DOCUMENTS DE TREBALL
DE LA FACULTAT D'ECONOMIA I EMPRESA

Col.lecció d'Economia

E13/291

Financial Integration, Trade Openness and International Transmission

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Acknowledgement I thank Giancarlo Corsetti, Georg Dürnecker, Alain Gabler, Alessandro Maravalle and Katrin Rabitsch for useful comments on this paper. The financial support from the Spanish Ministry of Science and Innovation through grant ECO2009-09847 and the Spanish Ministry of Education and Science through grant ECO2012-34046 is gratefully acknowledged.

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Resum
Com afecten l'obertura comercial i financera a la volatilitat macroeconòmica? La literatura existent, tant empírica com teòrica, no ha assolit encara un consens. Aquest article usa un model microfonamentat de dos països simètrics amb entrada endògena d'empreses per estudiar-ho.
L'anàlisis es du a terme per tres règims econòmics diferents amb diferents nivells d'integració internacional: una economia tancada, una autarquia financera i una integració plena. Es consideren diversos nivells d'obertura comercial, en forma de biaix domèstic de la demanda i l'economia pot patir pertorbacions en la productivitat del treball i en innovació. El model conclou que la incertesa macroeconòmica, representada principalment per la volatilitat del consum, la producció i la relació real d'intercanvi internacional, depèn del grau d'obertura i del tipus de pertorbació.

Abstract
How does trade and financial integration affect macroeconomic volatility? Neither empirical nor theoretical studies have reached a consensus on it. This paper uses a microfounded two-symmetric-country model with endogenous entry of firms to address the issue.
The analysis is conducted for three different regimes with different levels of international integration: a closed economy, a financial autarky and full integration. Different levels of trade openness are considered in the form of home biases and the economy may suffer from labor productivity and innovation shocks. The model concludes that macroeconomic uncertainty, in the form of consumption, output and terms of trade volatilities, depends on the degree of openness and on the source of the shock.

JEL classification codes: F31, F41, E32

Paraules clau: transmissió internacional de pertorbacions, volatilitat, integració, globalització.

Keywords: International transmission, volatility, integration, globalization.

1 Introduction

International financial integration is believed to have two major potential benefits: it enhances an efficient allocation of capital and helps countries sharing risk by reducing consumption and income volatility. So far, however, neither empirical nor theoretical studies have clearly demonstrated to what extent these claims are true. This paper uses a New Open Economy Macroeconomic (NOEM) model to shed some light on the theoretical side of this literature.

I use a two-symmetric-country model with endogenous entry of firms to address the issue. I develop a qualitative analysis, based on computational simulations of three scenarios: closed economy, financial autarky and fully integrated economy, which are subject to innovation and labor productivity shocks. I study the cross-country transmission of shocks and compare how macroeconomic volatilities evolve when countries move between scenarios and for different degrees of trade openness. The results can explain some of the ambiguity found in the empirical literature. In particular, I find that idiosyncratic labor productivity and innovation shocks can explain the nonlinear behavior of the volatility of the consumption-to-output ratio (henceforth, the ratio) and both the degree of trade openness and financial integration. Moreover, a closed economy opening to trade reduces all volatilities except that of the ratio. Finally, a country opening its capital market may suffer from increases or decreases of macroeconomic volatilities, relative to a financial autarky, depending on the source of the shock (in line with Buck et al., 2005) and on the level of trade openness, which indicates that both mechanisms of integration interact (in line with IMF, 2002).

The analysis is carried out in a set-up with market dynamics since the number of operating firms and supplied varieties changes endogenously. The introduction of this 'extensive margin' allows distinguishing between different types of productivity disturbances. One can shock either the productivity of manufacturing or that of the technology of creation of new varieties. Indeed, the presence of endogenous entry can alter the dynamic response to shocks, leading to greater persistence in the effects of monetary and real shocks (see Bergin and Corsetti, 2008). Indeed, entry may have notable welfare effects, to the degree that households derive utility from greater variety (i.e., there is love of variety in consumption and investment) and because the entry of new firms raises competition in a market, which lowers prices. Thus, it is relevant to take into account the behavior of the economy after these different impacts (see Corsetti et al., 2007 for a discussion on its importance).

The rest of the paper is organized as follows: Section 2 provides a brief literature review. Section 3 presents the model set-up of an economically integrated world and indicates the differences with financial autarky and the closed economy. Section 4 presents the quantitative exercise and its results: first the domestic and cross-border transmission of shocks and, second, the interaction between international integration and macroeconomic uncertainty are analyzed. Section 5 concludes.

2 Literature Review

2.1 Financial Integration and Volatility

Understanding the links between globalization and the dynamics of macroeconomic volatility has recently come to the forefront. This is mainly due to a burgeoning literature

that describes the first-order effects that volatility has on welfare (see, for instance, Loayza et al., 2007). However, literature disagrees on the strength and direction of such relationships. On the one hand, increased financial integration allows households to cushion against adverse domestic shocks by lending and borrowing abroad. This would cause a decline in the volatility of consumption (Bekaert et al., 2006). However, financial integration also increases the potential for the magnification of financial disturbances. Hence, output and investment volatilities may increase (Mendoza, 1994).

Indeed, Mendoza (1994) develops a stochastic dynamic business cycle model and concludes that quantitative variations in the volatility of output and consumption are quite small in response to the changes in the degree of financial integration. Moreover, it seems that larger and more persistent shocks enhance output volatility for higher levels of financial integration. On the contrary, Baxter and Crucini (1995) show that consumption volatility decreases, although output volatility increases as the level of financial integration goes up. They argue that these differences lie in the wealth effects and their interaction with different capital market regimes. Differently, Bekaert et al. (2006) find that financial liberalization tends to be associated with lower consumption volatility.

