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Ester Faia

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MACROECONOMIC AND WELFARE IMPLICATIONS OF FINANCIAL GLOBALIZATION

Ester Faia*
Goethe University Frankfurt, Kiel IfW and CEPREMAP

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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 and foster consumption smoothing. However the data show that for several countries financial liberalization leads to enhanced consumption volatility. This fact can be rationalized using 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 (even relative to output volatility) as agents are unable to exploit risk-sharing opportunities. In presence of risk-averse agents an increase in financial integration reduces welfare.

JEL classification codes: F3
Key words: limited enforcement, financial liberalization, consumption volatility

I. 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. Past literature has shown that increasing international

* Correspondence: Department of Money and Macroeconomics, Goethe University Frankfurt, House of Finance, Grueneburgplatz 1, 60323, Frankfurt am Main, Germany. E-mail: faia@wiwi.uni-frankfurt.de. Webpage: www.wiwi.uni-frankfurt.de/profs/faia. The first draft is from December 2006. I thank participants at ESRC conference on World Economy and Global Finance in Warwick, Paris 1/CEP conference on Internacional Economics and Finance, XV Internacional conference in Banking and Finance in Rome. I gratefully acknowledge financial support form the DSGE grant of the Spanish Ministry and Unicredit research grant. All errors are my own responsibility.

[1] See Lane and Milesi-Ferretti (2001), Kose, Prasad, Rogoff and Wei (2004) among others.

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 (1991), and Baxter and Crucini (1995), who study the business cycle implications of restricting international asset trading. This paper builds a small open economy model with collateral constraints on foreign lending to show that financial globalization, coupled with limited enforcement in financial markets, can increase consumption volatility (even relative to output volatility) and reduce welfare.

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. Accumulable durables play the role of substitution between home and foreign consumption. 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 volatile 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 nondurable goods. Durables in this model play a double role: they function as collateralizable wealth and they provide utility services (see 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 between durable and non-durable goods. Finally, it is assumed that agents face adjustment costs on durable consumption, an assumption that allows us to reproduce persistence in the pattern of various macro variables and in response to various shocks (see Topel and Rosen 1988). The borrowing limit incorporates the idea 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. A higher value of this parameter relaxes the collateral constraint on foreign lending. The collateral constraint is modelled following the lines of Kiyotaki and Moore (1997), Kocherlakota (2000), and Chari, Kehoe and McGrattan (2005) among others. In this environment net asset accumulation is determined by the borrowing limit and depends on the value of collateral: domestic impatient agents borrow from foreign patient agents. The difference in the discount factors between domestic and

foreign agents renders the constraint binding at all states and times, hence it pins down uniquely the distribution of assets across countries.

The quantitative properties of the model are studied under a variety of shocks (productivity, government expenditure, foreign demand shocks). Several results stand out. First, despite market incompleteness, the dynamic of the small open economy is stationary. The net asset accumulation is uniquely determined in the steady state and it is saddle path stationary in a neighborhood of the steady state. A crucial assumption for this result is that foreign agents have higher discount rates than domestic lenders. Domestic impatient agents borrow from foreign patient residents, so that the small open economy experiences a persistent current account deficit. Despite this, the current account deficit leads to stationary dynamics.[2] The impulse response analysis shows that the model is able to replicate some important stylized facts such as the co-movements of durable and non-durable consumption and the countercyclical behavior of the current account. Most importantly, the presence of collateral constraints on foreign lending, coupled with adjustment costs, induces persistent current account imbalances, a feature consistent with recent evidence.

Secondly, in the model an increase in financial liberalization increases consumption volatility (even relative to output volatility) in response to shocks. 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

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[2] This result echoes the ones in Schmitt-Grohe and Uribe (2004) who discuss three alternative assumptions (endogenous discount factor (Uzawa-type preferences), debt-elastic interest-rate premium, convex portfolio adjustment costs) to induce stationary dynamics in a small open economy under incomplete markets. Collateral constraints are an alternative way to induce stationarity.

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 induces 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 debt to collateral.

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

Finally the analysis considers the welfare consequences of financial liberalization and finds 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 us to account for the effects of stochastic volatility both on first and second moments of the variables that enter agents' utility.[3]

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 (non-durable) consumption volatility (even in terms of output volatility). By inspecting countries with high degree of informational asymmetries and less developed financial markets, Kose, Prasad, Rogoff and Wei (2004) find that an increase in financial openness tends to increase consumption volatility (even relative to output volatility). Those empirical studies highlight the consequences of limited international risk sharing for economies whose financial markets are characterized by strong informational asymmetries and poor financial development.

