institutional arrangements. The production sector of this economy is characterized by final good firms who produce with a linear production technology

[3] Although even in this case it is not clear that occasionally binding constraints produce significant aggregate effects. Indeed Krusell and Smith 1998 and Rios-Rull 1994 study the aggregate dynamics of economies in which households face occasionally binding borrowing constraints due to large amounts of uninsurable idiosyncratic risks and find that they are virtually identical to those observed in standard business cycle models.

using labor.

2.1 Domestic Households

Let $s^t = \{s_0, ...s_t\}$ denote the history of events up to date t, where s_t denotes the event realization at date t. The date 0 probability of observing history s^t is given by ρ_t. The initial state s^0 is given so that $\rho(s^0) = 1$. Henceforth, and for the sake of simplifying the notation, let's define the operator $E_t\{.\} \equiv \sum_{s_{t+1}} \rho(s^{t+1}|s^t)$ as the mathematical expectations over all possible states of nature conditional on history s^t.

Agents maximize the following expected discounted sum of utilities:

$$E_t \left\{ \sum_{t=0}^{\infty} \beta^t U(C_t) - V(N_t) + \Delta(\widetilde{D}_t) \right\} \tag{1}$$

where N_t denotes total labour hours, consumption:

$$C_t = \left((1-\alpha)^{\frac{1}{\eta}} C_{H,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{F,t}^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}} \tag{2}$$

is given by a Dixit-Stiglitz consumption aggregator of domestic and imported goods (with η being the intratemporal elasticity) and:

$$\widetilde{D}_t = D_t - \frac{\psi}{2}(\frac{X_t - \delta D_t}{D_t})^2 \tag{3}$$

where D_t is the real value of the stock of a durable good which is hold in positive amount for it generates utility, X_t is investment in durable goods, δ is the depreciation rate and the function $\frac{\psi}{2}(\frac{X_t - \delta D_t}{D_t})^2$ represents an adjustment cost function. The period utility function is separable in each of its argument. After defining $P_t \equiv [(1-\gamma)P_{H,t}^{1-\eta} + \gamma P_{F,t}^{1-\eta}]^{\frac{1}{1-\eta}}$ as the domestic price index and $s_t = \frac{P_{F,t}}{P_{H,t}}$ as the terms of trade, optimal demands for domestic and imported goods imply the following relation:

$$\frac{C_{H,t}}{C_{F,t}} = \frac{(1-\alpha)}{\alpha}(s_t)^{\eta} \tag{4}$$

The household receives at the beginning of time t a labor income of $W_t N_t$, where W_t is the nominal wage. Agents can borrow and lend in the world market at an interest rate R (which is assumed time invariant for simplicity). I denote by B_t the real amount (denominated in units of

domestic consumption) of the net foreign asset position. Agents can also buy and sell durables, D_t, in an internal competitive market[4]. The price of durable in terms of consumption goods is denoted Z_t.

The sequence of budget constraints in real terms reads as follows:

$$C_t + RB_t + Z_t \left(D_{t+1} - D_t(1-\delta)\right) \leq \frac{W_t}{P_t} N_t + B_{t+1} + \tau_t \tag{5}$$

The crucial assumption in this model is that agents face borrowing constraints on the world market. As the foreign lenders are not able to fully repossess their funding, debt and its services are guaranteed as repayable up to a certain fraction of the collateral value (limited liability constraint). The collateral corresponds to the future value of the durable good $Z_{t+1}D_t$, where Z is the price of the durable good. To formalize this idea I assume that domestic households face the following *period-by-period* borrowing constraint on debt:

$$RB_{t+1} \leq \Omega \; E_t\{Z_{t+1} \; D_{t+1}\} \tag{6}$$

Constraint (6) can arise in presence of limited enforcement without default[5]. In equilibrium debt repudiation never occurs as the lender would repossess the whole collateral value. Collateral is in fact used as a promise for repayment. The parameter Ω is the fraction of the future value of the collateral that is guaranteed to be repaid and can be interpreted as a down payment. Hence Ω reflects the degree of information asymmetry, of financial market integration and of debt repossession ability of foreign lenders which in turn depends upon legal and institutional arrangements. In general it is assumed that it is costly for foreign lenders to repossess the entire collateral value. Since increasing Ω allows to relax the borrowing limit and to increase the availability of foreign lending, I will assume that higher degree of financial liberalization is associated with higher value of Ω. The impossibility of equilibrium default implies that the borrowing constraint always holds with equality. As in this model agents are not subject to uninsurable idiosyncratic risk and since

[4] As the bigger fraction of durables is represented by residential housing, non-tradability is an empirically plausible assumption.

[5] Perri 2007 in the *New Palgrave Dictionary of Economics* clarifies that default occurs in equilibrium when limited enforcement is coupled with other frictions.

aggregate risk is bounded above, to ensure that equation (6) holds with equality it is enough to assume that $\beta < R^{-1}$[6].This also implies that agents in this economy are more impatient that standard consumption-smoothing agents.

Households choose the set of processes $\{C_t, N_t, B_{t+1}, D_{t+1}\}_{t=0}^{\infty}$ taking as given the set of processes $\{P_t,\ W_t,\ R,\ Z_t\}_{t=0}^{\infty}$ and the initial wealth B_0, D_0 so as to maximize (1) subject to (5) and (6). Let's define λ_t as the Lagrange multipliers on constraint (6). The following optimality conditions must hold:

$$U_{c,t}\frac{W_t}{P_t} = -V_{n,t} \tag{7}$$

$$U_{c,t} - \lambda_t = \beta E_t \left\{ R U_{c,t+1} \right\} \tag{8}$$

$$\begin{aligned} & Z_t U_{c,t} - Z_{t+1}\Omega\lambda_t + \Delta_{\underset{D_{t+1}}{\sim}} \psi(\frac{D_{t+1}-D_t}{D_t}) \\ = \ & E_t \left\{ \beta \Delta_{\underset{D_{t+1}}{\sim}} (1 + \psi(\frac{D_{t+2}-D_{t+1}}{D_{t+1}}) + \frac{\psi}{2}\frac{(D_{t+2}-D_{t+1})^2}{D_{t+1}^2}) \right\} + \beta(1-\delta)\ E_t \left\{ Z_{t+1} U_{c,t+1} \right\} \end{aligned} \tag{9}$$

$$Z_t = \frac{\Delta_{\underset{D_{t+1}}{\sim}}}{U_{c,t}} \psi(\frac{D_{t+1}-D_t}{D_t}) \tag{10}$$