Kose et al. (2003) address these questions at the empirical level and find that financial openness, as measured by gross capital flows over GDP, is associated with an increase in the ratio of consumption volatility to income volatility, opposite to the theoretical risk-sharing benefits of capital globalization. However, this relationship is found to be non-linear.[2] Above certain threshold the ratio starts to decrease again. The model I present produces and is able to explain this nonlinearity. Finally, Buck and Yener (2010) show that, in spite of the fact that G7 countries have become more open for financial capital in legal terms over the past decades and that capital flows have increased rapidly, there has been no consistent pattern for consumption volatility to increase or decrease. Indeed, they found that the change over time of the ratio of volatilities often depends on the country and the period of time.

2.2 Trade Integration and Volatility

The debate is equally open for the link between openness of the goods market and volatility. At a theoretical level, real exchange rate (RER) uncertainty may discourage international trade but, simultaneously, inter-country trade favors international transmission of shocks via RER and terms of trade (TOT), affecting their volatilities. Herwartz and Weber (2007) argue that the link is quite heterogeneous among countries and possibly non-linear.

Part of the literature retains that the effects are tight to the kind of shock -sector specific or common, i.e. affecting all sectors- and to the patterns of trade specialization (Krugman, 1993). If the increment of trade is mainly due to the increase of intraindustry trade because of the higher country-specialization in specific parts of the production process chain, the volatility of output could decline (Razin and Rose, 1992). This evidence can be interpreted as proof of the relation between volatilities and both financial and trade integration, i.e. globalization. Some theoretical research suggests that

[2]Evans and Hnatkovska (2007) explored an economy under three different levels of financial integration and also found a non-linearity in this relation.

output volatility has a positive interaction with trade openness in developing countries while it maintains a negative link in developed economies. Prasad et al. (2003) document that recent data on consumption volatility shows a decline in developed economies. Furthermore, the level of consumption volatility in developing countries is above that of developed ones. This evidence may prove the interaction between financial and trade integration expounded in IMF (2002).

Easterly et al. (2001) carry out an exploration of the sources of macroeconomic volatility using data for a sample of 74 countries over the period 1960-97 and conclude that an increase in the degree of trade openness leads to an increase in the volatility of output and consumption. Kose et al. (2003) also suggest the existence of a positive effect on volatilities due to the higher vulnerability to external shocks.

3 Model Set-up

The world consists of two symmetric countries, denoted by H (home) and F (foreign) and and endogenous number of tradable varieties. There is no capital accumulation but a cost to enter the market. Firms and households are homogeneous within countries and monopolistic firms set prices flexibly in order to maximize profits. Prices are relative and expressed in terms of the basket of consumption goods, which price is normalized to 1.

The set-up specifies the equations for the Home country, that exchange goods and assets with Foreign, i.e., a financially integrated country and, when necessary, indicates the differences with a country that exchanges only goods (financial autarky) and the closed economy (a complete autarky).

3.1 Households

The Home country is populated by a unit mass of homogeneous households. Their utility function is

$$U = \sum_{t=0}^{\infty} \beta^t \left(\ln C_t + \kappa \ln \left(N - \ell_t(j) \right) \right) \quad (1)$$

where 0<β<1 is the discount factor; C_t is the basket of consumption; $\ell_t(j)$, the labor supply; N, the total endowment of time a household can allocate between leisure and work. The basket of consumption is

$$C_t = C_{H,t}^{\gamma} C_{F,t}^{1-\gamma}, \quad (2)$$

where 0<γ<1 when the economy is open and in the closed economy. And

$$C_{H,t} = \left(\int_{h=0}^{n_t} c_t(h)^{\frac{\sigma-1}{\sigma}} dh \right)^{\frac{\sigma}{\sigma-1}}; C_{F,t} = \left(\int_{f=0}^{n_t^*} c_t(f)^{\frac{\sigma-1}{\sigma}} df \right)^{\frac{\sigma}{\sigma-1}}. \quad (3)$$

n(n^*) is the number of varieties *h(f)* produced in the home(foreign) country. For simplicity, I assume identical elasticity of substitution, σ>1. In the financially integrated scenario, households finance the creation of firms in both countries. To construct her investment portfolio, the household purchases a fraction $\lambda_{F,t+1}$($\lambda_{H,t+1}$) of the shares issued by foreign(home) firms which will operate next period. She affords her consumption expenditure and investment with the income received from her labor and from dividends of currently active firms. The dividends are proportional to her portfolio allocation: $\lambda_{H,t}$, $\lambda_{F,t}$. The budget constraint is

$$B_{t+1} + \lambda_{H,t+1} \int^{n_{t+1}} q_t(h)dh + e_t \lambda_{F,t+1} \int^{n^*_{t+1}} q^*_t(f)df +$$
$$+ \int^{n_t} p_t(h)c_t(h)dh + \int^{n^*_t} p_t(f)c_t(f)df = \qquad (4)$$
$$= \lambda_{H,t} \int^{n_t} \pi_t(h)dh + e_t \lambda_{F,t} \int^{n^*_t} \pi^*_t(f)df + w_t \ell_t(j) + (1 + i_t)B_t.$$

An initial investment is needed for a new firm to start producing at home(abroad), $q_t(h)$ ($q_t^*(f)$). ( ) are the profits of a single home (foreign) firm in home (foreign) currency; e_t is the nominal exchange rate and the law of one price holds, $p_t(h)=e_t p_t^*(h)$; $c_t(h)$ is the domestic demand for good h; w_t, the wage; lastly, B_t, the international riskless bond.

In the case of financial autarky and closed economy, $\lambda_H=1$ *and* $\lambda_F=0=B$.

3.2 Firms

A continuum of n(n*) firms in the home (foreign) country sell their products in both domestic and foreign markets. To produce a home variety at time *t+1*, entrepreneurs must incur a startup cost of $q_t(h)=P_{K,t}K_t$ at time t. This cost is financed by issuing equities in the international stock market. Firms are fully depreciated after one period of production. K_t, the size of which is randomly determined every period, is a composite good containing both home and foreign varieties:

$$K_t = K_{H,t}^{\delta} K_{F,t}^{(1-\delta)}, \qquad \textbf{(5)}$$

where $K_{H,t}$ and $K_{F,t}$ are the baskets of home and foreign final goods used for capital. The lower the $K_t(K_t^*)$ the more efficient is home (foreign) country in the creation of new firms or varieties.

