Globalisation and the international monetary transmission *

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Abstract

This contribution introduces multinational production and trade costs in a dynamic open economy in the tradition of the new open macroeconomics, so as to analyse the impact of exports and foreign direct investments on exchange rates and prices. The mode of foreign market access is shown to play a key role in the international transmission of productivity and policy shocks, such as changes in transport costs and the global monetary stance. A generalised policy of trade liberalisation, by deteriorating the terms of trade of host relative to source countries, is shown to favour consumers in the developed (investing) world. Similarly, an easing of the global monetary stance has asymmetric effects in borrowing and investing countries. A depreciation of the home currency reduces the purchasing power of domestic consumers in open economies that mainly host foreign direct investments.

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1 Introduction

Foreign direct investments (FDI) have grown tremendously in the past two decades mainly in developed but also in developing countries and overall multinational sales have even outpaced the remarkable expansion of trade in manufactures that has occurred in the period. Horizontal FDI, namely investment in foreign facilities that are designed to serve foreign customers, has

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played a starring role in this process with most horizontal FDI flows concentrated among similar, developed countries.[1] As a consequence, the mode of foreign market access has attracted a growing attention in the trade literature with a number of recent contributions that investigate the determinants of the entry behaviour of multinational firms. Actually, firms can serve foreign customers through a variety of channels, some of which entail the decision to go multinational: they can export their products to foreign consumers, serve them through foreign subsidiaries or affiliates, and license or contract foreign firms to produce or sell their products. [2] Much less attention has been devoted to foreign market servicing in the macroeconomic literature. Most contributions in this area have focused on the role of monetary uncertainty and exchange rate volatility in directing cross-border investments flows.[3] Despite there is ample evidence that international capital flows also exacerbate exchange rate volatility up to triggering exchange rate crises, theoretical models have mainly neglected the role of foreign direct investment in the international monetary transmission in tranquil (no-crises) periods. [4] There are some notable exceptions especially among recent developments in the new open economy macroeconomics, including, among others, Devereux and Engel (2001), Russ (2004) and Cavallari (2004).[5] Devereux and Engel investigate the welfare consequences of the exchange rate regime when production is diversified internationally. They find that global production helps to shelter the domestic economy from changes in foreign demand, thereby re-inforcing the traditional argument in favour of flexible exchange rates.

[1] Over the period 1986-2000, developed countries have received more than 70 percent of FDI inflows.

[2] Recent contributions that examine the choice of foreign market access include, among many others: Helpman, Mélitz and Yeaple (2003) for a model that incorporates horizontal FDI and trade, Yeaple (2003) and Aizenman and Marion (2004) for the choice between horizontal and vertical FDI and Antràs and Helpman (2003) for the outsourcing alternative.

[3] Since the 1980's, many empirical studies have investigated the role of exchange rate risk on FDI flows. The evidence thus far is, however, still unconclusive. Early contributions such as Cushman (1985) and Goldberg and Kolstad (1995) find that volatility increases the willingness of US multinationals to locate facilities abroad. Other studies, however, provide ample evidence to the contrary. Chackrabarti and Scholnick (2002), for example, find a negative relationship between exchange rate volatility and FDI flows from the US towards 20 OECD countries. Rogoff and Rheinart (2003) document the deleterious consequences of price and currency instability for FDI flows towards the African countries.

[4] The abrupt reversal in the flow of foreign direct investments towards East-Asian economies has played a key role in the currency turmoils in the late 90's.

[5] A general equilibrium monetary model with internationalized production is provided also by Ricci (1997), who studies firms' location choices and countries' specialisation patterns under alternative exchange rate regimes.

Kathryn Russ mainly focuses on the joint determinants of entry behaviour by multinational firms and exchange rate volatility, showing that the relationship between FDI flows and volatility crucially depends on whether the monetary shock originates in the home or the foreign country. Finally, the last paper stress the consequences of foreign direct investments for the design of optimal monetary rules and finds that significant gains to international monetary coordination arise when there are multinational firms.

In this paper, I follow such recent line of research and incorporate multinational production into a dynamic open economy in the tradition of the new open macroeconomics, with the aim of investigating the role of foreign market servicing in the international cyclical transmission. Resting on two basic premises, the specification of the model is kept as simplified as possible so as to provide a convenient closed-form solution. First, I assume that consumers care about the country of origin of final goods and effectively perceive goods produced in different locations as imperfect substitutes. The assumption captures the fact that once goods reach the sales market, they incorporate a substantial local marketing input and pass through non-competitive retailing networks. Second, I assume that there are two types of firms: national firms, that serve foreign customers through exports, and multinational firms that invest in production facilities abroad so as to serve the host country market. The multinational firm is assumed to replicate the whole production process in multiple locations, which therefore excludes any "vertical" motive for FDI that would involve the fragmentation of the production process across countries. The assumption of firm heterogeneity draws on a major insight of the new trade theory showing that only the most productive firms engage in foreign activities (the result is first due to Mélitz, 2002) and that only the most productive among those that operate in foreign markets engage in foreign direct investments (Helpman, Mélitz and Yeaple, 2003). The key reason why there are firms that invest abroad is well exemplified in the so-called proximity-concentration trade-off, according to which firms go multinational whenever the gains from avoiding transport costs outweigh the costs of maintaining capacity in multiple locations.

The mode of foreign market access is shown to play a key role in the international transmission of productivity and policy shocks, such as changes in transport costs and the global monetary stance. A decline in domestic productivity is associated with a permanent deterioration or an improvement in the country's terms of trade depending on whether foreign markets are mainly served through, respectively, direct investments or exports. Whenever countries engage in large bilateral multinational activities, the fall in home productivity raises the domestic-currency price for domestic and foreign goods, reducing the purchasing power of domestic consumers, yet leav-

ing foreign-currency prices unchanged. The opposite occurs in countries that mostly trade among each-others, where higher marginal costs at home raise the price of home goods for domestic as well as foreign consumers. The rise in the home terms of trade, by re-directing world expenditure in favour of foreign goods, allows to spread part of the costs of the productivity slowdown around the world.