Equation (7) gives the optimal choice of labor supply. Note that in this context the borrowing constraint does not affect the labour supply choice. Equation (8) is a modified Euler condition on intertemporal consumption demand. As it stands clear from equation (8) a binding borrowing constraint (which implies a positive λ_t) induces a intratemporal distortion in the value of consumption between two different dates. By defining $R_t^c = \frac{U_{c,t}}{E_t\{U_{c,t+1}\}}$ as the households' intratemporal price of consumption, when (6) binds, households face the following endogenous finance premium[7]:

$$E_t\{R_t^c - R\} = \frac{\lambda_t}{E_t\left\{U_{c,t+1}\right\}} \tag{11}$$

[6]The assumption that the borrowing limit holds with equality at an aggregate level is a good approximation even in presence of income heterogeneity. Indeed the fraction of agents who are rich enough to overcome the borrowing limit is typically small. See also Krusell and Smith 1998, Campbell and Hercowitz 2006.

[7]The present model with endogenous borrowing limit is akin to models with endogenous financing premia such as Carlstrom and Fuerst (1997) and Bernanke, Gertler and Gilchrist (1998) .

This implies that it is now more costly and that a higher premium is required to perform a shift in consumption between two different dates. An increase in the parameter Ω, by relaxing the borrowing limit, reduces the responsiveness of the lagrange multiplier, λ_t,to exogenous shocks, therefore reducing the size of the finance premium. The lower the λ_t, the higher is the marginal benefit of acquiring one additional unit of durable good which by relaxing the borrowing limit also allows to acquire an additional unit of non-durable consumption good.

Equation (9) is the efficiency condition for the intertemporal choice of the durable good. The intuition for this equation is as follows. The time t marginal cost of foregoing one unit of non-durable consumption (weighted by the price of the durable) is equated to its marginal gain which has three components. The first is the direct marginal utility of one additional unit of durable investment now and in the future:

$$E_t \left\{ \beta \Delta_{\underset{D_{t+1}}{\sim}} (1 + \psi(\frac{D_{t+2} - D_{t+1}}{D_{t+1}}) + \frac{\psi}{2} \frac{(D_{t+2} - D_{t+1})^2}{D_{t+1}^2} \right\} \tag{12}$$

The second is the expected marginal utility of one unit of non-durable consumption postponed into the future:

$$\beta(1-\delta) E_t \left\{ Z_{t+1} U_{c,t+1} \right\} \tag{13}$$

If the agent shifts today one unit of consumption from non-durable to durable goods, by acquiring more collateral he can increase his debt availability which in turn raises future consumption demand for non-durables.

The third component of the marginal gain is given by the shadow value of relaxing the liability constraint, $Z_{t+1}\Omega\lambda_t$, as an additional unit of collateral becomes available. From equation (9) it stands clear that a binding borrowing constraint induces an intertemporal *distortion* of magnitude $Z_{t+1}\Omega\lambda_t$ in the value of durable consumption between two different dates. Such wedge behaves as a tax on durable goods and changes in its magnitude can shift consumption from durable to non-durable goods. An increase in the paramter Ω has both a direct and an indirect impact on this wedge. Those two effects move actually in opposite directions. The direct impact comes form the fact that the size of the wedge itself depends upon Ω. A higher value of this parameter increases credit availability therefore acting as a positive *wealth* shock that reduces the demand

for collateralizable durable goods. In other words an increase in Ω increases the tax on durable good, $Z_{t+1}\Omega\lambda_t$, as it reduces the marginal benefit of durable relative to non-durable at the current date. The indirect impact comes from the fact a higher value of Ω, by relaxing the borrowing limit, reduces the size of λ_t. As the shadow value of the borrowing limit decreases the marginal benefit of one additional unit of collateral today increases. As λ_t enter the durable tax component, $Z_{t+1}\Omega\lambda_t$, a decrease in λ_t will induce agents to *substitute* non-durable with durable consumption goods. Later on our quantitative simulations will show that the second effect tends to prevail on the first so that in response to shocks we observe an increase in the volatility of non-durable consumption and a decrease in the volatility of durable consumption. Even in this case the distortion has an impact on the finance premium of durable investment and in turn on the volatility of the durable price.

Finally equation, (10), gives the asset price which captures part of the valuation effect as it shows that an increase in durable demand increases its price, thereby increasing its value.

2.2 Domestic Firms

There is a continuum of competitive firms each producing an homogenous final good. Each firm produces according to the following production function:

$$Y_t = A_t \; N_t \tag{14}$$

The cost minimizing choice of labor input implies:

$$\frac{W_t}{P_t} = A_t \tag{15}$$

2.3 Open Economy Relations

Under the small open economy assumptions we set $P^*_{F,t} = P^*_t$.Furthermore I assume that the law of one pice holds continuously so that $P_{H,t} = e_t P^*_{H,t}$ and $P_{F,t} = e_t P^*_{F,t}$ where e_t is the nominal exchange rate. Foreign demand of home produced goods is modelled as follows:

$$C^*_{H,t} = (\frac{P^*_{H,t}}{P^*_t})^{\eta} C^*_t \tag{16}$$

Let's define the terms of trade as $s_t = \frac{P_{H,t}}{P_{F,t}}$. Applying the law of one price and substituting the definition of terms of trade we obtain:

$$C^*_{H,t} = (s_t)^{\eta} C^*_t \tag{17}$$

and where $C^*_t = Y^*_t$. Foreign output is taken as exogenous by domestic residents and takes the following autoregressive process:

$$Y^*_t = (Y^*_{t-1})^{\rho} + \varepsilon^{Y^*}_t$$

2.4 Equilibrium Conditions

Aggregate bonds are in negative net supply and must satisfy the following conditions:

$$RB_{t+1} + \Omega E_t\{Z_{t+1} D_{t+1}\} = 0 \tag{18}$$

By substituting the real wage in the budget constraint of the domestic household using firms' optimality conditions we obtain an equation that links net debt accumulation to net exports as follows:

$$RB_t - B_{t+1} = Y_t - (C_t + Z_t X_t) \equiv NX_t \tag{19}$$

where:

$$X_t = D_t - D_{t-1}(1 - \delta) \tag{20}$$

denotes investment in durable goods. Equation (19) describes the current account dynamic which in this economy is governed by the accumulation of foreign debt.

