

Productivity, terms of trade and the ‘home market effect’*

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Abstract

This paper analyzes the international transmission and welfare implications of productivity gains and changes in market size when macroeconomic adjustment occurs both along the intensive margin of trade (changes in the relative price of existing varieties of tradable goods) and the extensive margin (creation and destruction of varieties). We draw a distinction between productivity gains that enhance manufacturing efficiency and gains that lower the cost of firms' entry and of product differentiation. Countries with lower manufacturing costs have higher GDP but supply their products at lower international prices. Instead, countries with lower entry costs supply a larger array of goods at improved terms of trade. Output growth driven by demographic expansions, as well as government spending, is associated with an improvement in international relative prices and firms' entry. While trade liberalization may result in a smaller array of goods available to consumers, efficiency gains from deeper economic integration benefit consumers via lower goods prices. The international transmission mechanism and the welfare spillovers vary under different asset market structures, depending on trade costs, the elasticity of labor supply, and consumers' taste for varieties.

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1 Introduction

A common view in trade and growth theory is that an increased supply of domestic goods is associated with the deterioration of a country's terms of trade, as the additional domestic supply is absorbed by international markets at falling prices. By the same token, stronger internal demand for domestic output reduces a country's supply of exports and improves its international prices. A key welfare implication is that domestic productivity gains are transmitted positively to the country's trading partners worldwide, thanks to changes in relative prices.¹ If the set of goods that a country produces and exports change over time, however, the tenet that a growing economy must experience weaker terms of trade is questionable. As argued by Krugman (1989), when domestic producers take advantage of enhanced productivity to change the attributes of their products, that country may enjoy the benefits of technological progress without experiencing any fall in its international prices.

Recent contributions to the literature have revisited the traditional wisdom from both a theoretical and empirical standpoint. The conventional view is espoused by Acemoglu and Ventura (2002), who emphasize that the association of capital accumulation with deteriorating terms of trade is an important factor contributing to a stable world income distribution. Yet, their empirical analysis unveils a positive correlation between terms of trade and human capital, interpreted as a proxy for product innovation. Hummels and Klenow (2005) document that richer countries tend to export more product varieties and benefit from stronger terms of trade.² This finding is corroborated by country-studies such as Kang (2004) for Korea. The quantitative analysis by Ghironi and Melitz (2005) also predicts terms of trade appreciation in response to productivity shocks which symmetrically reduce production costs and the costs of firms' entry. In the VAR analysis in Corsetti, Dedola and Leduc (2005, 2006), productivity shocks (identified via long-run restrictions) tend to improve terms of trade and the real exchange rate in the case of large countries such as the U.S. and Japan.³

¹This pattern of international transmission is clearly consistent with the Harrod-Balassa-Samuelson hypothesis, according to which countries with higher productivity growth in the tradable sector experience an increase in the relative price of their nontradable goods. Provided that the elasticity of substitution across tradables produced at home and abroad is sufficiently high, these countries will also experience an appreciation of their real exchange rates. Thus high productivity growth in tradables may simultaneously cause appreciation of the real exchange rate and weakening of the terms of trade.

²The role of goods variety in international trade is emphasized in Gagnon (2003), which documents that the growth of U.S. bilateral manufactured imports is strongly correlated with the average growth rate of GDP of the exporting countries. This study provides evidence that the puzzling differences in estimated income elasticities of imports and exports across countries, as pointed out by Houthakker and Magee (1969), may be attributed to the omission of variety effects in import demand.

³These papers also analyze in detail wealth and crowding out effects of productivity shocks in standard dynamic general-equilibrium models, emphasizing alternative mechanisms through which positive supply shocks can lead to terms of trade appreciation depending on trade elasticities and the degree of shock persistence.

Table 1: Growth in GDP and R&D and the terms of trade

Regression	(1)	(2)	(3)	(4)	(5)	(6)
GDP growth	-.039 (.102)		-.270 ^c (.140)	.348 ^c (.178)		.078 (.205)
R&D growth		.107 ^b (.050)	.138 ^a (.051)		.139 ^b (.062)	.132 ^b (.06)
<i>N</i>	80	77	77	80	77	77
<i>R</i> ² within	.06	.08	.04	.06	.08	.09
<i>R</i> ² between	.21	.004	.36	.21	.004	.005

Left hand side variable is the price of exports divided by price of imports. Standard errors in brackets with ^a, ^b and ^c respectively denoting significance at 1%, 5% and 10% levels. Estimation method: (1)-(3): Random-effects GLS; (4)-(6): Fixed effects. Constants and country dummies not shown. Source: OECD.

Debaere and Lee (2004) explicitly select R&D expenditure and per capita GDP relative to a country’s trading partners as empirical proxies for growth in product varieties. The results from their large panel analysis suggest that terms of trade indeed improve in response to these variables. Their findings can be interpreted as evidence in support of the view that productivity improvements affect trade volumes, terms of trade, and the real exchange rate differently, depending on whether they reduce the cost of producing existing goods as opposed to the cost of creating new varieties and firms.