An easing of the global monetary stance, wherever it is originated, boosts world demand and output as long as prices are sticky. The paper shows that a domestic monetary expansion mainly raises consumption and employment at home when bilateral FDI flows are large, while spreading its effect worldwide under international trade.

The paper is structured as follows. Section 2 models the world economy. Section 3 discusses the long-run implications of the model. Section 4 analyses the international monetary transmission under different modes of serving foreign customers. Section 5 concludes.

2 The model

The world economy comprises a home and a foreign country. Drawing on Corsetti and Pesenti (2002), we assume that countries are fully specialised in the production of one type of good, which can appear in an infinite variety of imperfectly substitutable brands. All varieties of goods are traded across countries. The well-known analytical properties in this class of models allow us to avoid a detailed derivation of the solution while focusing on the most novel implications of our specification. In what follows, foreign variables are denoted by asterisks. Unless otherwise stated, foreign prices and quantities coincide with the corresponding domestic variables and will not be explicitly indicated.

2.1 Consumers' preferences and intra-temporal choices

Each country is inhabited by a continuum of agents of unit mass. Expected lifetime utility of a typical home agent i is defined as:

$$\Omega_{it} = E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} U_{it}(C^i, \frac{M^i}{P}, L^i) \tag{1}$$

where flow utility is a positive function of real consumption, C, and real money balances, M/P, a negative function of labour effort, L,and β is the discount factor. In order to keep algebraic complexity at a bare minimum, we adopt the additively-separable specification:

$$U_{it} = \ln C_{it} + \chi \ln \frac{M_{it}}{P_t} - \kappa L_{it} \tag{2}$$

where κ is a real or productivity shock which can be interpreted as a shock to the natural rate of output, and χ is a nominal disturbance or velocity shock.

The real consumption basket C aggregates consumption of the the home, C_H, and the foreign good, C_F according to the Cobb-Douglas index:

$$C = \frac{C_H^{\gamma} C_F^{1-\gamma}}{\gamma^{\gamma} (1-\gamma)^{1-\gamma}} \tag{3}$$

The foreign goods that are distributed in the home market can be produced either abroad by foreign exporters or in the home country by local subsidiaries of foreign firms. We assume that goods produced in different locations are perceived as imperfect substitutes by final consumers:

$$C_F = C_{FF}^{1-\Psi^*} C_{FH}^{\Psi^*} \tag{4}$$

where C_{FF} is consumption of the foreign imported good, C_{FH} is consumption of the foreign good produced in the home country and the parameter Ψ^* captures the degree of internationalisation of foreign production: a value of Ψ^* close to one implies that almost all foreign firms are multinationals that serve the home market through subsidiaries located in the home country. The assumption of imperfect substitutability between imported and locally produced goods can be justified on the ground of differences in the distribution strategies pursued by importers and multinational firms. [6] Once goods reach the consumer, in fact, they incorporate a substantial local marketing input and may pass through non-competitive retailing networks, so that final goods that are produced in different locations and distributed through various channels are effectively differentiated.

Domestic as well as each type of foreign goods appear in an infinite variety of imperfectly substitutable types, indexed by $h \in [0,1]$ in the home country and $f \in [0,1]$ in the foreign country, and all varieties are consumed in the world economy. Consequently, the following consumption sub-indexes can be defined:

$$C_H = \left[\int_0^1 C_H(h)^{\frac{\phi-1}{\phi}} dh \right]^{\frac{\phi}{(\phi-1)}}$$

$$C_{FH} = \left[\int_0^{\Psi^*} \left(\frac{1}{\Psi^*} \right)^{\frac{1}{\phi^*}} C_{FH}(f)^{\frac{\phi^*-1}{\phi^*}} df \right]^{\frac{\phi^*}{(\phi^*-1)}} \tag{5}$$

[6] Importers, for example, may act as distributors that add some non-traded component in final consumption goods (see Corsetti and Dedola (2003)).

$$C_{FF} = \left[\int_{\Psi^*}^{1} \left(\frac{1}{1-\Psi^*} \right)^{\frac{1}{\phi^*}} C_{FF}(f)^{\frac{\phi^*-1}{\phi^*}} df \right]^{\frac{\phi^*}{(\phi^*-1)}}$$

where the parameters $\phi > 1$ and $\phi^* > 1$ capture the elasticity of substitution among different brands of, respectively, home and foreign goods.

The demands for the different types of consumption goods can be easily derived as follows:

$$\begin{aligned} P_H C_H &= \gamma PC \\ P_F C_F &= (1-\gamma) PC \end{aligned} \tag{6}$$

$$\begin{aligned} P_{FH} C_{FH} &= \Psi^* P_F C_F \\ P_{FF} C_{FF} &= (1-\Psi^*) P_F C_F \end{aligned} \tag{7}$$

$$\begin{aligned} C_H(h) &= \left(\frac{P_H(h)}{P_H} \right)^{-\phi} C_H \\ C_F(f) &= \left(\frac{P_F(f)}{P_F} \right) C_F \end{aligned} \tag{8}$$

where the corresponding price indexes are:

$$P = P_H^{\gamma} P_F^{1-\gamma} \tag{9}$$

$$P_F = P_{FH}^{\Psi^*} P_{FF}^{1-\Psi^*} \tag{10}$$

$$\begin{aligned} P_H &= \left[\int_0^1 P_H(h)^{1-\phi} dh \right]^{\frac{1}{1-\phi}} \\ P_{FH} &= \left[\frac{1}{\Psi^*} \int_0^{\Psi^*} P_{FH}(f)^{1-\phi^*} df \right]^{\frac{1}{1-\phi^*}} \\ P_{FF} &= \left[\frac{1}{1-\Psi^*} \int_{\Psi^*}^1 P_{FF}(f)^{1-\phi^*} df \right]^{\frac{1}{1-\phi^*}} \end{aligned} \tag{11}$$

2.2 Individual budget constraint and inter-temporal choices

Each Home resident holds home currency, two international bonds, B_H^i and B_F^{*i}, respectively denominated in home and foreign currency, and an equal share in all domestic firms. He receives labour income at the wage rate W for services provided to the domestic and foreign firms located in the home country, a share in the profits of home firms, Π, and pays non-distortionary net taxes, T, to the government. The flow budget constraint of agent i is:

$$\begin{aligned} B_{Ht+1}^i + \varepsilon_t B_{Ft+1}^i + M_{t+1}^i \quad \leq \quad & B_{Ht}^i(1+i_{t+1}) + \varepsilon_t B_F^{*i}(1+i_{t+1}^*) + M_t^i \\ & + W_t\left(L_{ht}^i + L_{ft}^i\right) + \Pi_t^i - P_t^i C_t^i - T_t^i \end{aligned} \tag{12}$$

where i and i^* are, respectively, home and foreign nominal interest rates and ε is the nominal exchange rate defined as units of home currency for one unit of foreign currency.