Output can be costlessly allocated to durable and non durable consumption goods, as well as to government expenditure. Hence the resource constraint in this economy reads as follows:

$$Y_t = C_{H,t} + C^*_{H,t} + X_t + G_t \tag{21}$$

2.5 Calibration

Preferences. Time is measured in quarters. To ensure that the borrowing constraint is always binding I assume that $\beta < R_t^{-1}$, therefore I set $\beta = 0.96$. Under this parametrization[8] the shadow value of borrowing is always positive. Utility is modeled as follows:

$$\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\tau}}{1+\tau} + \frac{\tilde{D}_t^{1-\gamma}}{1-\gamma}$$

The parameter σ is set equal to 2 as in most of the RBC literature. The parameter τ is set equal to 3 since it is assumed that 1/3 of the time is spent working. The parameter γ is set equal to 2 implying that preferences over durables exhibit a somewhat lower intertemporal substitution elasticity than the logarithmic case; this value falls within the range estimated by the empirical literature.Results are robust to several utility parametrization.

Technology. Consistently with Erceg and Levin 2002 I set $\psi = 300$. This value allows to obtain a volatility for durable goods higher than the one for non-durable as suggested by empirical evidence. The quarterly depreciation rate of the durable stock is set to $\delta = 0.025$; this value is consistent with a specification of the durable investment which includes both consumer durables and residential investment. I set the baseline parameter that defines the tightness of the endogenous borrowing limit so as to induce a steady state debt to equity (leverage) ratio of 0.4. Following Backus, Kehoe and Kydland 1995 the elasticity of substitution between home and foreign consumption, η, is set to 1.5. Finally the share of home consumption good, α, is chosen such that the steady state sum of exports and imports is 40 percent of output.

Stochastic processes. Following Prescott 1986 and McCallum and Nelson 2000 the standard deviation of the productivity shock is set to 0.007 and its persistence is set to 0.95. To determine the statistical properties of the foreign demand shock I measure world output as U.S. real GDP and using OECD quarterly data for the period 1970-2001 I seek for innovations by fitting an autoregressive process with time trend. I find that $\sigma_{\varepsilon_t^{Y^*}} = 0.00885$. The share of government expenditure over GDP in the steady state is set equal to 0.2. Log-government consumption evolves

[8] This value is also consistent with the value chosen in Krusell and Smith 1998.

according to the following exogenous process, $\ln\left(\frac{g_t}{g}\right) = \rho_g \ln\left(\frac{g_{t-1}}{g}\right) + \varepsilon_t^g$, where the steady-state share of government consumption, g, is set so that $\frac{g}{y} = 0.25$ and ε_t^g is an i.i.d. shock with standard deviation σ_g. Empirical evidence in Perotti 2004 suggests $\sigma_g = 0.008$ and $\rho_g = 0.9$.

The set of optimality conditions of the optimal plan can be described as follows:

$$E_t \{ \mathcal{H}(\Psi_{t+1}, \Psi_t, X_{t+1}, X_t)\} = 0 \tag{22}$$

where E_t denotes the mathematical expectations operator, conditional on information available at time t, Ψ_t is the vector of endogenous non-predetermined variables, and $X_t \equiv [x_{1,t}, x_{2,t}]$ is the state vector. The solution of the model is of the form (see Schmitt-Grohe and Uribe 2004) :

$$\Psi_t = g(X_t, \overline{\xi}) \tag{23}$$

$$X_{t+1} = h(X_t, \overline{\xi}) + \overline{\eta\xi}\ \varepsilon_{t+1} \tag{24}$$

Equation (23) and (24) describe the policy function and the transition function respectively. I compute a second order expansion of the functions $g(X_t, \overline{\xi})$ and $h(X_t, \overline{\xi})$ around the deterministic steady-state.

3 Quantitative Properties of the Model

We now turn to the analysis of the quantitative properties of the model with two purposes in mind. First, I evaluate the qualitative and quantitative response to various shocks. Secondly, I use the model to evaluate the welfare effects of increasing financial liberalization.

3.1 Dynamic Responses to Shocks

Before analyzing the business cycle properties of the model it is instructive to illustrate the dynamic responses of selected variables to various shocks. Figure 1 shows impulse responses of selected variables to a 1% increase in productivity. An increase in aggregate productivity increases output and wages. This increase in wealth induces an increase in consumption of both, durable and non-durable goods. Consistently with evidence reported in Erceg and Levin 2005 responses of both

variables are hump-shaped. The hump-shaped dynamics is due to the persistence introduced by the cost of adjusting durable investment. The increase in the demand for durable goods induces an increase in their price which in turn raises the future value of collateral. Finally, the increase in the value of collateral relaxes the borrowing limit, therefore increases the availability of loans and raises further the demand for both durable and non-durable goods. As capitals flow into the country, the relative demand between domestic and foreign consumption goods (bottom panel on the left in figure 1) increases and terms of trade depreciate.