$P_{k,t}$ is the price index for the basket K_t. Finally, δ are the preferences for capital varieties. And,

$$K_{H,t} = \left(\int_{h=0}^{n_t} k_t(h)^{1-\frac{1}{\sigma}} dh \right)^{\frac{\sigma}{\sigma-1}} ; K_{F,t} = \left(\int_{f=0}^{n^*_t} k_t(f)^{1-\frac{1}{\sigma}} df \right)^{\frac{\sigma}{\sigma-1}}. \qquad \textbf{(6)}$$

where $k_t(h)$ is the demand of the final good h by new entrants to build their plants. Hence, total investment at home is

$$I_{H,t} = n_{t+1} q_t(h) = n_{t+1} P_{K,t} K_t. \qquad \textbf{(7)}$$

Notice that δ and γ are measures of the degree of trade openness. δ=1 for the closed economy.

Once created, every firm produces a differentiated variety with homogeneous technology which requires only labor,

$$Y_t(h) = A_{H,t} \ell_t(h)^{\theta}. \qquad \textbf{(8)}$$

θ<1 indicates decreasing returns to scale. $Y_t(h)$ is the production of one firm; $p_t(h)$, the price of variety h and $\ell_t(h)$, labor demand for good h.

3.3 Equilibrium

3.3.1 Household's problem

Households maximize utility subject to the budget constraint. The first-order conditions are

$$\frac{w_t}{P_t C_t} = \frac{\kappa}{N_t - \ell_t(j)}, \tag{9}$$

$$C_{H,t} = \gamma \frac{P_t C_t}{P_{H,t}};\ C_{F,t} = (1-\gamma)\frac{P_t C_t}{P_{F,t}}; \tag{10}$$

$$c_t(h) = C_{H,t}\left(\frac{p_t(h)}{P_{H,t}}\right)^{-\sigma};\ c_t(f) = C_{F,t}\left(\frac{p_t(f)}{P_{F,t}}\right)^{-\sigma}; \tag{11}$$

$$B_{t+1}:\ \frac{1}{P_t C_t} = \beta(1+i_t)E_t\frac{1}{P_{t+1}C_{t+1}} \tag{12}$$

$$\lambda_{H,t+1}:\ q_{H,t} = E_t Q_{t,t+1}\Pi_{H,t+1}; \tag{13}$$

$$\lambda_{F,t+1}:\ e_t q^*_{F,t} = E_t Q^*_{t,t+1} e_{t+1}\Pi^*_{F,t+1}; \tag{14}$$

where $Q_{t,t+1}$ is the discount factor of future dividends and $q_{H,t}$ ($q^*_{F,t}$) is the country aggregate of $q_t(h)$ ($q^*_t(f)$). From equation (9) we get the endogenous supply of labor in hours; equation (10) shows the allocation of the consumption expenditure among home and foreign-produced goods; equation (12) is the standard Euler equation. Finally, equations (13) and (14) are the free-entry conditions for new firms. Firms will enter the market whilst the initial fixed cost is lower or equal to the expected profits. $\Pi_{H,t}$ are the aggregate profits of domestic firms. The welfare-based price index is

$$P_t = \frac{P_{H,t}^{\gamma} P_{F,t}^{1-\gamma}}{\Gamma}, \tag{15}$$

where $\Gamma = \gamma^{\gamma}(1-\gamma)^{1-\gamma}$. And,

$$Q_{t,t+1} = \frac{1}{1+i_t} = \beta E_t\left(\frac{P_t C_t}{P_{t+1}C_{t+1}}\right), \tag{16}$$

is the intertemporal rate of substitution between consumption in period t and t+1. Foreign households solve an analogous problem with symmetric preferences, i.e., they prefer foreign-produced varieties, *f*, as much as home households prefer home-produced varieties, *h*.

3.3.2 Firm's problem

During the *creation of varieties*, home firms choose the demand of each capital good, $k_t(h)$ and $k_t(f)$, and the amount of labor, by solving the following three minimization problems subject to technological constraints:

$$\min_{k_t(h)} \int_0^{n_t} p_t(h)k_t(h)dh - \zeta_t\left(\left(\int^{n_t} k_t(h)^{1-\frac{1}{\sigma}} dh\right)^{\frac{\sigma}{\sigma-1}} - K_{H,t}\right), \qquad \textbf{(17)}$$

which produces the first-order condition,

$$k_t(h) = \left(\frac{p_t(h)}{P_{H,t}}\right)^{-\sigma} K_{H,t}; \qquad \textbf{(18)}$$

$$\min_{k_t(f)} \int_0^{n_t^*} p_t(f)k_t(f)dh - \zeta_t^*\left(\left(\int^{n_t^*} k_t(f)^{1-\frac{1}{\sigma}} df\right)^{\frac{\sigma}{\sigma-1}} - K_{F,t}\right) \qquad \textbf{(19)}$$

from which

$$k_t(f) = \left(\frac{p_t(f)}{P_{F,t}}\right)^{-\sigma} K_{F,t}; \qquad \textbf{(20)}$$

and, finally,

$$\min_{\ell_t(h)} w_t \ell_t(h), \qquad \textbf{(21)}$$

thus, the first order condition is,

$$\phi_t = \frac{w_t}{\theta A_{H,t}} \ell_t(h)^{1-\theta}, \qquad \textbf{(22)}$$

where the shadow prices, represented by the lagrange multipliers, are $\zeta_t = P_{H,t} = n_t^{\frac{1}{1-\sigma}} p_t(h)$, $\zeta_t^* = P_{F,t}$ and ϕ_t, the marginal cost of production, respectively. Therefore, the optimal baskets of home and foreign capital are

$$K_{H,t} = \delta \frac{P_{k,t}K_t}{P_{H,t}}; K_{F,t} = (1-\delta)\frac{P_{k,t}K_t}{P_{F,t}}. \qquad \textbf{(23)}$$