In the same spirit as the panel studies quoted above, in Table 1 we report a panel regression for 20 OECD countries over the period 1980-2004.⁴ As we are interested in trend relations between output supply and international prices, the dependent variable in our regressions is the growth rate of the five-year average of the price of exports in terms of imports — which is the inverse of the terms of trade as defined in our analysis below. The first column in Table 1 shows that the correlation between GDP growth and (the inverse of the) terms of trade growth is not statistically significant. In the second column we replace the growth rate of GDP with the growth rate of gross domestic expenditure on R&D, a proxy for the growth of product variety.⁵ This regression suggests that there is a positive and significant (at the 5% level) relation between growth of domestic R&D and the relative price of exports. Next, we include both GDP and R&D growth rates. As shown in the third

⁴Australia, Austria, Belgium, Canada, Switzerland, Denmark, Spain, Finland, France, United Kingdom, Ireland, Italy, Japan, Korea, Netherlands, Norway, New Zealand, Portugal, Sweden, United States. We excluded countries with missing data prior to 1990, as well as Iceland, which is an outlier for R&D growth.

⁵Evidence that countries that conduct more R&D are more likely to export new products is emphasized in Broda, Greenfield and Weinstein (2006).

column, output growth has a negative impact on relative export prices (and significant almost at the 5% level), while R&D growth has a positive and significant effect (at the 1% level). We then use country fixed effects to control for unobserved country characteristics that may affect the behavior of their terms of trade. In this case, GDP growth is weakly positively correlated with relative export prices. But the positive and significant correlation with the growth rate of R&D remains robust. At a very minimum, these results suggest that the conventional view of the relation between growth and terms of trade does not tell the whole story.

As a tool to approach the current theoretical and empirical debate, this paper builds a stylized welfare-based macroeconomic model of international price adjustment. We specify a two-country world economy with an endogenous set of goods supplied by imperfectly competitive firms. Our model allows for transaction costs in international trade which raise the cost of imported goods and induce home bias in consumption, generating deviations from purchasing power parity (PPP) even though all goods are tradable. In response to country-specific changes in productivity and market size, macroeconomic adjustment occurs both along the intensive margin of trade (changes in relative prices of existing varieties of tradable goods) and the extensive margin (creation and destruction of varieties).

Our model thus encompasses the main elements of trade models that study the interaction between the ‘home market effect’⁶ and product innovation.⁷ Relative to this literature, especially the recent contribution by Ghironi and Melitz (2005), there are however three notable distinctions. First, we model endogenous labor supply. Second, we parameterize love for variety and study its positive and welfare implications. Third, we explicitly analyze the role of asset markets, contrasting the extreme cases of financial autarky and complete markets, and discuss how different degrees of international consumption risk insurance affect the international transmission mechanism. We do not model nontradable goods (thus our analysis does not encompass Harrod-Balassa-Samuelson effects) and deliberately focus on a static framework, abstracting from heterogeneity in productivity or trade costs and other microeconomic complexities. Our approach is meant to provide a tractable framework to carry out explicit welfare analyses, with emphasis on the macroeconomic implications of

⁶See e.g. Krugman (1980) and Helpman and Krugman (1985). When product markets are imperfectly competitive and internationally segmented, local demand conditions have a different impact on the profits of firms located in different countries. Because of trade costs, firms producing in the market with the stronger demand can take advantage of local market conditions better than firms producing elsewhere. Without entry, profits for the firms located in the country with the larger markets would increase relative to firms abroad. When entry is possible, the stronger market conditions induce the creation of new firms producing new varieties. According to the ‘home market effect’, a change in demand for domestically produced goods raises the number of varieties more than proportionally, and/or raises domestic factor prices.

⁷Contributions to this recent but fast-growing literature include Bergin and Glick (2003), Bernard, Eaton, Jenson and Kortum (2004), Melitz (2003), Ghironi and Melitz (2005) and Yeaple (2005) among others.

different factors driving output expansions.

Our main results are as follows. The international transmission and welfare implications of productivity growth crucially depend on whether such growth reduces the marginal costs of producing goods or the costs of creating new firms and varieties. Consistent with the conventional wisdom, a country that gains efficiency in manufacturing expands its output and exports, but experiences a deterioration of its terms of trade. In contrast, the terms of trade improve with product diversification driven by efficiency gains in setting up new firms and changing goods' attributes. To the extent that productivity gains in manufacturing and innovation activities are highly correlated, growth tends to be associated with stronger terms of trade.

Moreover, the macroeconomic impact of efficiency gains that reduce entry costs is similar to that of changes in market size — for a given level of GDP per capita, countries with a larger population tend to have stronger terms of trade. In accord with the new trade and geography literature, in our model output growth driven by demographic expansion is associated with an improvement in international relative prices. Similarly, firms' entry and terms of trade are enhanced by domestic demand due to government expenditure.