It is important to note that the ratio between current account and output decreases in response to a positive technology shock. This shows that the model can replicate the countercyclical behavior of the current account (see Backus and Kehoe 1989). Traditional models of the current account can replicate this fact only by relying on a strong income effect on imports. However Frenkel and Razin 1987 have shown that in models with an intertemporal approach to the current account this condition might not be sufficient to guarantee a countercyclical behavior of the current account. This is so since in those models the balance between the income and substitution effects interacts with the intertemporal saving decision. In particular for the current account to behave countercyclically one would need the pro-borrowing effect caused by an expected expansion of future output to overcome the pro-saving effect induced by an increase in current output. In our framework this is so due to a combination of elements. First, introducing adjustment costs on durables tends to protract the effect of shocks and this allows the pro-borrowing effect to compensate for the pro-saving effect. Secondly, as agents are more impatient than standard consumption-smoothing agents, they prefer to increase borrowing in face of positive shocks. The combination of those two elements allows the pro-borrowing effect to dominate the pro-saving effect; this in turn allows for a countercyclical current account dynamic.

Figure 2 shows impulse responses of selected variables to an increase in the foreign demand of domestically produced goods. The impact of this shock is rather small as it only enters additively the foreign consumption demand of domestically produced goods, but it does not affect directly the terms of trade dynamic. An increase in the foreign demand of domestically produced goods

appreciates terms of trade and reduces domestic demand of domestically produced goods. Overall domestic consumption of non-durable goods decreases. Despite this the increase in exports allows for a moderate increase in output. Once again the ratio between the current account and output behaves countercyclically. As credit availability decreases the stock of durables decreases as well.

Figure 3 shows impulse responses of selected variables to a government expenditure shock. An increase in government expenditure crowds out the demand for durable and non-durable consumption. The price of the durables falls and consequently the value of collateral decreases. This tightens the borrowing limit and reduces the availability of foreign lending which in turn further decreases the demand for both durable and non-durable goods. Despite this output increases as government expenditure has increased. As the domestic demand for non-durable falls, terms of trade appreciate. In this case the current account does not behave countercyclically: the reason for that is that the fall in the demand for durable has reduced the availability of collateral and consequently the pro-borrowing effect.

It is worth noting that our impulse responses show that durable and non-durable consumptions tend to co-move. This result is consistent with an important empirical regularity highlighted in Barsky, House and Kimball 2005 and Davis and Heatcote 2005. Both papers show that durable and non-durable consumptions tend to co-move in response to various shocks but that this regularity is at odd with either standard business cycle or sticky price models and propose some mechanism to overcome the puzzle. In my paper as both types of consumptions are financed through foreign lending their dynamics is simultaneously driven by the tightness of the borrowing limit. This implies that business cycle fluctuations of durable and non-durable goods tend to co-move. A mechanism similar to our is at work in Carlstrom and Fuerst 2006 in which durable and non-durable consumptions tend to co-move when their dynamics is constrained by a borrowing limit motivated by a hold-up problem.

3.2 Consumption Volatility and Financial Openness

We are now in the position to evaluate the effects of increased financial liberalization. Figure 4 shows impulse responses of selected variables to productivity shocks and for different values of the

parameter Ω, ranging from 0.3 to 0.8. In general we observe that when Ω increases the volatility of non-durable consumption, employment and output increases while that of durable consumption decreases. Those findings are the results of three combined effects.

1) *Wealth effect.* First, a higher degree of financial liberalization, by relaxing the borrowing limit, induces a positive *wealth effect*. For the borrower an exogenous increase in credit availability is akin to a positive income shock. Contrary to consumption-smoothing agents, borrowers are impatient and tend to increase borrowing in the face of such a positive income shock. Ultimately higher availability of foreign lending allows for an increase in consumption, thereby increasing fluctuations in non-durable consumption demand. The increase in fluctuations on the demand side also tends to increase fluctuations in output and employment.

In this context it is worth inspecting the dynamic of the shadow value of relaxing the borrowing limit at the margin (see third panel on the left in figure 4). This variable in fact provides exactly the marginal price of an increase in wealth and as expected it becomes more volatile as the parameter Ω increases.

2) *Wedge/substitution effect.* Secondly, as it stands clear from equation (9) as an additional unit of collateral becomes available the shadow value of relaxing the liability constraint, $Z_{t+1}\Omega\lambda_t$, changes. This shadow value represents an intertemporal *distortion* in the value of durable consumption between two different dates. Such wedge behaves as a tax on durable goods and changes in its magnitude can shift consumption from durable to non-durable goods at the current date. An increase in the paramter Ω has both a direct and an indirect impact on this wedge. Those two effects move actually in opposite directions. The direct impact comes form the fact that the size of the wedge itself depends upon Ω. A higher value of this parameter increases credit availability therefore acting as a positive *wealth* shock that reduces the demand for collateralizable durable goods. In other words an increase in Ω increases the tax on durable good, $Z_{t+1}\Omega\lambda_t$, as it reduces the marginal benefit of durable relative to non-durable at the current date. The indirect impact comes from the fact that a higher value of Ω, by relaxing the borrowing limit, reduces the size of λ_t. As the shadow value of the borrowing limit decreases the marginal benefit of one additional

unit of collateral today increases. As λ_t enter the durable tax component, $Z_{t+1}\Omega\lambda_t$, a decrease in $\lambda_t$will induce agents to *substitute* non-durable with durable consumption goods. Quantitatively the first effect seems to prevail as while the sensitivity of non-durable consumption increases when Ω increases, the contrary is true for the demand in durable goods.

3) *Valuation effect.* A shock that increases the price of durable also increases its collateral value, thereby increasing the borrowing capability at the extensive margin. Such *valuation effects* work in the same direction as the *wealth effect,* hence overall it tends to increase non-durable consumption volatility.

Figure 5 shows changes in the volatility of consumption with respect to changes in the tightness of foreign lending described by the parameter Ω. The volatility is computed including all shocks considered in the model. I find that consumption volatility is monotonically increasing with respect to the degree of financial openness. This is once again the result of three abovementioned effects.

To check robustness I test whether the relation found remains valid under different parametrization of trade openness[9]. As trade openness increases the country might import consumption volatility as it relies more on foreign production. I find no significant effect of trade openness, a result consistent with empirical evidence (see Easterly, Islam and Stiglitz 2001 and Kose, Prasad and Terrones 2003).