Firm *h* at time *t* has a demand of its variety *h*, to be used in building firms, of $n_{t+1}k_t(h)$. The price indexes for capital are,

$$P_{K,t} = \frac{(P_{H,t})^{\delta}(P_{F,t})^{1-\delta}}{\Gamma_\delta}; P_{K,t}^* = \frac{(P_{H,t}^*)^{1-\delta}(P_{F,t}^*)^{\delta}}{\Gamma_\delta}, \qquad \textbf{(24)}$$

where $\Gamma_\delta = \delta^\delta (1-\delta)^{1-\delta}$.[3]

Once in operation, firms maximize profits

$$\max_{p_t(h)} p_t(h)Y_t(h) - w_t\ell_t(h), \qquad \textbf{(25)}$$

subject to the technology restriction and demand function. Thus, the optimal price is

[3]The condition for stability requires that $1 > \theta \frac{\sigma-1}{\sigma}$.

$$p_t(h) = \frac{\sigma}{\sigma - 1}\frac{1}{\theta}\frac{w_t}{A_{H,t}^{\frac{1}{\theta}}}Y_t(h)^{\frac{1}{\theta}-1}. \qquad \textbf{(26)}$$

Prices consist of a constant markup over the marginal cost which depends crucially on the level of production, due to the non-linear technology.
One can write home aggregate profits as a constant fraction of total revenue. This depends both on the elasticity of substitution and the technological parameter:

$$\Pi_{H,t} = P_{H,t}Y_{H,t}\left(1 - \frac{\sigma - 1}{\sigma}\theta\right) = \left(\frac{\sigma(1-\theta)+\theta}{\sigma}\right)P_{H,t}Y_{H,t}. \qquad \textbf{(27)}$$

The real exchange rate for this economy is $RER_t = \frac{P_t}{e_t P_t^*} = \left[\frac{P_{F,t}}{P_{H,t}}\right]^{1-2\gamma}$ and terms-of-trade, $TOT_t = \frac{P_{H,t}^*}{P_{F,t}}$.

3.3.3 Market clearing

The clearing conditions for the financially integrated economy are:
Good markets

$$\begin{aligned} c_t(h) + c_t^*(h) + n_{t+1}k_t(h) + n_{t+1}^*k_t^*(h) &= Y_t(h); \\ c_t(f) + c_t^*(f) + n_{t+1}k_t(f) + n_{t+1}^*k_t^*(f) &= Y_t(f). \end{aligned} \qquad \textbf{(28)}$$

Labor markets

$$\begin{aligned} n_t\ell_t(h) &= \ell_t(j); \\ n_t^*\ell_t^*(f) &= \ell_t^*(j^*). \end{aligned} \qquad \textbf{(29)}$$

Financial markets

$$\begin{aligned} B_t &= -B_t^*; \\ \lambda_{H,t} &= 1 - \lambda_{H,t}^*; \lambda_{F,t} = 1 - \lambda_{F,t}^*. \end{aligned} \qquad \textbf{(30)}$$

Moreover, households in the financially integrated economy choose portfolios to get $P_tC_t = e_tP_t^*C_t^*$. I impose a balanced trade account for the financial autarky, $c_t^*(h)p_t(h)n_t = c_t(f)p_t(f)n_t^*$, where equations (30) do not apply.

4 Quantitative exercise

The scope of this exercise is two fold: First, to analyse the different consequences of shocks under the three economic scenarios I have considered. I explore the dynamics of domestic and foreign macroeconomic variables in the model after productivity and innovation shocks in sections 4.1 and 4.2. And, second, to study the relative change in macroeconomic volatility suffered by countries that open their borders to trade and to capital flows. In section 4.3, I show how volatility changes for some relevant macroeconomic variables conditional on the type of shock and for different degrees of openness.

Let us define the shock processes for Home in the following way

$$A_{H,t} = \phi_t A_{H,t-1} + (1-\phi_t) A_{H,0} + \eta_t; \quad \textbf{(31)}$$

$$K_t = \phi_{k,t} K_{t-1} + (1-\phi_{k,t}) K_0 + \eta_{k,t}, \quad \textbf{(32)}$$

where η_t is iid and ϕ_t and $\phi_{k,t}$ are the persistence of shocks. The baseline parameterization is summarized in Table 1. The degree of trade openness in capital goods, 1-δ, and consumption goods, 1-γ, are set to 0.44. This is the weighted average value for 12 European Union countries in 2004.[4] Although the model allows for different degrees of trade interaction in capital and goods market, the results are not conditional on this difference but on the aggregate level of international trade. The discount factor β is set to the standard value 0.99, to match an annualized interest rate of 4%. The elasticity of substitution between varieties, , is chosen to have a markup of 20%, which is the business cycle value generally found for advanced economies. Therefore, — (see, for instance, Bergin et al., 2007). κ=*1.75* is set to produce a steady state value of time devoted to work equal to *1/3*. The parameter value for decreasing returns to scale, θ, is 0.66 as in Galí (2008), a value commonly found in business cycle literature. Finally, I assume a persistence of shocks of 0.95.

Table 1: Parameterization

Parameter	Notation	Value
Home Bias in capital and consumption	δ, γ	*.66*
Discount factor	β	*.99*
Technology	θ	*.66*
Intratemporal elasticity of substitution	σ	*6*
Disutility of labor	κ	*1.75*
Total population	$L = L^*$	*1*
Shock persistence for A_H and A_F	$\phi = \phi^*$	*.95*
Shock persistence for K and K^*	$\phi_K = \phi_{K^*}$	*.95*

4.1 Transmission via trade openness

Figure 1 shows the impulse responses for the closed economy (solid lines) and the financial autarky (dashed lines) after a 1% positive deviation in η during fourty quarters. Variables are in logs.

[4] I follow Heathcote and Perri (2007) to compute the degree of openness. They use the weighted average of (imports+exports)/GDP where country weigths depend on their share in total GDP. I use an average of Austria, Belgium, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain and United Kingdom. The inclusion of the United States, Denmark, Norway, Sweden, Switzerland, Canada, Japan, Finland, Iceland, Malta, Australia, New Zealand, Cyprus, Israel, Korea and Singapore increases the degree of openness to 76%. Eaton and Kortum (2001) show that the home bias in capital goods is, in average, larger than that of consumption goods.