When a country improves its international prices via product diversification, its trade partners are hurt by higher import prices, but they benefit from the availability of a large variety of goods: the welfare spillovers need not be negative. With love of variety, sufficiently low trade costs imply that equilibrium changes in domestic varieties available to foreign consumers more than compensate the adverse movements in their terms of trade.⁸

Likewise, while trade liberalization benefits consumers via lower goods prices, efficiency gains from deeper economic integration may result in a smaller array of goods available to consumers. This raises the issue of whether world welfare could fall if consumers highly value variety — a point often stressed in the debate on the effects of globalization. We show that, for any degree of love for varieties, the gains from lower prices are always larger than the costs associated with a possible contraction in the set of goods supplied worldwide.

Finally, the transmission mechanism and especially the adjustment along extensive margins vary under different assets market structures. Under incomplete markets (which, in our static framework, we model as financial autarky), equilibrium wealth effects tend to dampen the magnitude of extensive margin adjustment in response to productivity gains. It is not necessarily true that the more productive countries supply more goods variety in

⁸These considerations raise important issues regarding the definition and use of appropriate welfare-based price indices, as their product baskets should reflect variations in the array and quality of goods available to consumers (a point stressed by Feenstra (1994) and more recently by Broda and Weinstein (2004a,b) among others).

equilibrium. With complete markets, instead, income transfers contingent on these gains reduce the magnitude of international price movements relative to the case of financial autarky, but magnify the equilibrium adjustment in varieties. In this case, variety production always concentrate in the more productive countries, independently of the type of productivity advantage (whether this corresponds to lower marginal costs or lower entry costs). The magnitude of these effects are sensitive to the elasticity of labor supply, especially in the case of perfect consumption insurance. A low elasticity tends to mute the response in variety to productivity gains, while amplifying their effect on prices.

The paper is structured as follows. Section 2 presents the model setup. Section 3 discusses its equilibrium properties. Section 4 analyzes productivity differentials. Section 5 studies asymmetries in market size, including the role of government spending. Section 6 considers some extensions of the models, focusing on the role of asset markets and the elasticity of labor supply. Section 7 sheds light on the welfare results with the help of simple numerical simulations. Section 8 concludes.

2 The model

The world economy consists of two countries, Home and Foreign — Foreign variables are denoted with a star. In each country there are households, firms, and a government.

There are L households in the Home country and L^* households in the Foreign country. Households consume a basket of differentiated tradable goods. They love variety of goods: they demand any ‘brand’ of both domestically-produced and imported goods available in the market. They supply labor to domestic firms only, and own claims on domestic firms’ profits. Labor is not mobile across borders.

Firms in each country produce goods for both the domestic and the export markets using domestic labor. The product varieties supplied by firms operating in the Home country are defined over a continuum of mass n and indexed by $h \in [0, n]$. Similarly, Foreign varieties are indexed by $f \in [0, n^*]$. The number of varieties produced in each country is endogenously determined in the model. There is free entry in the goods sector, but firms face fixed entry costs to start production of a particular variety. The entry costs consist of wages paid to the labor employed in developing the good and setting up the production line. Firms in both countries operate under conditions of monopolistic competition, so that each firm produces one variety only.⁹ Hence, an increase in n corresponds to both the introduction of

⁹From the vantage point of a new firm, producing a brand h or f already supplied by other firms is never more profitable than introducing a new good variety. Hence, in equilibrium firms are monopolistic suppliers of one good only.

new varieties in the Home country and the creation of new Home firms.

Governments are assumed to purchase goods from national firms only. They finance their expenditures G and G^* with lump-sum net taxes.

In this and the following three sections, we develop our analysis assuming financial autarky, i.e., an extreme case of incomplete asset markets at the international level. In Section 6, however, we will reconsider our results under the assumption of complete markets.

Throughout the paper, we find it convenient to choose the Home and Foreign wage as the numeraire in the Home and Foreign country, respectively. It follows that the exchange rate is defined as the relative price of Foreign labor in terms of Home labor units.

2.1 Firms

To produce final goods for the domestic and the export markets, firms have access to a technology which is linear in labor. The production function of the representative Home firm producing a specific variety h is:

$$Y(h) = \alpha \ell(h) \tag{1}$$

where $Y(h)$ is the output of variety h , $\ell(h)$ is labor used in its production, and α is a country-specific labor productivity innovation that is common to all Home firms.

To start the production of a variety h in the Home country, a firm needs to employ $1/\nu$ units of Home labor. The firm thus faces a fixed cost $q(h)$:

$$q(h) = w/\nu = 1/\nu \tag{2}$$

where w is the wage rate — normalized to one — and ν is labor productivity in the activities required to start a firm.¹⁰ Efficiency in setting up a firm does not necessarily coincide with productivity in manufacturing. Thus, in general α differs from ν .