Furthermore, I find that consumption volatility relative to output volatility also increases with respect to Ω. Indeed relative consumption volatility goes from 0.9049 to 0.9962 when Ω goes from 0.2 to 0.8. This result is consistent with Bekaert, Harvey and Lundblad 2002, Kose, Prasad and Terrones 2003 and Prasad, Rogoff, Wei and Kose 2005.

3.3 Welfare Implications

The final goal of the analysis so far conducted consists in evaluating the impact of capital flow liberalization on household's welfare. We have previously shown that an increase in financial openness induces an increase in macroeconomic volatility, hence we are now interested in assessing its impact on welfare. To fully account for the effects of the increased volatility on welfare I

[9]Results are not reported for brevity but are available upon request.

solved the model using second order approximations[10] which allow to account for the effects of stochastic volatility both on first and second moments of the variables in the model. Indeed, one cannot safely rely on standard first order approximation methods to compare the relative welfare associated with different financial liberalization regimes. In an economy with a distorted steady state stochastic volatility affects both first and second moments of those variables that are critical for welfare. Since in a first order approximation of the model's solution the expected value of a variable coincides with its non-stochastic steady state, the effects of volatility on the variables' mean values is by construction neglected. Hence different financial scenarios can be correctly ranked only by resorting on a higher order approximation of the policy functions. Additionally one needs to focus on the *conditional* expected discounted utility of the representative agent. This allows to account for the transitional effects from the deterministic to the different stochastic steady states respectively implied by each alternative financial scenario[11].

The welfare metric employed is given by the conditional expectation of the second order Taylor expansion of agents' utility:

$$\mathcal{W}_0 = \left\{ E_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t, \widetilde{D}_t) \right\} \tag{25}$$

Figure 6 shows changes in welfare with respect to changes in the parameter Ω ranging from 0.4 to 0.8. Agents' welfare is clearly decreasing with respect to the parameter defining the degree of financial liberalization. The reason for this is simple. A raise in in the parameter Ω increases both the volatility of consumption and employment. Since agents are risk averse the increase in volatility reduces welfare. Notice that this occur despite the fact that the volatility of durable goods is decreasing with respect to the same parameter.

Before closing it is worth exploring whether the negative link between welfare and financial openness remains unchanged for different values of the elasticity for durables demand. This parameter indeed affects the volatility of durable goods. More specifically the higher is the value of γ the lower is the volatility of durable goods in response to shocks. Figure 7 shows changes in

[10] See Kim and Kim 2003 for an analysis of the inaccuracy of welfare calculations based on log-linear approximations in dynamic open economies. See Kim et al. 2003 and Schmitt-Grohe and Uribe 2004 for a more general discussion.

[11] See Kim and Levin (2004) for a detailed analysis on this point.

welfare with respect to changes in the parameter that defines financial openness, Ω, and for two different values of γ (1.5 in the top panel graph and 3 in the bottom panel graph). Financial openness remains welfare detrimental for every value of the elasticity for durable goods. Additionally we observe that higher values of γ by reducing the volatility of durables tend to raise welfare.

4 Conclusions

This paper builds a small open economy with accumulable durable goods and a limit on foreign borrowing. It shows that financial liberalization coupled with incomplete markets in the form of limited commitment raises volatility of both durable and non-durable consumption goods and employment in response to various shocks. The main intuition comes from the fact that an increase in the degree of financial liberalization increases the sensitivity of foreign borrowing to fluctuations in collateral value, hence it amplifies fluctuations in the capital account. Such amplification effect is transmitted to both durable and non-durable consumption goods as they are both financed through foreign borrowing. In presence of risk averse agents this implies a fall in welfare. This result might rationalize the evidence reported by some studies that capital account liberalization raises consumption volatility even relative to that of output.

Although the paper provides some insights in understanding the implications of capital account liberalization more research is needed in order to explore the role of additional features which are not considered in this paper. First, it might be worth exploring the role of agents heterogeneity and uninsurable risk as with those features the precautionary saving channel might help agents to overcome the lack of risk-sharing opportunities in foreign lending. Secondly, the model presented neglects investment in physical capital: as a big fraction of foreign lending goes to finance this type of investment, the introduction of physical capital might play an important role in explaining the current account dynamic.

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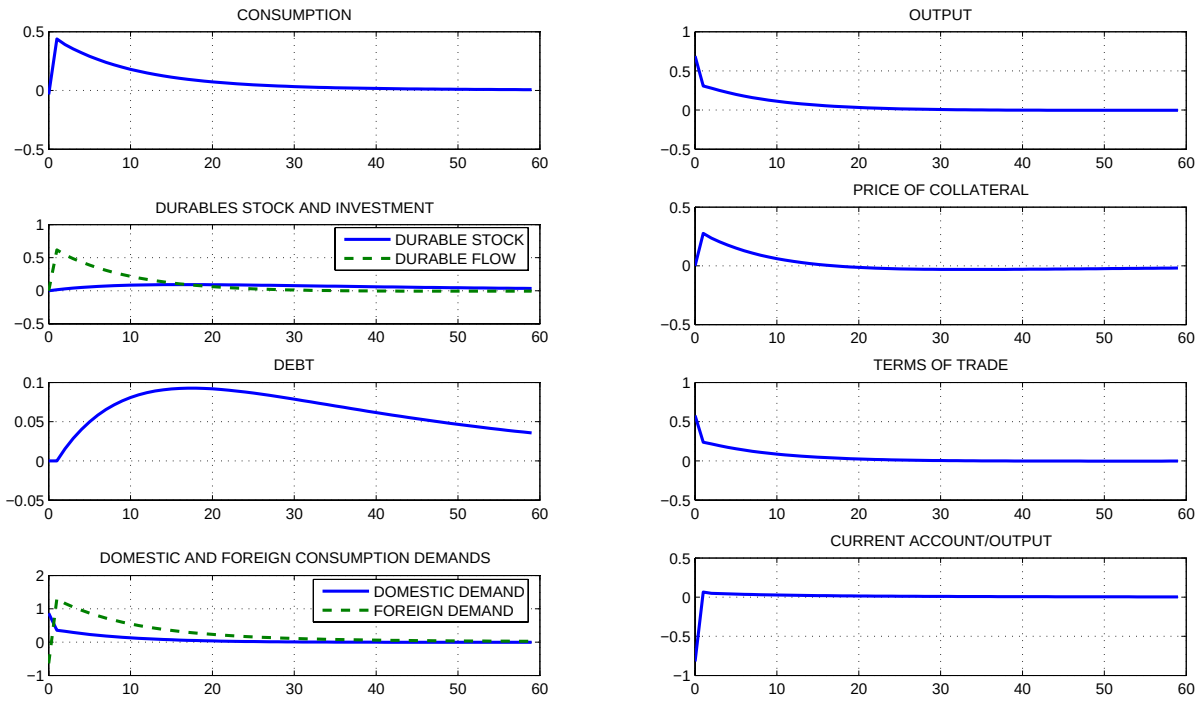