Home agents maximize utility (2) subject to their budget contraint (12) over their whole life horizon. Aggregating the first order conditions across agents, we can easily derive the money demand equation:

$$\frac{M_t}{P_t} = \chi C_t \frac{1+i_{t+1}}{i_{t+1}} \tag{13}$$

and the risk-adjusted uncovered interest rate parity:

$$E_t\left(\frac{\varepsilon_t}{P_{t+1}C_{t+1}}\right) = E_t\left(\frac{\varepsilon_{t+1}}{P_{t+1}C_{t+1}}\right)\frac{1+i_{t+1}^*}{1+i_{t+1}} \tag{14}$$

Finally, labour is supplied up to the point where the marginal increase in wage income equals the marginal disutility of labour effort:

$$\frac{W_t}{P_t} = \kappa C_t \tag{15}$$

2.3 Firms

The representative home firm h is the sole producer of the corresponding variety of the home good. We assume that a share Ψ of domestic firms serve foreign customers through subsidiaries located abroad and the remaining share operate via exports. The parameter Ψ may be thought of as a proxy for firms' heterogeneity, due, for example, to differences in the level and dispersion of productivity across firms. A number of contributions in the new

trade theory incorporate some form of firm heterogeneity when modelling the entry behaviour in foreign markets and find that it plays a key role in explaining the structure of international trade and the mode of foreign market access. A common finding in this literature is that only the most profitable firms access foreign markets and only the most profitable among those operating in foreign markets engage in foreign direct investments. [7] As it is common in proximity-concentration models, we further assume that exports entail iceberg-type transport costs, so that for one unit of the final good to arrive at a foreign destination $\tau > 1$ units must be sent. These shipping costs capture a variety of (variable) costs associated with international trade and not associated with foreign direct investment.[8] Foreign investments, on the other hand, typically involve a larger amount of sunk costs, such as entry costs, which are independent from sales. Horizontal multinational activity is mainly motivated by accessing markets in the presence of trade frictions: firms invest in sales facilities abroad whenever the gain in avoiding shipping costs outweigh the sunk costs of maintaining capacity in multiple locations (the proximity-concentration trade-off).[9]

2.3.1 Production location

Technology is linear in labour and symmetric across countries and goods' varieties. The production function of a national home firm for sales to domestic residents and exports is given by:

$$Y(h) = L_h^i$$

where L_h^i is the home labour input.

The production function of a multinational home firm for sales to foreign residents is given by:

$$Y^*(h) = L_h^{i^*}$$

where $L_h^{i^*}$ is the foreign labour input. The structure of technology captures the fact that the multinational firm incurs some production costs abroad and is therefore directly affected by foreign productivity shocks as well as by a change in the nominal exchange rate.

[7] A non-exhastive list of contributions stressing the role of firm heterogeneity in explaining the structure of trade includes Mélitz (2002), Helpman, Mélitz and Yeaple (2003), Ghironi and Mélitz (2004) and Russ (2004).

[8] Despite the post-war trend towards trade liberalisation, international goods markets appear to remain remarkably segmented. Tariff barriers range on average between 4 and 5 per cent of the price of traded goods, while trade costs - including tariff and non-tariff barriers, shipping and distribution costs - vary greatly across classes of goods (Hummels (1999, 2001).

[9] The proximity-concentration model is due to Markusen (1984).

2.3.2 Pricing strategy

Monopolistic competitors set prices so as to maximize the expected present value of profits given market demand. In the absence of nominal rigidities, optimal prices mark up nominal marginal costs:

$$\begin{aligned} \widetilde{P}_{Ht} &= \Phi W_t \quad \widetilde{P}^*_{HHt} = \frac{\Phi \tau W_t}{\varepsilon_t} \quad \widetilde{P}^*_{HFt} = \Phi W^*_t \\ \widetilde{P}^*_{Ft} &= \Phi^* W^*_t \quad \widetilde{P}_{FHt} = \Phi^* W_t \quad \widetilde{P}_{FFt} = \Phi^* \tau \varepsilon_t W^*_t \end{aligned} \tag{16}$$

where $\Phi \equiv \phi/(\phi-1)$ and $\Phi^* \equiv \phi^*/(\phi^*-1)$ are indexes of monopoly distortions in, respectively, the home and foreign markets.[10]

Our model allows for nominal rigidities by assuming that agents set the price of their product at the beginning of each period, before shocks realize, and are committed to meet market demand at the given price for one period. We assume that goods produced in the sales markets are priced in local currency. This is obviously true for domestic firms selling to domestic residents, as there would be no reason to set prices in a foreign currency. Subsidiaries of foreign firms, instead, could in principle set prices in their own currency and let the local currency price of their products vary with the nominal exchange rate. There is ample evidence, however, that multinational firms engage in substantial pricing to market activities through their sales facilities located in foreign markets, effectively discriminating prices across markets (Lipsey, 1999). Optimal pre-determined prices for goods produced in the sales markets are set as a mark-up on expected nominal marginal costs:

$$\begin{aligned} \overline{P}_{Ht} &= \Phi E_{t-1}(W_t) \quad \overline{P}^*_{HFt} = \Phi E_{t-1}(W^*_t) \\ \overline{P}^*_{Ft} &= \Phi^* E_{t-1}(W^*_t) \quad \overline{P}_{FHt} = \Phi^* E_{t-1}(W_t) \end{aligned} \tag{17}$$

A different assumption is made for traded goods, whose price can be set in the currency of consumers, in the one of producers or according to any combination of these two pricing strategies. Empirical evidence on traded good prices, as documented by, among others, Goldberg and Knetter (1997), Engel (1999), Parsley and Wei (2001) and, more recently, Campa and Goldberg (2004) points to a degree of exchange rate pass-through into import prices which is higher than zero on average although far below unity.[11] Following

[10] All firms face similar pricing problems and, therefore, set identical prices in a symmetric equilibrium. This fact is used in deriving equations (16), (17) and (19).