Variety h is sold to domestic agents (both private and public) or exported to households overseas. Shipping goods abroad entails transportation ‘iceberg’ costs, denoted by τ and expressed in units of the export good. The resource constraint for variety h is therefore:

$$Y(h) \geq LC(h) + (1 + \tau) L^* C^*(h) + G(h) \tag{3}$$

where $C(h)$ is consumption of good h by the representative Home resident, $C^*(h)$ is consumption of good h by the representative Foreign resident, and $G(h)$ is Home government purchases of good h .

¹⁰Alternative parameterizations of the entry costs would leave substantially unaltered our qualitative results. For instance, one could consider a convex entry cost as an increasing function of the overall number of varieties. In this case the Foreign entry cost would depend on the number of Home varieties, adding a negative international spillover to the analysis.

Let $p(h)$ denote the price of one unit of good h sold in the domestic market, and $p(f)$ the price of imports f , both expressed in terms of domestic wages. Similarly $p^*(h)$ is the price of variety h imported by the Foreign country and $p^*(f)$ is the price of variety f sold in the Foreign country, both expressed in terms of Foreign wages. Let ε denote the exchange rate, defined as the relative price of Foreign labor in terms of Home labor units. Using the above notation, Home operating profits in domestic labor units are:

$$\Pi(h) \equiv p(h) LC(h) + \varepsilon p^*(h) L^* C^*(h) + p(h) G(h) - \ell(h) \quad (4)$$

Similar expressions hold for the Foreign country.

2.2 Households and government

The utility of the representative national household is a positive function of consumption C and a negative function of labor effort ℓ . As household preferences are defined over a very large set of goods, utility is a well-defined (and non-decreasing) function of all goods available in the market. Namely, C is a composite good that includes all varieties:

$$C = A \left[\int_0^n C(h)^{1-\frac{1}{\sigma}} dh + \int_0^{n^*} C(f)^{1-\frac{1}{\sigma}} df \right]^{\frac{\sigma}{\sigma-1}} \quad (5)$$

and, following Benassy (1996), the term A is defined as:

$$A \equiv (n + n^*)^{\gamma - \frac{\sigma}{\sigma-1}} \quad (6)$$

In the expressions above, σ denotes the elasticity of intratemporal (i.e., across varieties) substitution, with $\sigma > 1$, and the parameter γ measures the degree of consumers' love for variety. Precisely, $\gamma - 1$ represents the marginal utility gain from spreading a given amount of consumption over a basket that includes one additional goods variety. Assuming that this marginal utility of variety is non negative implies $\gamma \geq 1$.

Consumers' preferences for variety play an important role in our analysis of international welfare spillovers in Section 7. Note that if we set $\gamma = \sigma / (\sigma - 1)$, expression (5) is equivalent to the standard Dixit-Stiglitz consumption index. In this case, the marginal utility of variety is $1/(\sigma - 1)$, i.e., it is strictly tied to the elasticity of substitution σ (which in equilibrium determines the size of the markups in the product market). However, vis-à-vis the goals of our study, there is no particular reason for restricting the analysis to this case. Thus, the formulation we adopt allows for a separate treatment of different dimensions of consumers' preferences.¹¹

¹¹See the discussion in the working paper version (1974) of Dixit and Stiglitz (1977), as well as in Benassy (1996). An issue with Benassy's specification is that introducing a new variety has an external effect on the utility derived from existing varieties. While this externality in preferences does not play any qualitative role in our welfare results, it should not be overlooked in quantitative studies.

Domestic households entirely own domestic firms. They finance the fixed costs of setting up firms and introducing goods varieties. Denoting these costs by I for the Home country, we can write:

$$I \equiv \int_0^n q(h) dh \quad (7)$$

In return, each Home household receives an equal share of profits of all firms in the domestic economy:

$$\Pi \equiv \int_0^n \Pi(h) dh \quad (8)$$

In addition, they earn labor income ℓ and pay taxes T , assumed to be lump sum. In financial autarky, the budget constraint for the representative Home household is therefore:

$$\int_0^n p(h) C(h) dh + \int_0^{n^*} p(f) C(f) df + I \leq \ell + \Pi - T \quad (9)$$

Similar expressions hold for the Foreign representative household.

Positing a separable utility function of the form:¹²

$$U = \frac{C^{1-\frac{1}{\psi}}}{1-\frac{1}{\psi}} - \ell \quad (10)$$

with ψ symmetric across countries, the optimal choice of $C(h)$, $C(f)$, and ℓ by the representative Home household satisfies:

$$C(h) = A^{\sigma-1} \left(\frac{p(h)}{P} \right)^{-\sigma} C, \quad C(f) = A^{\sigma-1} \left(\frac{p(f)}{P} \right)^{-\sigma} C \quad (11)$$

and:

$$PC^{1/\psi} = w = 1 \quad (12)$$

where P is the utility-based consumer price index (CPI), defined as the minimum expenditure required to purchase one unit of the basket C :

$$P = \frac{1}{A} \left[\int_0^n p(h)^{1-\sigma} dh + \int_0^{n^*} p(f)^{1-\sigma} df \right]^{\frac{1}{1-\sigma}} \quad (13)$$