The comparison between these two scenarios sheds light on the consequences of opening a country to international trade. For the country suffering the shock, real variables behaive in similar ways and differences limit to changes in the magnitude of the response. Just after the shock, the intensive margin, i.e., production per firm, , increases. The extensive margin, i.e., the number of operating firms and varieties, cannot react due to the necessary time-to-build. Firms are created using final goods, which are now cheaper to produce and households, aware of the persistence of the shock and richer thanks to a higher output, save and invest more to take advantage of high productivity. From , *n* starts increasing at the expense of the intensive margin.
When the country trades, the neighbour receives part of the effects of the shock. The mechanism of transmission is the terms of trade. In the closed economy, prices of varieties, , climb immediately after the shock due to a higher demand and start decreasing only with the increase of competition (increase of n). On the contrary, in the financial autarky, prices and the price index of home-produced goods reduce.[5] The reduction of home prices makes imports relatively more expensive for a country that must balance its trade every period, i.e., TOT deteriorates for Home. Therefore, home consumption is not so benefited from the shock. The foreign country benefits from cheaper prices for its imports and can increase consumption, which pushes output up. However, the creation of firms is relatively more expensive compared to Home and households decide to create less firms.[6] The transmission is positive because a positive shock in one country generates improvements in consumption and output in the other.

[5] The consumer price index, P, reduces in the closed economy and makes creation cheaper. However, it has been normalized in the model and cannot be plotted.
[6] Remember that and are set above 0.5, implying home biases in technologies for consumption and capital goods. Therefore, Home country uses relatively more goods produced at Home than Foreign country.

Figure 1: Closed Economy and Financial Autarky after a shock on A_H.

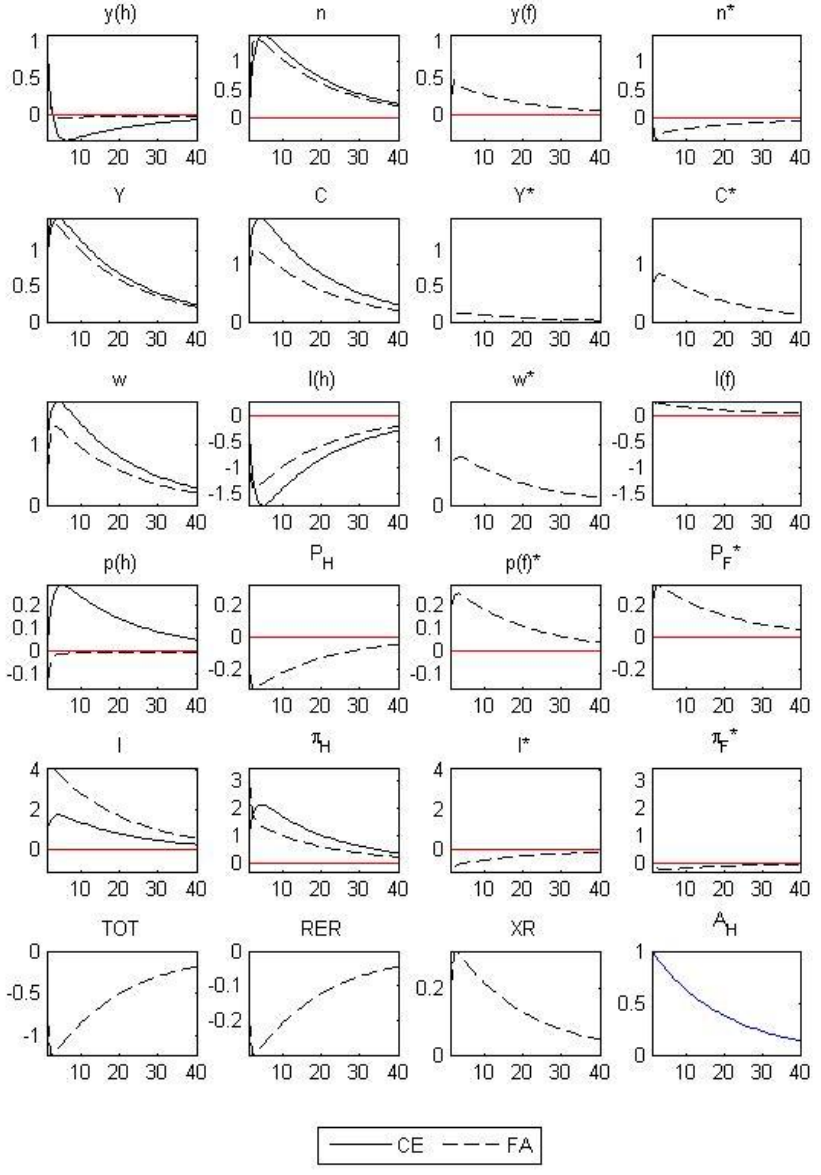


Figure 2: Closed Economy and Financial Autarky after a shock on K.