On the theoretical side, much work has been done to study the role of financial integration for business cycle fluctuations.[4] Most of the analyses have found that restricting asset trading does not alter significantly the business cycle implications of the standard international RBC model.[5] Recently some authors have focused on

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

[4] See Cole and Obstfeld (1989), Mendoza (1991), Baxter and Crucini (1995) among many others.

[5] Altough some authors have shown that the impact of financial openness on macroeconomic volatility depends upon the source of shocks, fiscal versus monetary shocks (see Obstfeld and Rogoff 1995).

the implications of portfolio allocations for business cycle volatilities and monetary policy (see Devereux and Sutherland (2009)), while others have introduced various forms of international financial market incompleteness. Levchenko (2005) uses a framework with limited commitment as in Kocherlacota (2000) and shows that domestic risk sharing arrangements might deteriorate in face of financial integration. He finds that, in such an environment, individual consumption might become more volatile, but aggregate consumption volatility will nevertheless decrease. Finally Mendoza and Smith (2006) 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 the presence of high leverage.

This paper is also related to a recent literature showing that binding collateral constraints can be successfully employed in closed economy models to replicate several business cycle stylized facts.[6] In the open economy literature borrowing limits have been used to analyse various issues such as sudden stops (see Mendoza 2006, Chari et al. 2005), over-borrowing (see Uribe 2006), global imbalances (see Mendoza et al. 2009) and welfare gains from financial integration (see Mendoza et al. 2007). Most of those studies introduce borrowing constraints in which physical capital plays the role of collateral. This paper, on the contrary, considers the role of durable goods as collateral. The reason for the latter modeling assumption is twofold. First, our analysis focuses on consumers' loans: there is significant evidence that consumers' loans require the borrower to post some collateral and that housing or durable goods represent, in most economies, the largest form of collateral (see Black et al. (1996) and Attanasio et al. (2008)). Interestingly, while the introduction of binding collateral constraints based on physical capital leads to reduced output volatility in the presence of financial globalization, this paper shows that using durable consumption as collateral helps to explain the enhanced consumption volatility induced by capital liberalization.

The rest of the paper is divided as follows. Section II presents the model and calibration. Section III presents the results in terms of quantitative and welfare properties of the model. Section IV concludes.

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[6] See Iacoviello (2005), Campbell and Hercowitz (2006).

II. 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 upon the degree of informational 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 using labor.

A. 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 $E_t\{.\} \equiv \sum_{s+1} \rho(s^{t+1}|s^t)$ as the mathematical expectations over all possible states of nature conditional on history s^t. Agents maximize the following expected discounted sum of utilities:

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

where N_t denotes total labor hours, consumption:

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

is given by a Dixit-Stiglitz consumption aggregator of domestic, $C_{H,t}$, and imported goods, $C_{F,t}$, with η being the elasticity of substitution and:

$$\tilde{D}_t=D_t-\frac{\psi}{2}\left(\frac{X_t-\delta D_t}{D_t}\right)^2, \tag{3}$$

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

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

The household receives at the beginning of time t a labor income of W_tN_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). The variable B_t denotes 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.[7] 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 foreign lenders are unable 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 it is assumed that domestic households face the following period-by-period borrowing constraint on debt:

$$RB_{t+1} \leq \Omega E_t\left\{Z_{t+1}D_{t+1}\right\}. \tag{6}$$

Constraint (6) can arise in presence of limited enforcement without default. In equilibrium debt repudiation never occurs as the lender would repossess the whole

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

collateral value. Collateral is in fact used as a promise for repayment. Section II.F shows that under the assumption of agents' heterogeneity across countries, the constraint is binding at all states and times; this allows us to pin down uniquely the net asset position of the small open economy. 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, it is assumed that higher degree of financial liberalization is associated with higher value of Ω.