[11] The extent to which movements in the nominal exchange rate pass through into final prices vary substantially across sectors.

Corsetti and Pesenti (2001), we assume that firms set the foreign-currency price for their products according to the following scheme:

$$\begin{aligned} P^*_H(h) &= \widehat{P}_H(h)\varepsilon^{-\eta^*} \\ P_F(f) &= \widehat{P^*}_F(f)\varepsilon^{\eta} \end{aligned} \tag{18}$$

where $\widehat{P}_H(h)$ is the pre-determined price for good h in home currency and $\widehat{P^*}_F(f)$ the pre-determined foreign-currency price for good f . In this setting, $\eta^* = \eta = 0$ corresponds to local currency pricing: firms set prices in the consumers' currency, so that prices consumers face do not respond to movements in the exchange rate. The case $\eta = \eta^* = 1$ corresponds to producers' currency pricing: producers set the price in their own currency, implying that import prices move in the same proportion as the nominal exchange rate.

Optimal price setting for sales in foreign markets yields:

$$\begin{aligned} \overline{P}^*_{HHt} &= \frac{\Phi\tau E_{t-1}(W_t P^*_t C^*_t \varepsilon_t^{1+\eta^*})}{\varepsilon_t^{\eta^*} E_{t-1}(P^*_t C^*_t \varepsilon_t)} \\ \overline{P}_{FFt} &= \frac{\Phi^*\tau E_{t-1}(W^*_t P_t C_t \varepsilon_t^{-1-\eta})}{\varepsilon_t^{-\eta} E_{t-1}(P_t C_t \varepsilon_t^{-1})} \end{aligned} \tag{19}$$

In foreign markets, the ex post mark-up is inversely related with nominal marginal costs and the nominal exchange rate. This implies that exporters will consider both movements in nominal marginal costs and the exchange rate in the future when setting prices. Whenever they expect the domestic currency to appreciate, a fall in ε, thereby reducing sales revenue in foreign currency, they will set foreign-currency prices at a premium so as to hedge against declining profits.

Optimal prices (19) and (17) are valid for any distribution of the underlying shocks, provided the participation constraints are not violated:

$$\begin{array}{cccccc} \overline{P}_H & \geq & W & \widehat{P}_H \geq W\tau & \overline{P}^*_{HF} & \geq W^* \\ \overline{P}^*_F & \geq & W^* & \widehat{P^*}_F \geq W^*\tau & \overline{P}_{FH} & \geq W \end{array} \tag{20}$$

In what follows, the domain of real and nominal shocks is restricted so that the above constraints are always satisfied.

2.4 Government's budget constraint

The domestic government rebates all seignorage revenue in lump-sum transfers to households:

$$\int_0^1 M_{it} - M_{it-1} di + \int_0^1 T_{it} di = 0 \tag{21}$$

Governments affect the stock of domestic monetary assets by controlling the short-term interest rate. Following Corsetti and Pesenti (2001), it is useful to define an index of monetary stance μ in the home country such that:

$$\frac{1}{\mu_t} \equiv \beta(1 + i_{t+1}) E\left[\frac{1}{\mu_{t+1}}\right] \tag{22}$$

In equilibrium, it is immediate to derive μ as the inverse of the marginal utility of consumers' wealth, PC.[12] Expression (22) links a given time path of μ to a corresponding sequence of home nominal interest rates: a monetary expansion is associated with a higher μ and a lower i.

2.5 Aggregate resource constraints

Asset markets' equilibrium requires that international bonds are in zero net supply:

$$\int_0^1 B^i_{Ht} di + \int_0^1 B^{*i}_{Ht} di = 0 \quad \int_0^1 B^i_{Ft} di + \int_0^1 B^{*i}_{Ft} di = 0 \tag{23}$$

Goods market clearing in the home country requires that the aggregate supply of home goods coincides with world demand:

$$Y_H \geq C_H + C^*_H \tag{24}$$

Equilibrium in the labour market yields:

$$L \geq C_H + C^*_{HH} + C_{FH} \tag{25}$$

where $L = \int_0^1 L^i di$.

Aggregating the budget constraints (12) across home agents and using the government (21) and resource constraints (24) and (25), yields the aggregate accounting equation for the home economy:

$$PC = P_H C_H + \varepsilon P^*_H C^*_H + W C_{FH} - \varepsilon W^* C^*_{HF} \tag{26}$$

where use has been made of the assumption of initial financial autarky in each country, i. e. $B_{H0} = B_{F0} = 0$. As usual in this class of models, net

[12] We have recursively used the index of monetary stance in the Euler equation (14).

assets are zero in any point in time provided initial non-monetary wealth is zero. [13]

3 The flexible price benchmark

Using demands (6) and (7) and flexible prices (16) into the aggregate accounting equation (26) yields the equilibrium exchange rate:

$$\widetilde{\varepsilon} = \frac{1-\gamma}{\gamma}\frac{\mu}{\mu^*}\frac{(1-\frac{\Psi^*)}{\Phi^*})}{(1-\frac{\Psi)}{\Phi})} \tag{27}$$

In the absence of nominal rigidities, the nominal exchange rate is proportional to the relative monetary stance. A domestic monetary expansion, an increase in μ, leads to an exchange rate depreciation, an increase in $\widetilde{\varepsilon}$. It is noteworthy to stress that the response of the exchange rate to domestic monetary conditions is higher in open and highly integrated economies.