Figure 1: **Impulse response of selected variables to domestic productivity shocks.**

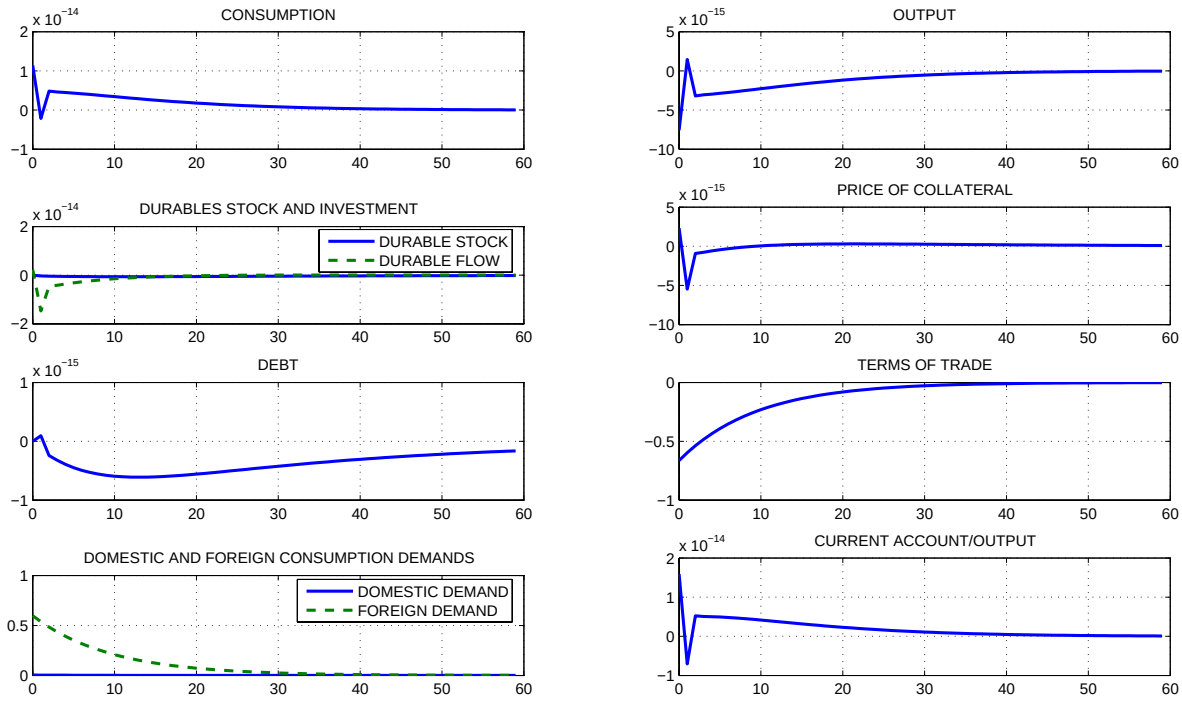

Figure 2: **Impulse response of selected variables to foreign demand shocks.**

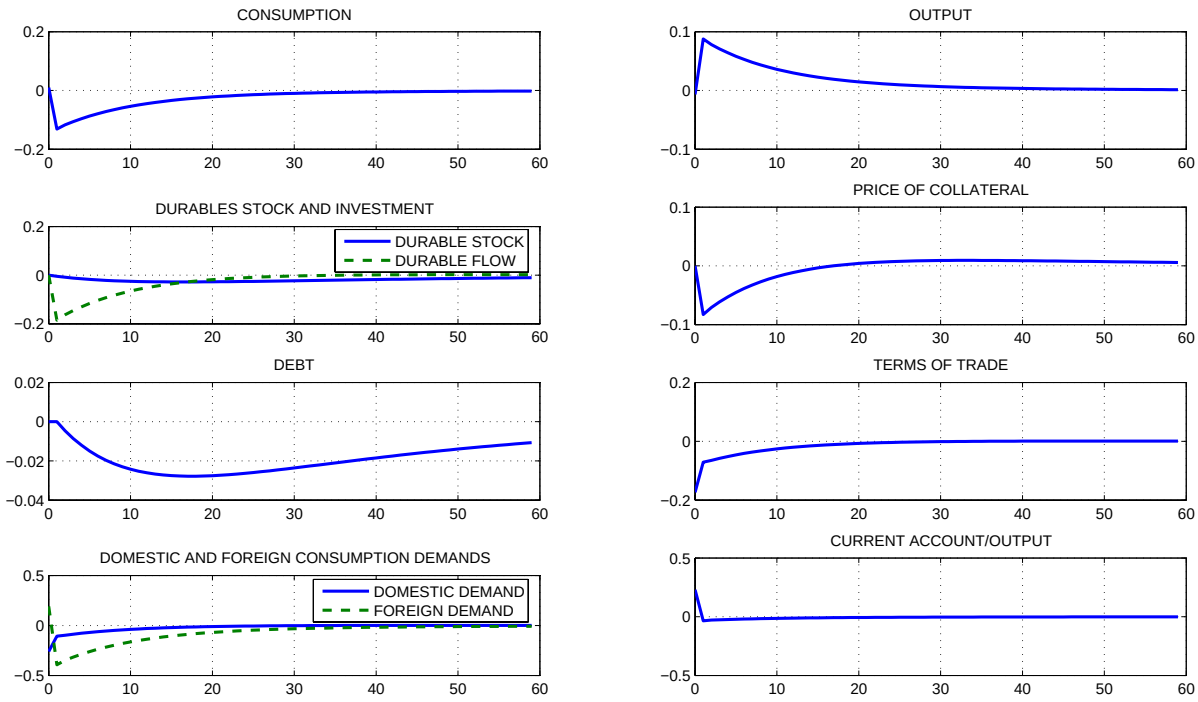

Figure 3: **Impulse response of selected variables to government expenditure shocks.**