Households choose the set of processes $\left\{C_t, N_t, B_{t+1}, D_{t+1}\right\}_{t=0}^{\infty}$ taking as given the set of processes $\left\{P_t, W_t, R, Z_t\right\}_{t=0}^{\infty}$ 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 multiplier on constraint (6). The following optimality conditions must hold:

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

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

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

$$Z_t = \frac{\Delta_{\tilde{D}_{t+1}}}{U_{c,t}}\psi\left(\frac{D_{t+1}-D_t}{D_t}\right). \tag{10}$$

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 $R_t^c = \frac{U_{c,t}}{E_t\left\{U_{c,t+1}\right\}}$ as the households' intratemporal price

of consumption, when (6) binds, households face the following endogenous finance premium:

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

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 nondurable consumption (weighted by the price of the durable) is equated to its marginal gain, which has three components.

The first component is the direct marginal utility of one additional unit of durable investment now and in the future:

$$E_t\left\{\beta\Delta_{\tilde{D}_{t+1}}\left(1+\psi\left(\frac{D_{t+2}-D_{t+1}}{D_{t+1}}\right)+\frac{\psi}{2}\frac{\left(D_{t+2}-D_{t+1}\right)^2}{D_{t+1}^2}\right)\right\}. \tag{12}$$

The second component 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, $Z_{t+1}\Omega\lambda_t$ since 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 which 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 enters the durable tax component, namely $Z_{t+1}\Omega\lambda_t$, a decrease in λ_t will induce agents to *substitute* non-durable with durable consumption goods. The quantitative simulations shown in the next section show that the second effect tends to prevail on the first, so that, in response to shocks, a higher value of leads to 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*, since it shows that an increase in durable demand increases its price, thereby increasing its value.

B. 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:

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

C. Foreign households and open economy relations

The rest of the world can be thought as approximating a continuum of countries whose trade balance is zero. This implies that $P^*_{F,t} = P^*_t$ Variables with a star index denote variables for the rest of the world. Agents in the rest of the world behave as

standard consumption smoother. Let's define μ as the discount factor of foreign residents. As those agents are patient, in equilibrium the borrowing constraint is never binding. We will return on this point later. This implies that the following consumption Euler condition holds:

$$U_{c^*,t} = \beta E_t \left\{ \frac{R}{\pi^*_{t+1}} U_{c^*,t+1} \right\}. \tag{16}$$

Interest rates in the rest of the world are exogenously given. For simplicity it is also assumed that foreign agents have linear utility. This implies that the foreign interest rate is constant and equal to:

$$R = \frac{1}{\mu}.$$

Preferences for domestically produced goods and imported goods can be described as follows:

$$C^*_t \equiv \left[(1-\gamma)^{\frac{1}{\eta}} C^*_{F,t}{}^{\frac{\eta-1}{\eta}} + (\gamma)^{\frac{1}{\eta}} C^*_{H,t}{}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}. \tag{17}$$

Since the law of one pice holds continuously, it follows 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. Given the above aggregator optimal demand of home produced goods reads as follows:

$$C^*_{H,t} = \left(\frac{P^*_{H,t}}{P^*_t} \right)^{-\eta} C^*_t. \tag{18}$$

Applying the law of one price and substituting the definition of terms of trade, $s_t = \frac{P_{F,t}}{P_{H,t}}$:

$$C^*_{H,t} = (s_t)^{\eta} C^*_t, \tag{19}$$

and where $C^*_t = Y^*_t$. Foreign output is taken as given by domestic residents and follows an autoregressive process:

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

D. Equilibrium conditions

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

$$RB_{t+1} + \Omega E_t \left\{ Z_{t+1} D_{t+1} \right\} = 0. \tag{20}$$

By substituting the real wage in the budget constraint of the domestic household and using firms' optimality conditions, it is possible to obtain an equation that links net debt accumulation to net exports:

$$RB_t - B_{t+1} = Y_t - \left(C_t + Z_t X_t \right) \equiv NX_t. \tag{21}$$

Equation (21) describes the current account dynamic, which in this economy is governed by borrowing limit on 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:

$$Y_t = C_{H,t} + C^*_{H,t} + X_t + G_t. \tag{22}$$

E. Stationarity of the equilibrium

In a seminal work, Obstfeld and Rogoff (1995) have shown that under market incompleteness the steady state of an open economy model is characterized by unit roots. This implies that the steady state depends upon initial values and transient shocks have long run effects. In subsequent works several methods have been proposed to recover stationarity: parameter and functional form restrictions (see Cole and Obstfeld 1989, Corsetti and Pesenti 2001), endogenous discount factor (Uzawa-type preferences), debt-elastic interest-rate premium, convex portfolio adjustment costs (see Schmitt-Grohe and Uribe 2003). The present model is also characterized by a stationary dynamic due to the presence of a binding collateral constraint.[8] Let's recall the following three assumptions:

Assumption 1 (preferences) Preferences are *well-behaved*: the Hessian is semi-definite negative and Inada conditions for consumption hold.