Equilibrium prices and quantities in the world economy are given by:

$$\begin{aligned}
\widetilde{P}_H &= \Phi\kappa\mu \\
\widetilde{P}^*_{HH} &= \frac{\Phi\tau\kappa\mu}{\varepsilon} \\
\widetilde{P}^*_{HF} &= \Phi\kappa^*\mu^* \\
\widetilde{P}_{FF} &= \Phi^*\tau\varepsilon\kappa^*\mu^* \\
\widetilde{P}_{FH} &= \Phi^*\kappa\mu \\
\widetilde{P}^*_F &= \Phi^*\kappa^*\mu^*
\end{aligned} \tag{28}$$

$$\begin{aligned}
\widetilde{L} &= \frac{1}{\kappa}\left(\frac{\gamma}{\Phi} + \frac{(1-\gamma)(1-\Psi)(1-\frac{\Psi^*)}{\Phi^*})}{\Phi\tau(1-\frac{\Psi}{\Phi})} + \frac{(1-\gamma)\Psi^*}{\Phi^*}\right) \\
\widetilde{L}^* &= \frac{1}{\kappa^*}\left(\frac{1-\gamma}{\Phi^*} + \frac{\gamma(1-\Psi^*)(1-\frac{\Psi}{\Phi})}{\Phi\tau(1-\frac{\Psi^*}{\Phi^*})} + \frac{\gamma\Psi}{\Phi}\right)
\end{aligned} \tag{29}$$

$$\widetilde{C} = \frac{1}{\Phi_W}\left(\frac{(1-\gamma)(1-\frac{\Psi^*}{\Phi^*})}{\tau\gamma(1-\frac{\Psi}{\Phi})}\right)^{(1-\Psi^*)(\gamma-1)}\left(\frac{1}{\kappa}\right)^{\gamma+(1-\gamma)\Psi^*}\left(\frac{1}{\kappa^*}\right)^{(1-\gamma)(1-\Psi^*)} \tag{30}$$

[13] As pointed by Corsetti and Pesenti (2002), a balanced current account is the result of three hypothesis: i) a Cobb-Douglas consumption index ii) logarithmic utility in consumption and iii) zero initial net assets.

$$\widetilde{C}^* = \frac{1}{\Phi_W}\left(\frac{(1-\gamma)\left(1-\frac{\Psi^*}{\Phi^*}\right)}{\tau\gamma(1-\frac{\Psi}{\Phi})}\right)^{(1-\Psi)\gamma}\left(\frac{1}{\kappa}\right)^{\gamma(1-\Psi)}\left(\frac{1}{\kappa^*}\right)^{1-\gamma+\gamma\Psi}$$

In the flexible-price benchmark, employment is exclusively determined by *country-specific* real shocks and global monopoly distortions. A negative shock to home productivity, an increase in κ, leads to a fall in employment as a result of the attempt on the part of economic agents to smooth labour effort along time. Employment is negatively associated with monopolistic distortions in domestic and foreign goods markets, with the latter playing a role whenever countries engage in bilateral foreign investment activities.

Consumption in the world economy is a function of global monopolistic distortions and global shocks. World consumption is low when monopolistic distortions are high anywhere in the world. Movements of the terms of trade ensure that the benefits and costs from country-specific productivity shocks spread around the world, changing the composition of world spending. It is easy to verify that the home terms of trade, defined as the home-currency price of exports in terms of imports, are given by:

$$\widetilde{Q} = \tau^{\Psi^*-\Psi}\frac{\Phi}{\Phi^*}\left(\frac{\left(1-\frac{\Psi^*}{\Phi^*}\right)(1-\gamma)\kappa^*}{(1-\frac{\Psi}{\Phi})\gamma\kappa}\right)^{\Psi-1+\Psi^*} \tag{31}$$

Observe first, that countries characterised by a net inflow of direct investments, $(\Psi^* > \Psi)$, may be vulnerable to a policy of trade liberalisation as represented by a symmetric, worldwide decrease in iceberg-type transport costs. As (31) shows, a drop in transportation costs τ deteriorates the terms of trade of host relative to source countries, which in turn implies that the fall in the price of traded goods mostly favours consumers in the developed (investing) world. [14] This is not to say, however, that trade liberalization is counter-productive for less developed countries. The negative terms of trade effect can in fact be more than compensated in welfare terms by the corresponding boost in domestic output. Insofar as falling trade costs reduce the profitability of foreign direct investments relative to exports, cross-border capital flows help to bridge the output gap between host and source countries. Remarkable differences in the FDI experience of less developed and developed countries are actually documented in recent empirical studies as regards both the factors that determine the location of FDI activities across

[14] This is remiscent of the long-lasting debate on the secular deterioration of the terms of trade of developing countries initiated by Singer (1950). It is currently widely accepted that the terms of trade across developed and less developed countries move to a much lesser extent than previously thought and may not have a secular trend, once transport costs, product quality and cross-country specialisation patterns are accounted for (Salvatore, 2001).

countries and the macroeconomic impact of foreign investments. Blonigen and Wang (2004) suggest that FDI activities mainly favour less developed countries, where foreign investments are more likely to crowd-in domestic investments. They further document that FDI inflows positively affect output growth in less developed countries, while the impact is negligible in more developed economies.

Second, a change in relative productivity may be associated with a deterioration or an improvement in the country's terms of trade depending on the extent of foreign investments across countries. In less integrated and symmetric economies ($\Psi^* = \Psi \simeq 0$), a decline in domestic productivity raises the relative price of home exports, partially shifting the costs of the productivity slowdown abroad. The consequent deterioration of the foreign country's terms of trade, in fact, reduces the purchasing power of foreign consumers and implies that consumption falls in both countries. [15]

Among highly integrated and similar economies ($\Psi^* = \Psi \simeq 1$), a fall in productivity at home implies a decrease (deterioration) in the domestic terms of trade. High marginal costs at home raise the price for domestic as well as foreign goods, thereby reducing the purchasing power of domestic consumers. The decline in home productivity does not affect the foreign-currency price of home and foreign goods (the "internal" terms of trade in the foreign country): the expenditure switching channel of international cyclical transmission is completely obscured in this case. As long as bilateral foreign direct investments are large relative to trade flows, domestic consumption is effectively isolated from world cyclical conditions. One notable feature of the equilibrium outcome in strongly integrated and symmetric economies is that aggregate output is much more correlated across countries than consumption, as it is true in the data for most industrialised countries. Whenever $\Psi = \Psi^* = 1$, equations (30) and (29) imply that aggregate output is equalised across countries:

$$Y_H = Y_F^* = \frac{1}{\Phi_W}\left(\frac{1}{\kappa} + \frac{1}{\kappa^*}\right)$$

while consumption is proportional to relative productivity shocks :

$$\frac{C}{C^*} = \frac{\kappa^*}{\kappa}$$

[15] When $\Psi = \Psi^* = 0$, consumption is fully stabilised in the world economy (perfect risk-sharing):

$$\frac{C}{C^*} = \frac{1-\gamma}{\gamma}\tau^{2\gamma-1}$$

More open economies obtain a larger share of world consumption and the more so the smaller transport costs. Our model is isomorphic to Obstfeld (2001) in this case.