Note from (12) that the parameter ψ in (10) plays a crucial role in the choice between consumption and leisure. Also, given our choice of numeraire, movements in the CPI correspond to movements in aggregate consumption with elasticity $-\psi$, or $C = P^{-\psi}$. As domestic households provide labor in a competitive market both for firms' start-up and production activities, the resource constraint in the Home labor market is:

$$L\ell \geq \int_0^n \frac{Y(h)}{\alpha} dh + \int_0^n q(h) dh \quad (14)$$

¹²In our model we assume constant marginal disutility of labor, corresponding to an infinite Frisch elasticity of labor (the latter is defined as the elasticity of labor supply relative to the real wage, keeping constant the marginal utility of consumption). In Section 6 we show that, under financial autarky (balanced trade), our main results remain qualitatively unchanged under alternative specifications with a lower (finite) Frisch elasticity.

Similar expressions hold in the Foreign country.

We posit that the governments spend only on local varieties. The Home government budget constraint is therefore:

$$\int_0^n p(h) G(h) dh = LT \quad (15)$$

For simplicity, we assume that public demand for each specific variety has the same price elasticity σ as private demand, so that:

$$G(h) = \left(\frac{p(h)}{P_G} \right)^{-\sigma} G \quad G^*(f) = \left(\frac{p^*(f)}{P_G^*} \right)^{-\sigma} G^* \quad (16)$$

where G and G^* denote total public consumption in the two countries and P_G and P_G^* are government spending deflators which involve only prices of domestically-produced varieties.¹³

2.3 Prices

The prices charged by Home firms take the standard form of markups over marginal costs, equal in our setup to labor costs per unit of product:

$$p(h) = \frac{\sigma}{\sigma - 1} \frac{1}{\alpha} \equiv p \quad (17)$$

$$\varepsilon p^*(h) = \frac{\sigma}{\sigma - 1} \frac{1}{\alpha} (1 + \tau) = p(1 + \tau) \quad (18)$$

Similar expressions hold in the Foreign country. Note that productivity gains (higher α or α^*) lower marginal costs and reduce product prices proportionally.

The equilibrium utility-based CPIs are equal to:

$$P = p B^{\frac{1}{1-\sigma}} / A, \quad P^* = p^* B^{*\frac{1}{1-\sigma}} / A \quad (19)$$

where:

$$B \equiv n + n^* \phi (\varepsilon p^* / p)^{1-\sigma}, \quad B^* \equiv n^* + n \phi (\varepsilon p^* / p)^{\sigma-1} \quad (20)$$

and, borrowing a familiar notation from the international trade literature, $\phi \equiv (1 + \tau)^{1-\sigma}$. The parameter ϕ is positive and less than one; the case $\phi = 0$ corresponds to infinite trade costs and the case $\phi = 1$ to zero trade costs. Finally, as governments spend only on domestic varieties, in equilibrium the public consumption indices P_G and P_G^* are simply p and p^* , respectively.

¹³This specification deliberately assumes that governments do not care about variety, that is, the parameter γ in public preferences is equal to one. This has no first-order impact on our results as long as we analyze shocks around an initial equilibrium where government expenditures are zero.

In what follows, we will refer to different measures of international relative prices. The exchange rate ε measures the relative price of labor, as mentioned above. The terms of trade, TOT , measures the relative price of tradable varieties, and is defined as:

$$TOT \equiv \varepsilon p^* / p \quad (21)$$

The terms of trade provide a measure of international relative prices focused on the *intensive* margin of trade. A different measure of international prices that also accounts for the *extensive* margin of trade is the the welfare-based real exchange rate, denoted by RER and defined as:

$$RER \equiv \varepsilon P^* / P = \left(\frac{n\phi + n^*TOT^{1-\sigma}}{n + n^*\phi TOT^{1-\sigma}} \right)^{\frac{1}{1-\sigma}} \quad (22)$$

Note that, because of endogenous entry and trade costs, the CPI-based real exchange rate RER need not move in tandem with the terms of trade even though all goods are traded and no Harrod-Balassa-Samuelson effect materializes.¹⁴ In fact, without trade costs — i.e. with $\phi = 1$ — the real exchange rate would be constant in our model, and PPP would hold. But as trade costs generate home bias in consumption, asymmetric shocks induce deviations from PPP, regardless of the fact that in our framework all goods are traded.

Using (17) (and recalling that $w = w^* = 1$), it is apparent that in our economy with symmetric markups across border, the terms of trade are simply given by relative unit labor costs, i.e., $(1/\alpha)/(1/\alpha^*)$. Note that these are both average and marginal costs from the firms' vantage point. In contrast, the real exchange rate coincides with relative real wages, i.e., $(1/P)/(1/P^*)$.