[8] I thank Eleni Iliopulos for pointing to me this feature of the model.

Assumption 2 (discounting) $\beta, \mu \in (0,1)$; $\beta < \mu$.
Assumption 3 (technology): F is homogeneous of degree 1 with $F \in C^2$, $F_N > 0$, $F_{NN} \leq 0$. Moreover $F(0) = 0$, $\lim_{N \to 0} F'(N) = +\infty$, $\lim_{N \to \infty} F'(N) = 0$.

Proposition 1. Under assumptions 1-3, and in a close neighborhood of the steady state, the collateral constraint, $RB_{t+1} \leq \Omega E_t \left\{ Z_{t+1} D_{t+1} \right\}$, *is binding at any date and any state and determines uniquely the net asset position.*

Following Becker (1980) and Becker and Foias (1987), (1994) it is possible to show that, under assumptions 1 to 3, constraint $RB_{t+1} \leq \Omega E_t \left\{ Z_{t+1} D_{t+1} \right\}$ holds at any state and at all times. Becker (1980) and Becker and Foias (1987), (1994) argue that this amounts to demonstrating the existence and uniqueness of a *dominant consumer*, namely the patient households. Consider the Euler condition of domestic agents:

$$1 - E_t \left\{ \beta \frac{U_{c,t+1}}{U_{c,t}} R \right\} = \lambda_t R. \tag{23}$$

By evaluating eq. (23) at the steady state and substituting the steady-state relation $R = \frac{1}{\mu}$, we obtain:

$$\mu - \beta = \lambda > 0 \ . \tag{24}$$

As the Lagrange multiplier is positive, the constraint is binding at the steady state. Hence the net asset position of the small open economy is uniquely determined by the borrowing constraint.

Corollary. The net asset position does not possess unit roots.

As the Euler condition in the steady state, (24), does not depend on initial conditions but solely on model parameters, the net asset position does not posses unit roots. Hence collateral constraints can be seen as a stationarity inducing device, hence, using the terminology in Schmitt-Grohe and Uribe (2003), they allow to "close" the small open economy.

For this reason it is worth discussing a comparison with the methods proposed in Schmitt-Grohe and Uribe (2003) to "close" the small open economy. First, while the methods proposed in Schmitt-Grohe and Uribe (2003) require to impose a certain

long run level of external assets, collateral constraints require the exogenous determination of the parameter Ω. Like the methods proposed in Schmitt-Grohe and Uribe (2003), collateral constraints allow us, on the one side, to deliver stationarity of the net asset position, on the other side to induce persistent movements in the current account. For this reason they can be usefully employed to explain persistent global imbalances. Finally, the present model features a country premium given by:

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

Such premium resembles the one featured in the model with debt elastic interest rate presented in Schmitt-Grohe and Uribe (2003).

As explained later on the assumptions that domestic residents have a higher discount factor than foreign households, hence that the borrowing constraints binds at all times and all states, allows us to amplify fluctuations in consumption and to capture the above mentioned evidence that consumption volatility increases in response to an increase in financial liberalization.

F. Calibration

Preferences. Time is measured in quarters. Following Krusell and Smith (1998) and in accordance with $\beta < R^{-1}$, β is set to 0.96. Under this parametrization the shadow value of borrowing is always positive. Utility is modeled as follows:

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

The parameter σ is set equal to 2 as in most of the RBC literature. The parameter τ is set equal to 3 since this delivers a steady state value of working time of 1/3. 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 a wide range of preference parameters.