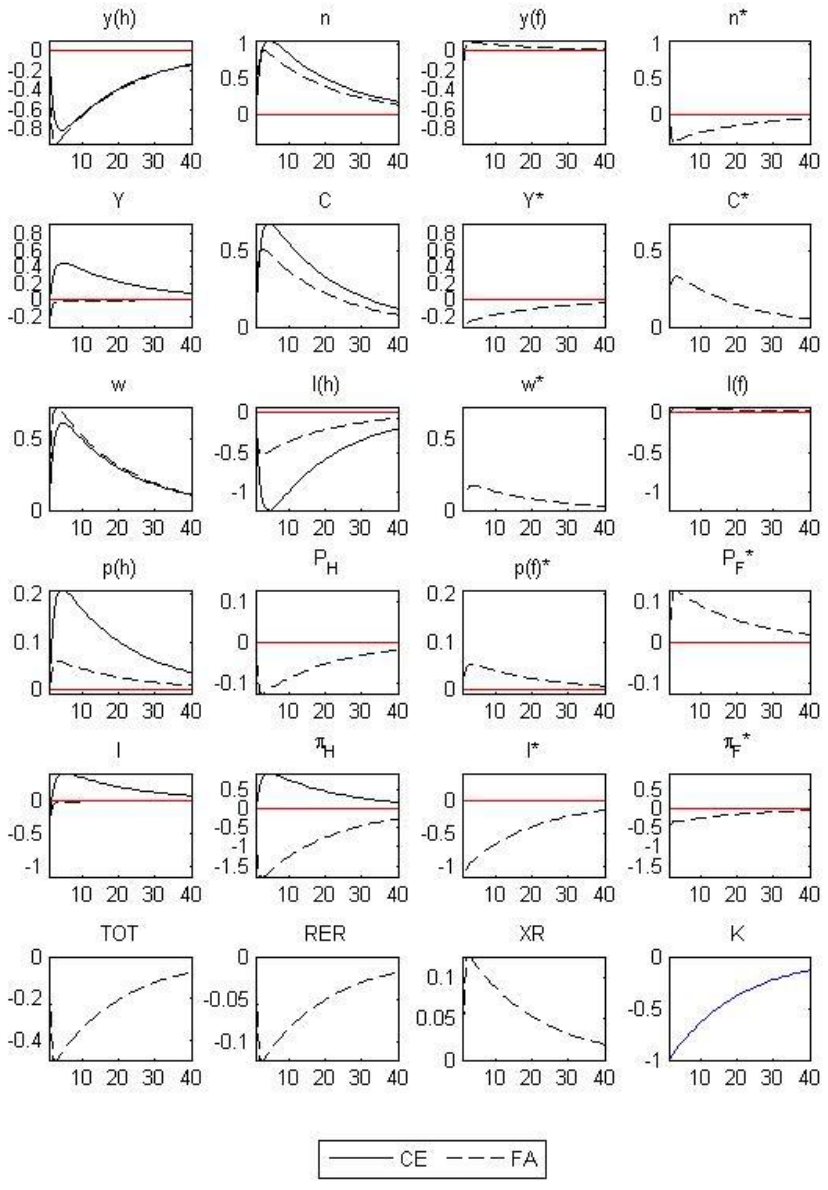


Figure 2 shows the impulse responses after a 1% negative deviation in η_k, i.e., a reduction in the cost of innovation or creation of new firms and varieties. The shock generates an upsurge of creation of new firms. However, since production is as costly as before the shock, production per firm decreases from the very first moment. Notice that investment increases in the closed economy and decreases in the financial autarky. The reason for this opposite response lays on the response of the extensive margin and its effect on the price index. The country opened to trade benefits from foreign demand, which is partially redirected towards the most efficient country. This motivates the innovation further and, therefore, the startup of more firms. Moreover, it also reduces the price index of home goods further, which makes creation even cheaper. As a result, the

investment necessary to generate the larger number of firms just after the temporary shock is lower than in the steady state value. The change in the level of competition (increase in the number of firms) in the two scenarios together with the fact that part of the extra consumption in the open countries is done in foreign goods determine the relative change in aggregate profits. In the financial autarky, the aggregate decline of production in the intensive margin is larger than the aggregate increase of production in the extensive margin, causing a small and short-lived reduction in economic growth and the reduction of profits. Notice that the transmission to Foreign is also positive in consumption, although milder than after a shock on η, and in output. Indeed, prices, , have not decreased as much as after a shock on η . As a consequence, households in both countries, who redirect part of the demand towards Home goods, benefit less from the reduction of prices and have less income left for the demand of Foreign goods. The result is the temporary reduction in Y^*

From Figure 1 and 2 one can conclude that, regardless of the autarky of financial markets, shocks are transmitted across borders via relative prices (TOT and exchange rate). This allows for some consumption smoothness. However, it also makes the country vulnerable in front of foreign shocks.

4.2 Transmission via financial integration

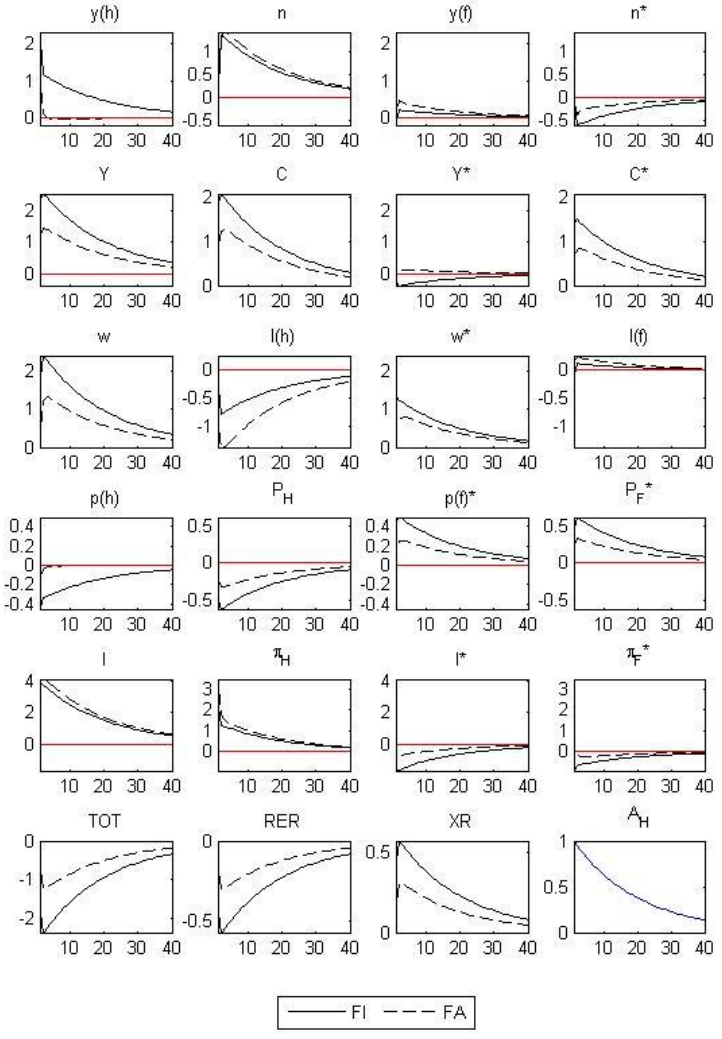
Figures *Figure 3* and *Figure 4* report the impulse responses for the financial integrated (solid lines) and financial autarkic world (dashed lines) after a shock on productivity and on innovation respectively. They help to understand the transmission of real shocks into macroeconomic variables and across borders when a country opens its financial market.