3 Firms' profits and product varieties in the global economy

3.1 Free entry

To characterize the model solution, we start by using (11), (12) and (19), and write the operating profits earned by imperfectly competitive firms as follows:

$$\Pi(h) = \frac{p(h)Y(h)}{\sigma} = \frac{1}{\sigma} \left(\frac{A}{p} \right)^{\psi-1} \left[\frac{L}{B^{\frac{\sigma-\psi}{\sigma-1}}} + \phi \frac{L^* \varepsilon^\sigma (p^*/p)^{\sigma-\psi}}{B^{*\frac{\sigma-\psi}{\sigma-1}}} \right] + \frac{p}{\sigma} G \equiv \pi \quad (23)$$

¹⁴Recent literature has emphasized potential measurement problems that arise when consumption baskets are not properly constructed so as to account for changes in the number of goods varieties (see Feenstra (1994) and Broda and Weinstein (2004a,b) among others). In a similar spirit, we could keep n and n^* constant in the above expressions of P and P^* and construct a measure of real exchange rate not adjusted for changes in varieties, thus inappropriate to measure welfare changes but closer to reported statistics. This measure of real exchange rate would always move in tandem with TOT . Ghironi and Melitz (2005) carry out a numerical assessment of the gap between the welfare based real exchange rates and what they dub 'empirical exchange rates' based on price indices that do not take into account the variety effect.

Home profits depend on sales to domestic consumers, to foreign consumers, and to the government. The above expression sheds light on the role of the ‘home market effect’ in the transmission mechanism. With strictly positive trade costs (i.e., $\phi < 1$), and holding the number of varieties and relative prices constant, an increase in Home market size (an increase in L) raises operating profits at Home more than abroad. More generally, any shock that increases Home sales affects Home firms’ profits more than Foreign firms’. We return to this point below.

With free entry, optimal investment in new varieties implies that the value of a firm is equal to the cost of creating a variety, and in equilibrium this must be equal to the value of operating profits. Thus competition in the goods market implies the following *free entry conditions*:

$$q = \frac{1}{\nu} = \pi \quad (24)$$

$$q^* = \frac{1}{\nu^*} = \pi^* \quad (25)$$

In equilibrium, a fall in entry costs must translate into a corresponding fall in operating profits per firm. For a given relative wage, and positive trade costs, the mechanism of adjustment requires that a rise in the number of varieties supplied by domestic firms would reduce profits.

Note that, as profits are proportional to global sales, the entry cost pins down firms’ size. Using this result, we can write the size of each firm as a function of the ratio between productivity levels, α and ν , as well as the elasticity σ :

$$Y(h) = (\sigma - 1) \alpha / \nu \quad (26)$$

After substituting this expression in (14), it follows that Home employment per capita is $\ell = \sigma n / (L\nu)$. We can also write Home GDP as:

$$GDP = \ell L / p = (\sigma - 1) n \alpha / \nu \quad (27)$$

where GDP is measured in terms of Home goods.

3.2 Balance of payments and equilibrium

Aggregating private and public budget constraints in any of the two countries, we can write the *balance of payments* in terms of Home labor units as follows:

$$\phi A^{\psi-1} \left[\frac{p^{1-\psi} n L^* \varepsilon^\sigma (p^*/p)^{\sigma-\psi}}{B^{*\frac{\sigma-\psi}{\sigma-1}}} - \frac{p^{*1-\psi} n^* L \varepsilon^{1-\sigma} (p^*/p)^{\psi-\sigma}}{B^{\frac{\sigma-\psi}{\sigma-1}}} \right] = 0 \quad (28)$$

With financial autarky, the balance of payments coincides with the trade balance: the two terms above are Home exports less Home imports, both inclusive of trade costs.

Using the balance of payment equilibrium (28), the two free entry conditions (24) and (25), as well as the equation for Home profits (23) and its Foreign analog, it can be checked that equilibrium profits are:

$$\pi = \frac{1}{\nu} = \frac{L}{\sigma n} P^{1-\psi} + \frac{1}{\sigma} pG \quad (29)$$

$$\pi^* = \frac{1}{\nu^*} = \frac{L^*}{\sigma n^*} P^{*1-\psi} + \frac{1}{\sigma} p^* G^* \quad (30)$$

where $P^{1-\psi} = PC$ is total private domestic expenditure. The above expressions highlight how an increase in the number of varieties affects profits via consumption demand. Focus on (29). On the one hand, an increase in n raises real wages, corresponding to a fall in the price of consumption P (as defined in (13)) by $1 - \gamma$, the marginal welfare gain of goods diversity. Higher real wages lead to an increase in consumption C by $\psi(\gamma - 1)$. However, the increase in total consumption expenditure $P^{1-\psi} = PC$ depends on the sign of $(\psi - 1)(\gamma - 1)$, i.e. on the relative strength of the income and substitution effect from higher real wages on the demand for leisure. Namely, when $\psi < 1$, the income effect is dominant with higher real wages leading agents to demand more leisure and consumption demand rising by less than the fall in P ; with $\psi = 1$, instead, income and substitution effects cancel out, and PC remains constant. On the other hand, a ceteris paribus increase in the number of domestic goods implies substitution away from existing goods by -1 (as n appears in the denominator of the right hand side of (29)). Combining both considerations, the net effect is therefore given by $\psi\gamma - \gamma - \psi$, whose sign is *a priori* ambiguous.