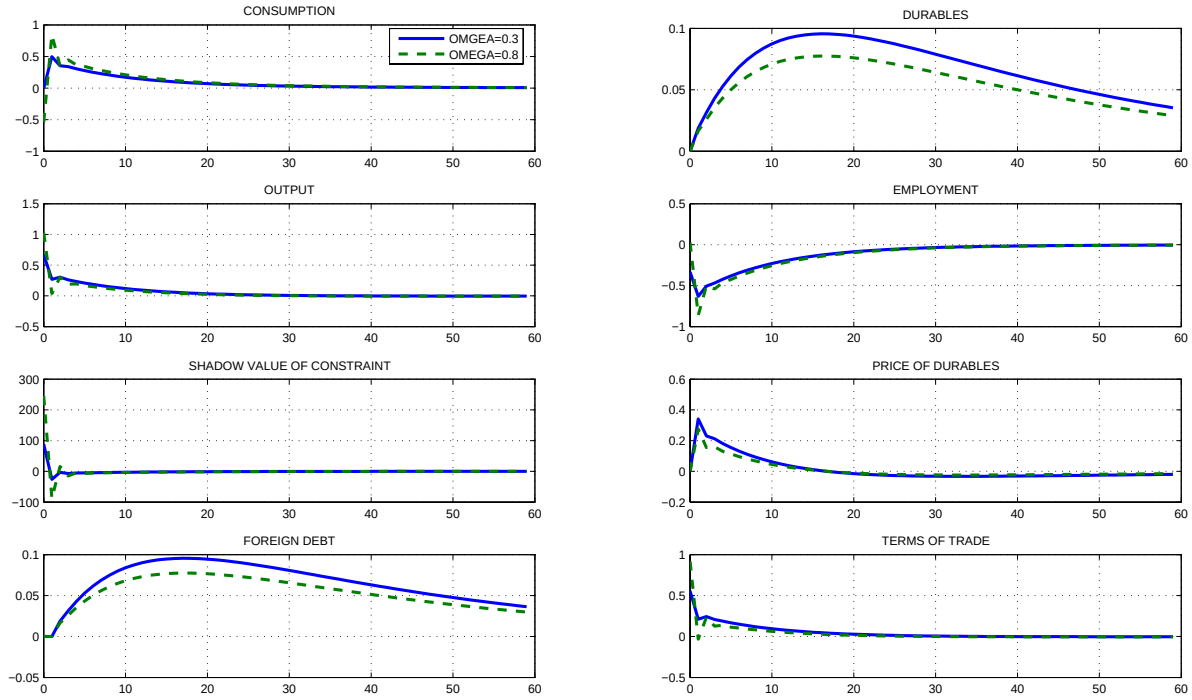

Figure 4: **Impulse responses of selected variables to productivity shocks.**

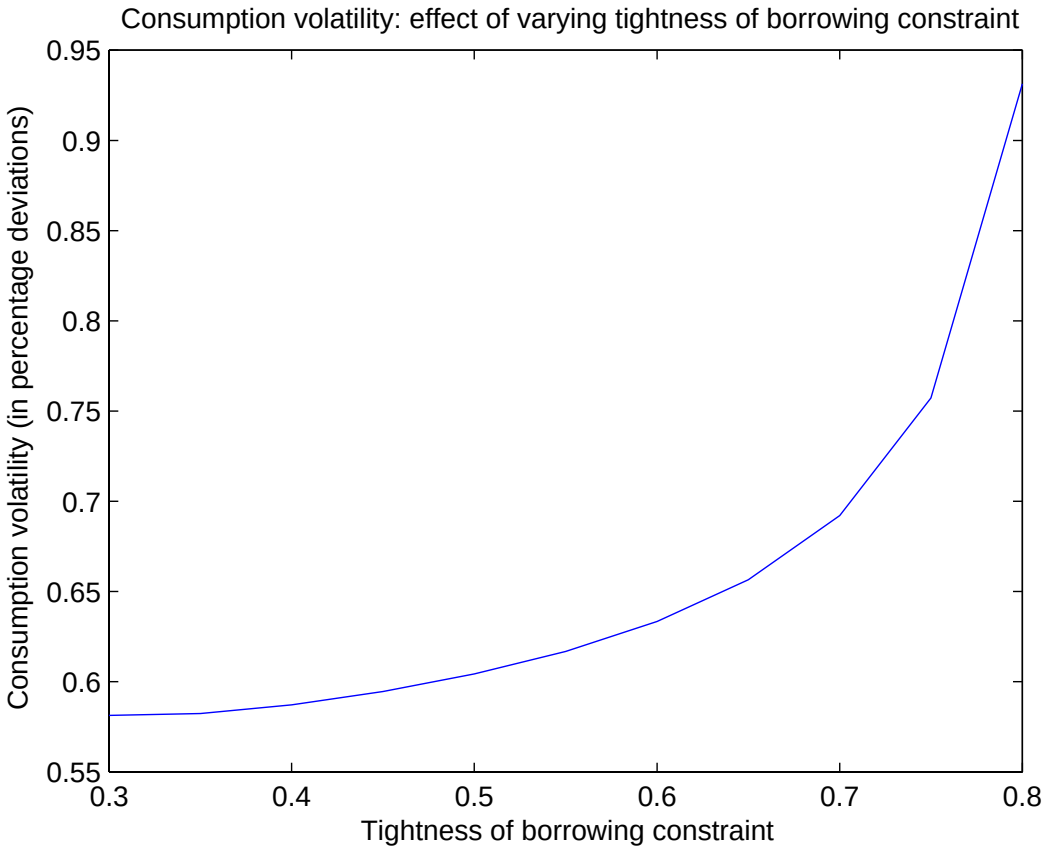
Consumption volatility: effect of varying tightness of borrowing constraint
Consumption volatility (in percentage deviations)
0.95
0.9
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.3
0.4
0.5
0.6
0.7
0.8
Tightness of borrowing constraint