The main difference between a financial integrated world and a financial autarky is that households own domestic and foreign equities issued by firms in the former regime. Therefore, when a country receives a positive shock, households in the foreign country can take advantage by investing more in the relatively more productive country. As a consequence, a share of the profits are also sent abroad.

The financial integrated and the financial autarkic economy have similar responses to a positive shock in Home productivity (see *Figure 3*). Terms of trade deteriorates by more in the former case. However, countries are not forced to keep a balanced trade, which pushes foreign demand towards cheaper home goods and generates a larger output and consumption at home. For the same reason foreign output is damaged by the Home shock, although foreign households can still enjoy a larger consumption, even larger than in the financial autarky thanks to their participation in Home firms and the possibility of keeping a temporary unbalanced trade.

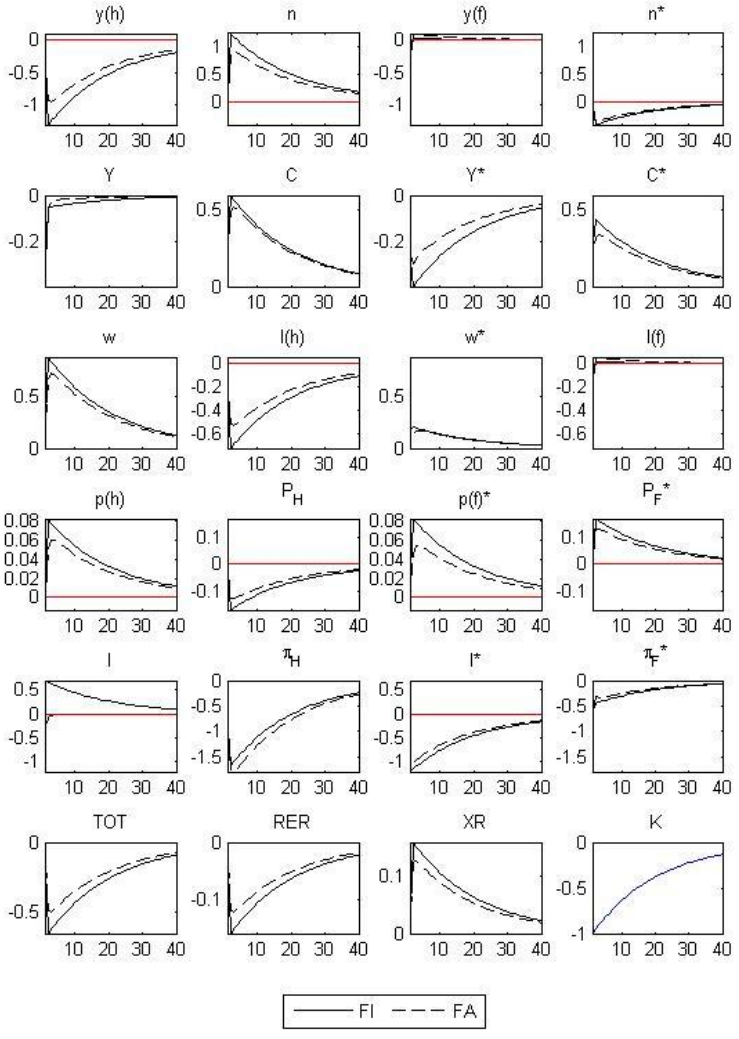
Notice that the new international linkage permits a larger response of the intensive margin after a shock on the productivity of production, i.e. increases more than in the financial autarky because agents can allocate savings more efficiently.

Figure 3: Financial Autarky and Financial Integration after a shock on productivity.



In a similar way, differences after a shock on innovation are mainly reduced to differences in the magnitude of the response but not in the direction. The exception is in Home investment, which now increases (as it does in the closed economy). The explanation lays in the larger response of the extensive margin. The cost of creation per firm is lower, but more domestic and foreign resources are attracted by more efficent innovation possibilities in Home, pushing Home investment up.

Figure 4: Financial Autarky and Financial Integration after a shock on innovation



4.3 Changes in aggregate volatility

Figure 5 shows the evolution of conditional macroeconomic volatilities (in standard deviations) over trade openness, following productivity shocks (η) and innovation shocks (η_k), where $\gamma = \delta$ and a high value means low openness.[7]

Stepping from a closed economy to a financial autarky that trades in goods reduces the volatility of consumption, the number of firms σ_n and the firm size σ_{ℓ}. Therefore, trade integration boosts the international share of the risk originated by country shocks through TOT (like in Cavallo (2008) empirical analysis). However, some differences arise by comparing the sources of the shocks: the conditional volatility of consumption-to-output, $\sigma_{C/Y}$, is higher with financial autarky but decreasing (nonlinear) in openness after a

[7]The rest of the parameters keep the baseline values.

productivity(innovation) shock.[8]

Let us focus on η first. For extreme values of γ, the possibilities of risk-sharing via TOT are small. For very low γ, the bulk of home production is sold abroad. Hence, when a shock occurs at Home, very little changes for home households. Foreign demand of Home goods increases Y, which pushes home consumption up. Hence, C/Y does not move so much. Instead, for very high γ the same shock produces huge adjustments in the purchasing power of home households who, now, consume a large share of the cheaper goods, exacerbating C/Y volatility.