Choosing a benchmark value for γ is not obvious, as we are not aware of any empirical/quantitative work on the subject. However, the assumption that consumers value diversity, that is, $\gamma > 1$, is not very strong. The literature adopts various benchmark values for ψ , mostly between $1/2$ and 2 . In what follows we restrict ψ such that $\sigma > \psi$ and $\psi < \gamma/(\gamma - 1)$. This reasonable parameterization insures that entry of firms leads to a fall of profits of existing firms and that a fall in the marginal cost of entry generates entry of firms.

The system of three equations (29), (30) and (28) determines the three endogenous variables ε , n and n^* as functions of the exogenous variables ν , ν^* , α , α^* , L , L^* , G and G^* for given parameters σ , ψ , γ and ϕ . It is straightforward to verify that if $\nu = \nu^* = \alpha = \alpha^* = L = L^* = 1$ and $G = G^* = 0$, there is a symmetric equilibrium such that $\varepsilon = 1$, $n = n^*$, $\ell = \ell^* = P^{1-\psi} = P^{*1-\psi} = \sigma n$, where the number of varieties produced in each country is:

$$n^{\psi+\gamma-\gamma\psi} = 2^{(\psi-1)(\gamma-\frac{\sigma}{\sigma-1})} \sigma^{-\psi} (\sigma-1)^{(\psi-1)} (1+\phi)^{(\psi-1)/(\sigma-1)} \quad (31)$$

In what follows we take a first-order approximation of the model in the neighborhood of this equilibrium and consider the local effects of variations in the exogenous variables. In our

comparative statics exercises we consider only changes to Home exogenous variables, with the understanding that similar results hold with respect to changes in Foreign variables. The total number of varieties available to households worldwide is determined according to:

$$[\psi + \gamma(1 - \psi)] \frac{dn + dn^*}{n} = \frac{dL}{L} + \frac{1}{\sigma - 1} dG - (1 - \psi) \frac{d\alpha}{\alpha} + \frac{d\nu}{\nu} \quad (32)$$

Recalling that the coefficient on the left hand side is positive, the number of varieties in the global economy unambiguously rises with a larger Home market size (L), higher Home government spending on Home goods (G), and gains in efficiency in setting up firms and creating new goods in the Home country (ν). Instead, the effects of gains in manufacturing productivity are ambiguous, depending on the value of ψ . Note however that productivity innovations affecting both manufacturing costs and entry costs symmetrically, i.e., $d\alpha/\alpha = d\nu/\nu$, unambiguously lead to global entry.¹⁵

4 Domestic and international implications of productivity differentials

4.1 Productivity gains in manufacturing

One may expect that countries experiencing higher productivity turn out to be the world suppliers of most product varieties, sold abroad at a relatively low international price. In what follows we show that, in our world where international consumption risk is not diversified efficiently, such conjecture is not necessarily verified in equilibrium.

Consider the macroeconomic effects of gains in manufacturing productivity by the Home country, i.e., an increase in α for an unchanged level of α^* . Table 2 summarizes the response of a set of macroeconomic variables in both countries. From (26), we know that at the intensive margin, Home firms unambiguously raise the scale of their production, while the scale of Foreign firms is unaffected. Thus, the amount of output supplied by each Home producer increases. However the equilibrium response of the number of varieties supplied

¹⁵Note that, depending on the interaction between love for varieties (parameterized by γ) and market power in production (parameterized by σ), the number of varieties may be too low or too high relative to the planner's optimum (see Benassy (1996)). In the symmetric equilibrium, taking the ratio of the planner's optimal number of varieties n_P to the number of varieties supplied in a market allocation, it can be shown that $(n_P/n)^{\psi + \gamma(1 - \psi)} = (\gamma - 1) \sigma^\psi (\sigma - 1)^{1 - \psi}$. The planner chooses the number of varieties depending on the marginal gain of agents from diversity, i.e., $\gamma - 1$. The private sector however chooses to introduce varieties depending on the elasticity of substitution σ that determines the monopolistic profits. The mismatch between the planner's incentive and the private incentive to introduce varieties is the explanation of the market failure. In the standard Dixit-Stiglitz case with $\gamma = \sigma/(\sigma - 1)$, the number of varieties in a market equilibrium is inefficiently low in our model, that is $n_P > n$. The reason is that with endogenous labor supply, a relative price distortion arises between consumption goods (for which a markup applies) and leisure (for which no markup applies). The marginal rate of substitution between consumption and leisure is then different from the rate at which labor and consumption can be transformed and this induces inefficiency.