A higher cross-country correlation of output than consumption, the so-called consumption-output anomaly, is one of several puzzles in international macroeconomics. The paradox arises as one would expect consumption to be equalised across countries through trade in financial assets. Perfect risk-sharing in a world with complete asset markets automatically yields perfect correlation among consumption differentials across countries, as predicted by standard real business cycle models (Backus, Kehoe and Kydland (1992)). [16] In our framework of effectively complete markets, less than perfect risk-sharing in consumption is the result of market segmentation due to direct servicing of foreign customers. A decline in home productivity does not affect the purchasing power of foreign consumers as long as they attach a positive value to the distribution services of local subsidiaries of home firms. Cross-country output correlation, instead, is positively associated with the degree of internationalisation in production, since a slowdown in home productivity will reduce the amount of goods produced out of domestic labour services and hence the profits of domestic firms as well as foreign multinationals.

Equation (31) further shows that the response of the terms of trade to productivity disturbances is higher the more similar the mode of foreign market access across countries. As already shown, the costs and benefits of a change in domestic productivity are more likely to spread their effects outside the domestic borders among economies with strong bilateral trade ties, while mostly remaining inside the domestic borders in case of large bilateral investments flows. When countries are highly asymmetric regarding the mode of foreign market access, as it is the case with host and source countries, relative international prices are almost invariant to country-specific productivity shocks. This implies that despite lower trend productivity, less developed (host) countries need not experience a secular deterioration in their terms of trade relative to the developed world, as it appears in long-horizon terms of trade data for the two groups of countries (see footnote 14).

Finally, consider the real exchange rate $R \equiv \varepsilon P^*/P$ as defined using the consumption-based price indexes in the two economies. These price indexes change over time as a result of movements in transportation costs as well as changes in the world cyclical conditions. Using equilibrium prices (28) and the nominal exchange rate (27) yields the real exchange rate under flexible prices:

[16] Incomplete asset markets are not as pervasive as implied by actual macroeconomic data. Moreover, the gain from international risk-sharing appear to be negligible (Cole and Obstfeld (1991)).

$$\widetilde{R} = \frac{1-\gamma}{\gamma} \frac{(1-\frac{\Psi^*)}{\Phi^*})}{(1-\frac{\Psi)}{\Phi})} \left(\frac{\kappa}{\kappa^*}\right)^{-\Psi\gamma-\Psi^*(1-\gamma)} \tau^{(1-\Psi)\gamma-(1-\Psi^*)(1-\gamma)} \tag{32}$$

Despite price flexibility, purchasing power parity may not hold, $R \neq 1$. Many studies document that real exchange rate movements are highly persistent, so much that the hypothesis of unit roots in real exchange rate data can hardly be rejected for most industrialised and developing countries, implying a violation of the purchasing power parity. [17] Recently, tests for (mean or trend) stationarity in long-horizon time series have been developed that take into account the possibility of structural breaks, namely a change in the mean or the trend or both the mean and trend of the data. [18] Allowance for structural changes strongly improves the results in favour of stationary real exchange rates, implying that a weak form of purchasing power parity holds for most industrialised countries (Papell and R. Prodan (2003)). Nonetheless, the convergence to parity is very slow: it takes more than 5 years on average for the exchange rate to return to its long-run mean or trend (Murray and Papell (2002), Lothian and Taylor (1996)).

Deviations from purchasing power parity may arise from transport costs and foreign direct investment in our model. In a less integrated world, ($\Psi = \Psi^* \simeq 0$), failures of the law of one price are mainly due to trade costs:

$$\widetilde{R} = \tau^{2\gamma-1}$$

It is worth stressing that a rise in trade frictions is associated with an appreciation of the real exchange rate in large and closed economies ($\gamma > 1/2$).

A high degree of global production, ($\Psi = \Psi^* \simeq 1$), implies that violations of the purchasing power parity are positively associated with cross-country differences in size, cyclical conditions and monopoly distortions:

$$\widetilde{R} = \frac{(1-\gamma)\,\phi\kappa^*}{\gamma\phi^*\kappa}$$

4 International monetary transmission

Using demands (6) and (7) and optimal pre-determined prices (17) and (19) into the aggregate accounting equation (26) gives the nominal exchange rate when prices are pre-determined:

[17] Early stationarity tests for real exchange rate data are surveyed in Rogoff (1996). See Froot and Rogoff (1996) for a very long-run perspective on PPP.

[18] See Taylor (2002), Engel (2000) and Ng and Perron (2001) among others.

$$\overline{\varepsilon}_t = \frac{1-\gamma}{\gamma}\frac{\mu_t}{\mu_t^*}\frac{(1-\frac{\Psi^*\kappa\mu_t}{\Phi^* E(\kappa\mu_t)})}{(1-\frac{\Psi\kappa^*\mu^*}{\Phi E(\kappa^*\mu^*)})} \tag{33}$$

Comparing equations (33) and (27) reveals that the short- and long-run nominal exchange rates are equalised when production is entirely domestic, namely when $\Psi^* = \Psi = 0$. Despite price rigidities and incomplete pass-through, the nominal exchange rate immediately jumps on its new steady-state value following a change in the global monetary stance in this case. As trade and the current account are invariably balanced when all production costs are incurred at home, countries consume precisely their sales revenue. This in turn implies that the nominal exchange rate is proportional to the relative monetary stance at any point in time.