Technology. The adjustment cost parameter is set to $\psi = 600$. This value allows to obtain a volatility for durable goods higher than the one for non-durable as suggested by the 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. The

baseline parameter capturing the tightness of the borrowing limit is set so as to induce a steady state debt to equity (leverage) ratio of 0.4. Following Backus, Kehoe and Kydland (1992) 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 McCallum and Nelson (2000) the standard deviation of the productivity shock is set to 0.0056 and its persistence is set to 0.95. The statistical properties of the foreign demand shock are determined as follows. World output is measured as U.S. real GDP. Using OECD quarterly data for the period 1970-2001, the innovations in output are found by fitting an autoregressive process with time trend. Estimation leads to the following value for the volatility of innovations, $\sigma_{\varepsilon_t^{y^*}} = 0.00885$. The share of government expenditure over GDP in the steady state is set equal to 0.2. Log-government consumption evolves 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 $\rho_g = 0.9$. Notice that an alternative parametrization of the shocks would not alter the main qualitative results.

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

$$E_t\left\{\mathcal{H}(\Psi_{t+1}, \Psi_t, X_{t+1}, X_t)\right\} = 0, \tag{25}$$

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):

$$\Psi_t = g(X_t, \bar{\xi}), \tag{26}$$

$$X_{t+1} = h(X_t, \bar{\xi}) + \bar{\eta}\bar{\xi}\varepsilon_{t+1}. \tag{27}$$

Equation (26) and (27) describe the policy function and the transition function respectively. Simulations are computed by taking a second order expansion of the functions $g(X_t, \bar{\xi})$ and $h(X_t, \bar{\xi})$ around the deterministic steady-state.

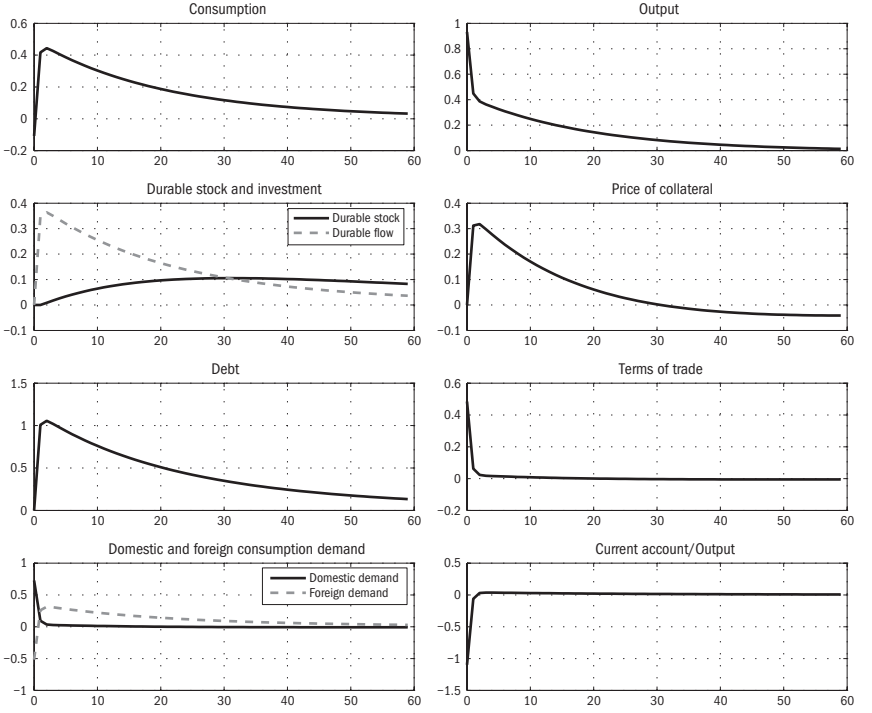
III. Quantitative properties of the model

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

A. 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. Responses of both variables are hump-shaped. The hump-shaped dynamic is due