When the shock is on η, firms reach more efficiency in the production of final goods, and innovation, which requires these final goods, becomes cheaper as well. Instead, when the shock is on η_k, innovation gains efficiency whereas final goods used in creation do not. This is the reason for the lower conditional volatility of C/Y for low levels of openness. When openness increases, the volatility generated by productivity shocks can be diversified via TOT as it has been explained. Instead, the volatility coming from a K shock is transmitted to a lesser extent due to its reduced impact on P_H and conditional $\sigma_{C/Y}$ increases.

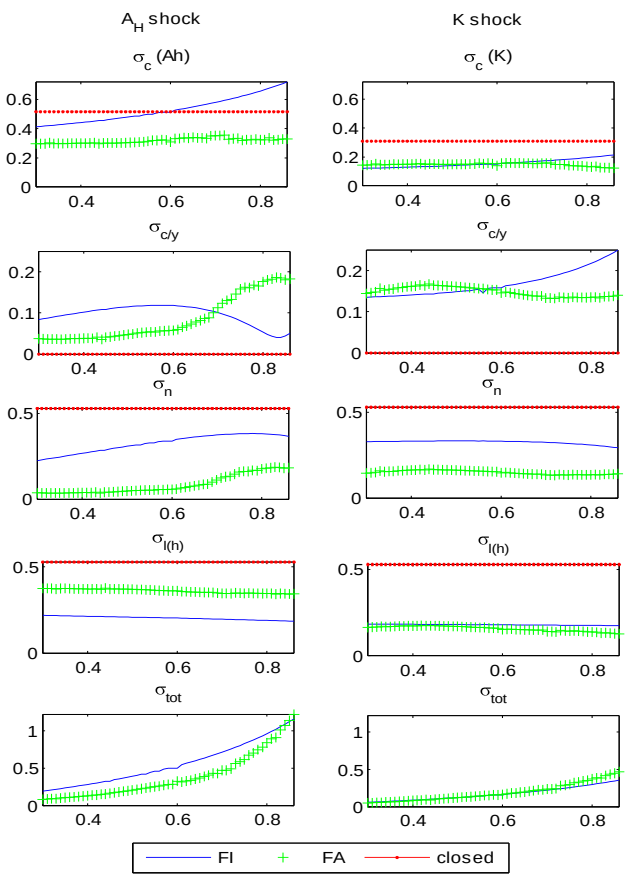
Now, compare the financial autarky with a financially integrated country. For the same level of trade openness, and regardless of the shock, output (as Buck et al. (2005) established) and the number of firms are more volatile in the financial integration scenario. The financial integrated economy suffers from higher volatilities in consumption after productivity shocks, whilst η_k shocks generate nonlinear patterns in relative consumption volatility compared to financial autarky. As a consequence, $\sigma_{C/Y}$ also changes its relative conditional volatility depending on the level of trade openness. A positive productivity shock makes demand of home goods and creation of firms at Home more attractive. This redirects world investment, exploiting the higher efficiency of creation to its maximum, causing σ_n to be larger. Hence, price indices are more reactive. The latter two effects increase σ_Y. The first requires larger adjustments in the demand of home goods to create more firms, the second pushes households demand of consumption goods. When γ is high, home households that pay lower prices in a large share of their consumption goods and receive most of the home profits benefit most. Hence, consumption moves with output and $\sigma_{C/Y}$ is below its FA counterfactual. When the country becomes open, a larger share of the instability caused by the shock is transmitted to Foreign via TOT and profits. Therefore, output still reacts a lot whereas

[8]In the closed economy, $\frac{C_t}{Y_t} = 1 - \frac{I_t}{Y_t}$ and savings equal investment, therefore, $\sigma_{C/Y} = \sigma_{I/Y}$. Moreover, due to the utility specification, which is a monotonic transformation of a Cobb-Douglas function, $\frac{C}{Y}$ is constant. Hence, $\sigma_{C/Y} = 0$. This is no longer true for the open economy where Y and C include exports and imports and, for financial integration, domestic savings are no-longer equal to domestic investment.

consumption at home benefits less. Now $\sigma_{C/Y}$ is above the FA case.[9]

Relative conditional $\sigma_{C/Y}$ goes in the opposite direction after a η_k shock. As said before, this shock causes lower adjustments in aggregate prices compared to productivity shocks. When γ is high, the first period after the innovation shock output decreases (less is needed to create firms) whilst consumption increases (although not as much as in financial autarky, because of profit sharing and the lower adjustment of prices), causing large movements in $\frac{C}{Y}$. For low γ, more foreign goods are used for innovation. Hence, the innovation shock releases less home production, stabilizing output. Consumption adjustment is also humbler due to profit sharing. Together, these offer lower $\sigma_{C/Y}$.

Figure 5: Aggregate volatility in the three scenarios



[9]The threshold is *somewhere* above $\gamma = 0.5$ due to the symmetry between countries and the nature of the idiosyncratic shocks. Shocks generate exchange rate depreciation which may improve Home situation when home bias in consumption exists and, therefore, the need of imports is low whereas the country still exports a bit.

5 Conclusions

This paper explores how macroeconomic volatilities change when the economy opens its borders to the goods market and to financial markets. It addresses the issue with a two-country microfounded model and two real shocks: on innovation and on labor productivity.

The main results are: first, financial integration and trade openness do play a role with macroeconomic volatilities. Indeed, changes in the capability of terms of trade and profit-sharing to transmit shocks, depending on the degree of integration in both international connections, help to explain the nonlinearity of consumption-to-output volatility found in empirical studies. Second, conditional to innovation shocks, any kind of integration reduces macroeconomic volatilities for a closed economy. However, whether financial integration would reduce consumption volatility for a country that was in financial autarky depends on the initial degree of trade openness. The more countries become open to trade the more likely financial integration helps Home reduce the conditional volatility of consumption-to-output ratio. Third, with financial integration, the model predicts lower instability of firm size and higher instability of the extensive margin (number of firms) compared to a financial autarky, which is an interesting result to be empirically examined.

Clearly, integration implies opening one's door to new linkages with the rest of the world. This brings benefits but also new sources of uncertainty. It is crucial for authorities to know how their economies are affected. This model sheds some light on the mechanism behind changes in the level of aggregate uncertainty.

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