A richer exchange rate dynamics materialises in a globalised world with nominal rigidities. The nominal exchange rate in equation (33) reacts to other cyclical conditions than monetary policy and can also respond in a non-linear way to a change in the relative monetary stance. [19] Exchange rate over- or undershooting is the result of short-run capital flows due to profit transfers across countries. For an intuitive account of the point, suppose that home productivity unexpectedly rises. In the absence of nominal rigidities, domestic prices would fall, switching world demand in favour of domestic goods and leaving the nominal exchange rate unaffected. With sticky domestic prices, demands for the different varieties of domestically produced goods do not change. The main economic effect of the productivity change will be on the profits of the firms located in the home country, either national or multinational firms. As local affiliates of foreign multinationals repatriate their unexpectedly high profits, capital outflows towards the foreign country depreciate the home currency. It is worth noticing that the exchange rate moves in the opposite direction following a change in *expected* pruductivity. The expectation of lower nominal marginal costs at home induces foreign multinationals to charge lower prices onto home consumers, which in turn shifts expenditure towards home goods and contributes in appreciating the home currency.

A unilateral monetary expansion is associated with a more or less than proportional depreciation of the home currency depending on cross-country differences in the pattern of foreign direct investments. When prices are

[19] Exchange rate deviations from fundamentals are temporary: inspection of equations (33) and (27) immediately reveals that the short and long-run exchange rates coincide on average. Once prices adjust, profits are stabilised across countries and both the trade and the current account are invariably balanced without any need for a change in the exchange rate.

sticky in local currency, a depreciation of the home currency reduces the profits of foreign multinationals while raising those of home subsidiaries abroad. Countries that mainly host foreign multinationals will then experience a reduction in capital outflows due to profit transfers abroad, which in turn helps dampening the depreciation of the domestic currency. The opposite occurs in source countries.

Equilibrium prices and quantities are given by:

$$\begin{aligned}
\overline{P}_H &= \Phi E_{t-1}\left(\kappa_t \mu_t\right) \\
\overline{P}^*_{HH} &= \frac{\Phi \tau E_{t-1}(\kappa_t \mu_t \kappa^* \mu^*_t \varepsilon_t^{1+\eta^*})}{\overline{\varepsilon}_t^{\eta^*} E_{t-1}(\kappa^* \mu^*_t \varepsilon_t)} \\
\overline{P}^*_{HFt} &= \Phi E_{t-1}(\kappa^* \mu^*_t) \\
\overline{P}^*_{F} &= \Phi^* E_{t-1}(\kappa^* \mu^*_t) \\
\overline{P}_{FF} &= \frac{\Phi^* \tau E_{t-1}(\kappa_t \mu_t \kappa^* \mu^*_t \varepsilon_t^{-1-\eta})}{\overline{\varepsilon}_t^{-\eta} E_{t-1}(\kappa_t \mu_t \varepsilon_t^{-1})} \\
\overline{P}_{FH} &= \Phi^* E_{t-1}(\kappa_t \mu_t)
\end{aligned} \tag{34}$$

$$\begin{aligned}
\overline{L} &= \left(\frac{\gamma \mu_t}{\Phi E_{t-1}(\kappa \mu_t)} + \frac{(1-\Psi)\,\gamma}{\Phi \tau} \frac{\mu^*_t \overline{\varepsilon}_t^{\eta^*} E_{t-1}(\kappa^* \mu^*_t \overline{\varepsilon}_t)}{E_{t-1}(\kappa_t \mu_t \kappa^* \mu^*_t \overline{\varepsilon}^{1+\eta^*})} + \frac{(1-\gamma)\,\Psi^*}{\Phi^*} \frac{\mu}{E_{t-1}(\kappa_t \mu_t)} \right) \\
\overline{L}^* &= \left(\frac{(1-\gamma)\,\mu^*_t}{\Phi^* E_{t-1}(\kappa^* \mu^*)} + \frac{(1-\Psi^*)\,\gamma}{\Phi^* \tau} \frac{\mu_t \overline{\varepsilon}_t^{-\eta} E_{t-1}(\kappa_t \mu_t \varepsilon_t^{-1})}{E_{t-1}(\kappa_t \mu_t \kappa^* \mu^*_t \overline{\varepsilon}_t^{-1-\eta})} + \frac{\gamma \Psi}{\Phi} \frac{\mu^*_t}{E_{t-1}(\kappa^* \mu^*)} \right)
\end{aligned} \tag{35}$$

$$\begin{aligned}
\overline{C} &= \frac{\mu_t \overline{\varepsilon}_t^{\,-(1-\gamma)\eta(1-\Psi^*)}}{\Phi_W} \left((E_{t-1}(\kappa_t \mu_t))^{\gamma+(1-\gamma)\Psi^*} \left(\frac{\tau E_{t-1}(\kappa_t \mu_t \kappa^* \mu^*_t \overline{\varepsilon}_t^{-1-\eta})}{E_{t-1}(\kappa_t \mu_t \overline{\varepsilon}_t^{-1})} \right)^{(1-\gamma)(1-\Psi^*)} \right)^{-1} \\
\overline{C}^* &= \frac{\mu^*_t\ \overline{\varepsilon}^{\gamma\eta^*(1-\Psi)}}{\Phi_W} \left((E_{t-1}(\kappa^* \mu^*_t))^{1-\gamma+\gamma\Psi} \left(\frac{\tau E_{t-1}(\kappa_t \mu_t \kappa^* \mu^*_t \overline{\varepsilon}_t^{1+\eta^*}}{E_{t-1}(\kappa^* \mu^*_t \overline{\varepsilon}_t)} \right)^{\gamma(1-\Psi)} \right)^{-1}
\end{aligned} \tag{36}$$

As long as prices are sticky, consumption and employment in the world economy are determined by global monetary conditions: nominal spending is controlled by governments through monetary policy and output accommodates any change in aggregate demand. Productivity shocks affect current consumption and employment only indirectly through movements in the nominal exchange rate, while feeding completely into *expected* consumption and employment and into labour effort. The minor role of supply shocks in driving aggregate consumption and output is consistent with the so-called

New Keynesian view of the business cycle, as synthesised by Clarida, Galì and Gertler (1999). An unexpected shock to productivity leads to a very small, if any, change in relative prices, which in turn implies that the supply of goods available for consumption does not change by much. [20]

Monetary policy is transmitted in the world economy through changes in world demand and the terms of trade. An easing of the global monetary stance, wherever it is originated, boosts world demand and ouput. The capacity of monetary authorities to affect international prices and re-direct expenditure across countries crucially depends on the pricing strategies of the firms that operate in foreign markets, while the mode of foreign market access is key to the employment spillovers throughout the world.