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



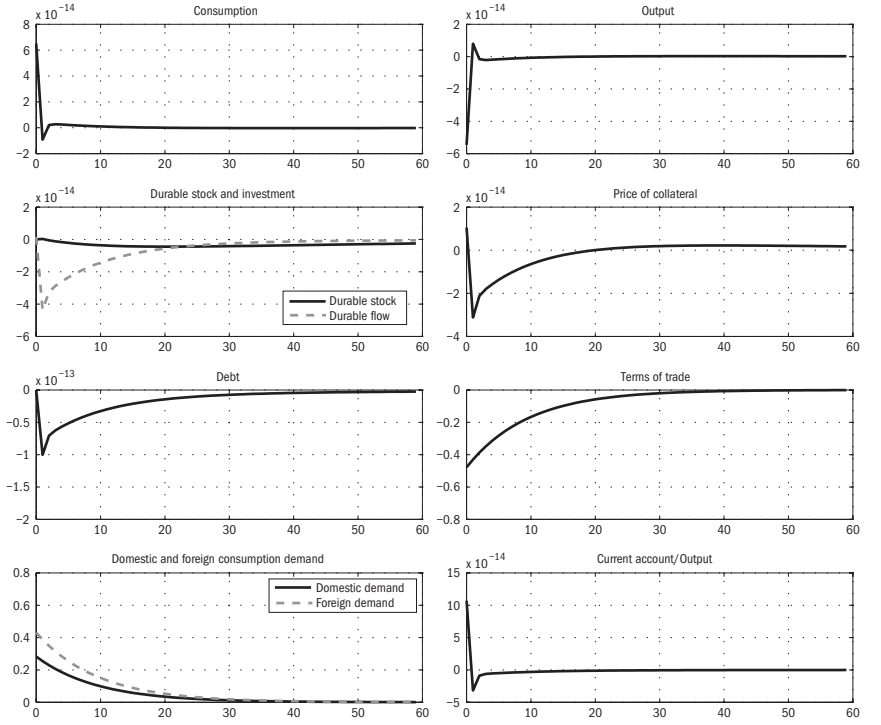
to the persistence introduced by the cost of adjusting durable investment. The increase in the demand for durable goods induces an increase in their price, which, in turn, raises the future value of collateral. Finally, the increase in the value of collateral relaxes the borrowing limit, therefore increases 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. Importantly the presence of borrowing constraints, coupled with adjustment costs, induces persistent current account imbalances, a feature consistent with recent evidence.

Another interesting feature of the model stems from the fact 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, induces a countercyclical current account dynamic.[9]

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 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 increases domestic wealth, which in turn increases

[9] The more recent literatura has shown that several other assumptions can deliver countercyclical current account dynamic. See for instance Mendoza (1991), Uribe and Yue (2006).

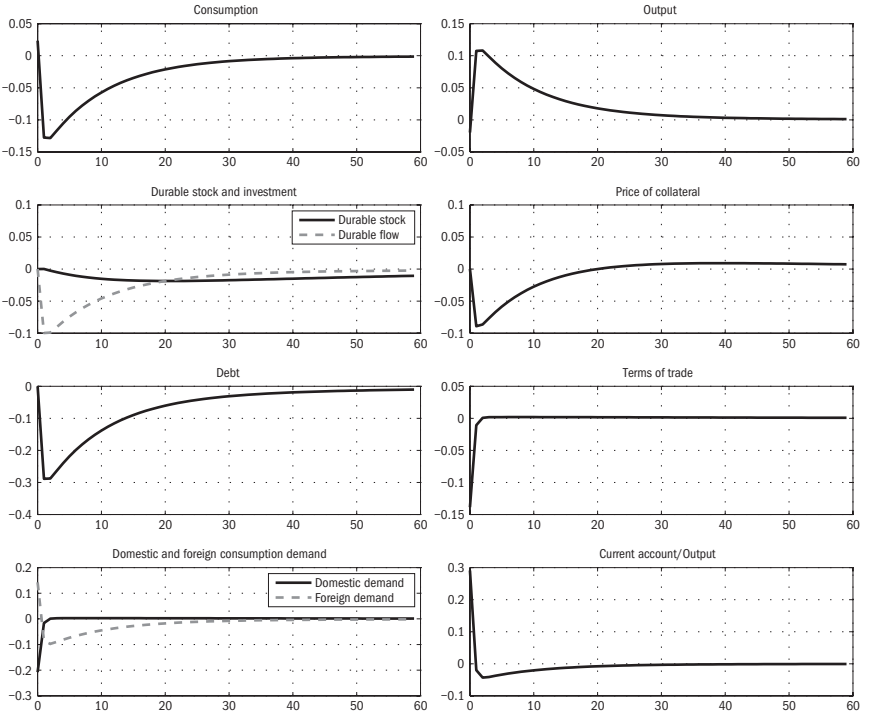
Figure 2. Impulse response of selected variables to foreign demand shocks



domestic consumption. However, the ensuing terms of trade appreciation induce agents to shift demand from domestically produced goods and foreign produced goods, therefore abating the initial increase in domestic consumption. The fall in exports induces a decrease in output. Once again the ratio between the current account and output behaves countercyclically. The fall in the value of durables induces a fall in credit availability from the rest of the world.