Figure 5:

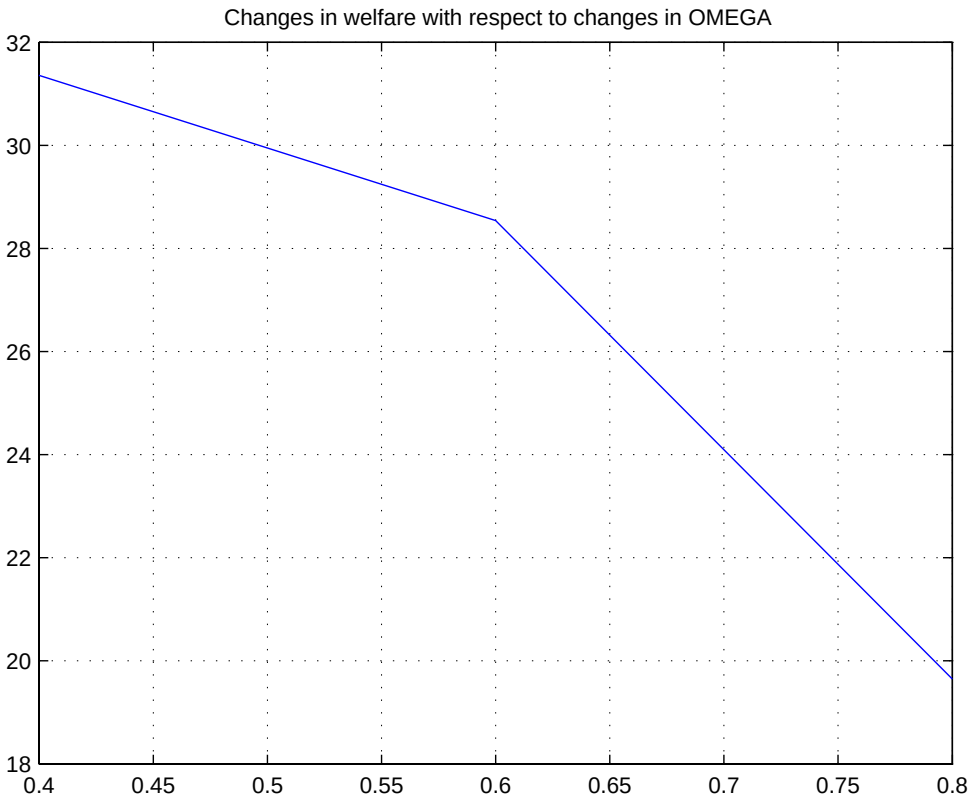
Changes in welfare with respect to changes in OMEGA
32
30
28
26
24
22
20
18
0.4
0.45
0.5
0.55
0.6
0.65
0.7
0.75
0.8

Figure 6:

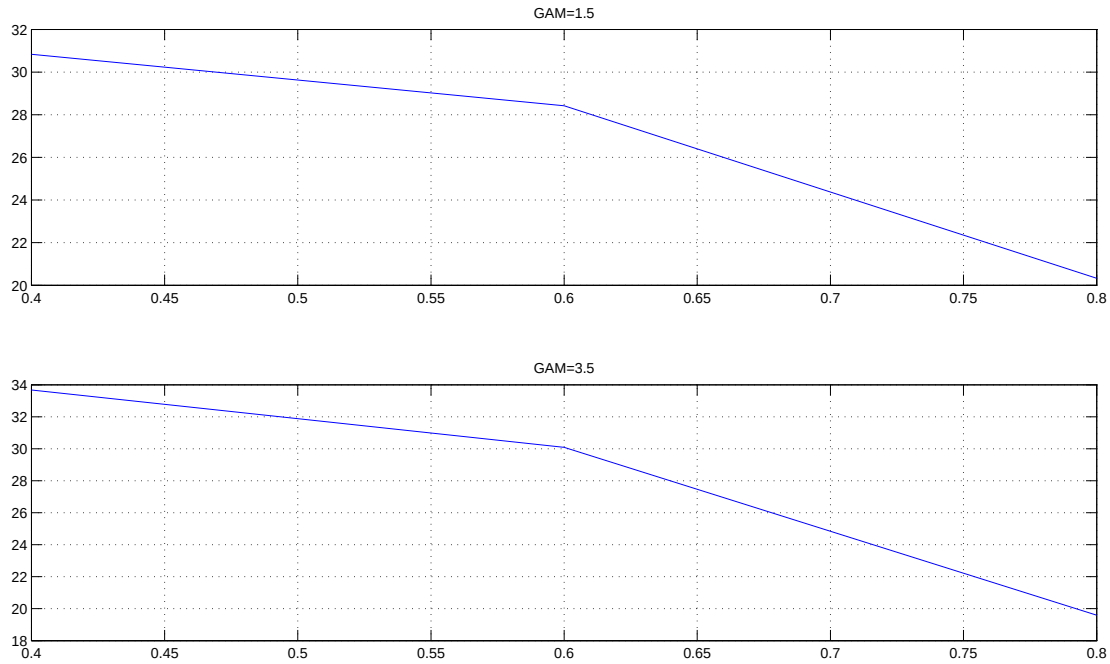

Figure 7: **Changes in welfare with respect to changes in financial openness for two different values of γ.**