In a high pass-through environment, i.e. when $\eta = \eta^* \simeq 1$, a domestic monetary expansion raises consumption worldwide. The depreciation of the home currency, in fact, deteriorates the home terms of trade and switches world expenditure in favour of home goods. Since domestic prices are predetermined, home consumer prices rise and foreign consumer prices fall in the same proportion with the consequence that consumption rises in both countries. Worldwide employment need to increase as well in order to provide a larger amount of goods for consumption. When production is less integrated worldwide, $\Psi = \Psi^* \simeq 0$, domestic employment bears the burden of adjustment. Consequently, the domestic monetary expansion certainly benefits foreign residents, yet turning potentially harmful for domestic consumers. The monetary easing is more likely to be a "beggar myself " policy in an overheated scenario, where the welfare loss from increasing labour effort more than compensates the welfare gain from higher consumption. In highly integrated economies, the upsurge in world demand can be partly accommodated by subsidiaries of home firms located in the foreign economy. An easing of the domestic monetary stance raises foreign employment in this case.

When local prices are invariant to exchange rate movements, as it is the case when prices are mainly set in the consumers' currency ($\eta = \eta^* \simeq 0$), an easing of the home monetary stance boosts domestic consumption only. Despite fixed local prices, however, international monetary spillovers may be not negligible. First, a home monetary easing leads to an increase in foreign employment whenever production is not entirely globalised, so as to meet the temporary boost in external demand. Second, there is the expectation channel of monetary transmission. In our model this is exemplified by the fact that expected marginal costs of the firms that serve foreign markets depend on the nominal exchange rate as well as on the correlation between

[20] All prices in (34) respond to real shocks via exchange rate changes.

nominal and real shocks across countries. A monetary policy regime shift, as the move from flexible to fixed exchange rates, can then be associated with a permanent change in the level and volatility of consumption and employment worldwide.

Finally, it is easy to show that nominal and real exchange rates move together:

$$\overline{R} \propto \overline{\varepsilon}^{1-\eta^*(1-\Psi)\gamma-\eta(1-\Psi^*)(1-\gamma)} \tag{37}$$

High correlation between changes in nominal and real exchange rates is a well-known fact in international macroeconomics and finance. As documented by Mussa (1986), real exchange rates become much more volatile when nominal exchange rates are allowed to float. Moreover, real exchange rate variability tends to reflect almost perfectly nominal rate variability, with independent movements in price levels playing a minor role, if any, along the business cycle. As apparent in equation (37), nominal and real exchange rate movements are almost perfectly correlated among countries characterised by a similar mode of foreign market access. A depreciation of the home currency is instead associated with a less than proportional real depreciation when the pattern of foreign direct investments varies substantially across countries.

Consider for instance the case of unilateral direct investments from the home country, i.e. $\Psi = 1$ and $\Psi^* = 0$. A one percent depreciation of the home currency raises home import prices by η percent while leaving foreign-currency prices unaffected. Consequently, the home real exchange rate depreciates by one percent when the degree of exchange rate pass through is zero and by γ percent when pass through is complete. A unilateral monetary expansion then reduces the purchasing power of domestic consumers, particularly so in large and relatively closed countries, namely when $\gamma \to 1$. By the same token, a depreciation of the home currency triggers a rise (depreciation) in the real exchange rate that varies between one and $1-\gamma$ percent in countries that mainly host foreign direct investments. Trade openness puts a check on the incentive to ease monetary policy in this case, as the more open the economy the higher the real depreciation. The asymmetric effects of an easing of the monetary stance in borrowing and investing countries is consistent with the empirical evidence documented in Terra (1998), showing that there is a strong negative relation between inflation and openness among highly indebted countries during the debt crisis while this correlation is not observed among creditor countries nor during the pre-crisis period.

5 Conclusions

This contribution has incorporated horizontal foreign direct investments along with exports in a new open economic macroeconomic model and has investigated the implications of the mode of foreign market access for the international transmission of policy and productivity shocks. The mode of foreign market access is shown to play a key role in explaining a number of well-known puzzling facts in international macroeconomics.

First, the paper finds that asymmetric cyclical developments, as represented by cross-country productivity differentials, trigger a permanent change in the terms of trade of countries that are characterised by a similar mode of foreign market access. Moreover, the costs and benefits of a change in domestic productivity spread their effects outside the domestic borders when the economies have strong bilateral trade ties, while mostly remaining inside the domestic borders in case of large bilateral investments flows. Since foreign direct investments effectively shut down the terms of trade channel of international cyclical transmission, the cross-country correlation of consumption is shown to be less than the correlation of output among highly integrated economies, as it appears in the data for most industrialised countries. The terms of trade between countries that mainly host foreign direct invetments and the source countries, on the other hand, are found to be almost invariant to country-specific shocks. This implies that despite lower trend productivity, less developed countries need not experience a secular deterioration in their terms of trade relative to the developed world, as it appears in long-horizon terms of trade data for the two groups of countries.

Second, the paper finds that nominal exchange rate overshooting (or undershooting) occurs in a globalised world with nominal rigidities, as a result of short-run capital flows due to profit transfers across countries. Moreover, short-run excess volatility in nominal exchange rates is positively associated with real exchange rate volatility and the correlation between the two variables crucially depends on the pattern of foreign direct investments. In the source countries, a depreciation of the home currency triggers a less than proportional real depreciation and the more so the more open the economy. The opposite is true in host countries, where nominal and real exchange rates are almost perfectly correlated when trade openness is very high.

Our analysis can be extended along at least two directions. First, the model can be easily amended so as to consider the role of monetary insitutions, such as the exchange rate regime or the degree of monetary conservativenness, in the choice of the most convenient way to serve foreign customers. Second, modelling the entry behaviour in foreign markets is a priority in this research program: times are ripe for bridging the gap between trade and mon-

etary theory and considering the whole variety of modes of foreign market access in a world with nominal rigidities.

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