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 this is that the fall in the demand for durable has

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



reduced the availability of collateral and, consequently, the pro-borrowing effect. Finally, once again we observe persistent current account imbalances.

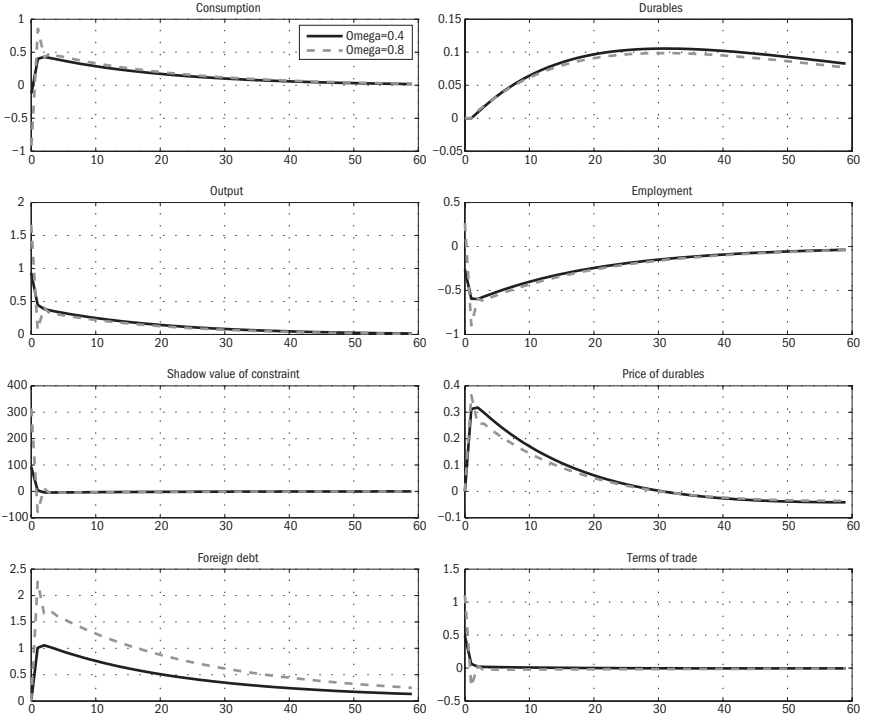
It is worth noting that our impulse responses show that durable and non-durable consumptions tend to co-move. This result is consistent with an important empirical regularity highlighted in Barsky, House and Kimball (2005). Both papers show that durable and non-durable consumptions tend to co-move in response to various shocks, but that this regularity is at odd with either standard business cycle or sticky price models. For this reason they propose some mechanisms to overcome the puzzle. In the present paper, since 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.

B. 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

Figure 4. Impulse responses of selected variables to productivity shocks



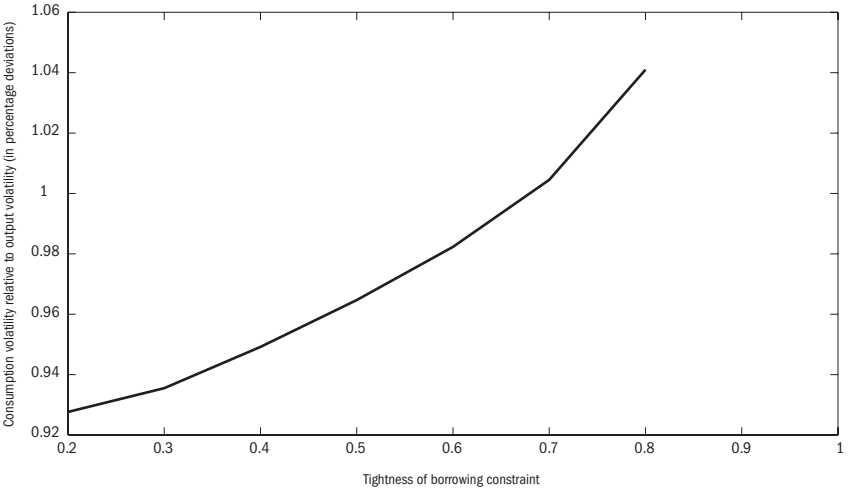
fluctuations on the demand side also tends to increase fluctuations in output and employment.

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), when 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*, which reduces the demand for collateralizable durable goods. In other words, an increase in Ω increases the tax on durable good, $Z_{t+1}\Omega\lambda_t$, since 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 enters 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. Quantitatively the first effect seems to prevail. Indeed, 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 (relative to the volatility of output) 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. Results show that consumption volatility is monotonically increasing with respect to the degree of financial openness. This is once again the result of three abovementioned effects. This result is consistent with Prasad, Rogoff, Wei and Kose (2004).

Figure 5. Changes in the volatility of consumption (relative to the volatility of output) with respect to changes in the tightness of foreign lending described by the parameter Ω



Robustness checks are performed to test whether the relation found remains valid under different parametrization of trade openness.[10] As trade openness increases the country might import consumption volatility as it relies more on foreign production. No significant effect of trade openness is found, a result consistent with empirical evidence (see Easterly, Islam and Stiglitz (2001)). Additionally the relation has been tested under the alternative assumptions: 1. different timing of the collateral constraint as follows: $RB_{t+1} \leq \Omega E_t \left\{ Z_{t+1} D_t \right\}$; 2. Greenwood, Hercovitz and Hoffman (1988) preferences with respect to non-durable consumption and labour. The relation between consumption volatility (relative to output volatility) and the parameter Ω remains increasing in all cases. Results are reported in a separate appendix available at the *Journal of Applied Economics*.

C. 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

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

for the effects of the increased volatility on welfare the model is solved using second order approximations which allow to account for the effects of stochastic volatility both, on first and second moments.[11] 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.

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

$$W_0 = \left\{ E_0 \sum_{t=0}^{\infty} \beta^t U\left(C_t, N_t, \tilde{D}_t\right) \right\}. \tag{28}$$

Figure 6 shows changes in welfare with respect to changes in the parameter Ω ranging from 0.4 to 0.8 and for two different values of the elasticity of durable demand, the parameter γ (1.5 in the top panel graph and 3.5 in the bottom panel graph). In both panels 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 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 occurs despite the fact that the volatility of durable goods is decreasing with respect to the same parameter.

It is worth noting that the negative link between welfare and financial openness remains unchanged for different values of the elasticity for durables demand. This parameter 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.

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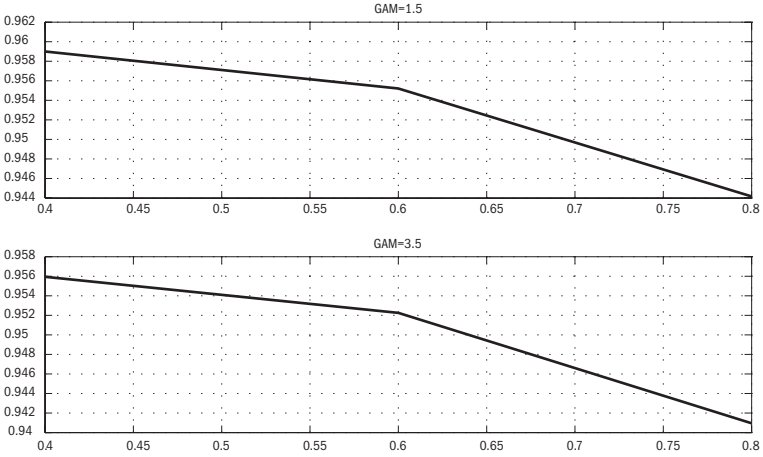
[11] See Kim and Kim (2003) for an analysis of the inaccuracy of welfare calculations based on log-linear approximations in dynamic open economies. See Kim and Levin (2004) and Schmitt- Grohe and Uribe (2004) for a more general discussion.

Figure 6. Changes in welfare with respect to changes in financial openness for two different values of γ



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 increase welfare.

IV. Conclusions

This paper builds a small open economy with a collateral constraint on foreign lending. 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 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 rationalizes evidence, reported in various studies, which states that capital account liberalization raises consumption volatility, even relative to output volatility. Other interesting results emerge: the presence of a collateral constraint induces persistent current account imbalances in response to shocks, a feature consistent with recent empirical evidence for countries experiencing a high degree of financial globalization. Importantly current account imbalances in this model are compatible with a long run stationary distribution of assets.

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