Table 2: Comparative statics — Changes in productivity α

$$\frac{dn/n}{d\alpha/\alpha} = -\frac{1-\psi}{2[\psi+\gamma(1-\psi)]} - \frac{(\sigma-1)(1-\psi)}{2(\sigma-\psi)} \left[1 - \frac{2\psi(\sigma-1)\phi}{\Delta} \right] \quad (33)$$

$$\frac{dn^*/n^*}{d\alpha/\alpha} = -\frac{1-\psi}{2[\psi+\gamma(1-\psi)]} + \frac{(\sigma-1)(1-\psi)}{2(\sigma-\psi)} \left[1 - \frac{2\psi(\sigma-1)\phi}{\Delta} \right] \quad (34)$$

$$\frac{d\varepsilon/\varepsilon}{d\alpha/\alpha} = -\frac{[(\sigma-\psi)(1-\phi) + (\sigma-1)(1+\phi)](\sigma-1)}{\Delta} \in (-1, 0) \quad (35)$$

$$\frac{dTOT/TOT}{d\alpha/\alpha} = 1 + \frac{d\varepsilon/\varepsilon}{d\alpha/\alpha} > 0 \quad (36)$$

$$\frac{dRER/RER}{d\alpha/\alpha} = \frac{\psi(1-\phi)(\sigma-1)}{\Delta} > 0 \quad (37)$$

$$\frac{dP/P}{d\alpha/\alpha} = \begin{cases} \frac{1}{1-\psi} \frac{dn/n}{d\alpha/\alpha} < 0 & \psi \neq 1 \\ -\frac{2\sigma-1}{2\sigma-1+\phi} < 0 & \psi = 1 \end{cases} \quad (38)$$

$$\frac{dP^*/P^*}{d\alpha/\alpha} = \begin{cases} \frac{1}{1-\psi} \frac{dn^*/n^*}{d\alpha/\alpha} & \psi \neq 1 \\ -\frac{\phi}{2\sigma-1+\phi} < 0 & \psi = 1 \end{cases} \quad (39)$$

$$\Delta = (2\sigma-1)[\sigma-\psi(1-\phi)] - \sigma\phi > 0 \quad (40)$$

by either Home firms or Foreign firms is ambiguous, as shown by equations (33-34): high-productivity countries need not produce and export a larger array of goods than their low-productivity trading partners. To gain insight on this result, contrast the micro and macro dimensions of the transmission mechanism. From the vantage point of an individual Home firm, productivity gains that reduce the marginal costs of production represent an opportunity to expand its market share and profits via a reduction in the price of its product. However, as the improvements in productivity affect the domestic economy as a whole, all Home firms experience the same fall in marginal costs: thus, they all compete with each other by cutting prices, which results in higher real wages.

The response of demand to this economy-wide fall in prices is crucial for the equilibrium outcome. As discussed above, a fall in the price of consumption affects aggregate consumption demand with elasticity ψ . When this elasticity is below one, a strong wealth effect on the demand for leisure leads to a less than proportional expansion in the demand for

consumption goods. Thus, lower prices translate into lower profits for the Home firms. As profits are now insufficient to cover the unchanged entry costs, some firms exit the Home market reducing the number of Home-produced varieties. Conversely, when $\psi > 1$, a fall in prices raises demand more than proportionally, driving up profits and therefore the number of varieties supplied in equilibrium. There is no change in Home varieties when $\psi = 1$.¹⁶

So, the above analysis suggests that gains in productivity may have either no effects, or even negative effects, on the array of varieties produced in a country, depending on the interplay of wealth effects and labor supply responses. While the adjustment at the intensive margin squares well with the theoretical presumption that production should rise in regions that are more efficient in manufacturing, adjustment at the extensive margin can actually go the other way around.

The international impact of productivity gains can be synthetically characterized by looking at the effects of α on the three international prices ε , TOT and RER . The relative price of labor ε unambiguously appreciates, as shown in (35): Home labor becomes more expensive in response to productivity improvements in domestic manufacturing. This effect is stronger when trade costs are relatively high, implying that demand movements are stronger at Home than abroad. But even though the Home factor becomes more expensive in the world economy, the prices of Home varieties unambiguously fall with productivity gains: the appreciation of the relative price of labor is not enough to compensate for the direct effect of higher productivity on the marginal costs, and the terms of trade of the Home country deteriorate:

$$1 > \frac{dTOT}{d\alpha} = 1 + \frac{d\varepsilon/\varepsilon}{d\alpha/\alpha} > 0 \quad (41)$$

While TOT captures only the effects of changes in international prices along the intensive margin of trade, the real exchange rate RER also accounts also for changes in the structure of production across trading partners. In our case RER depreciates with a rise in α , moving in the same direction as the terms of trade but in the opposite direction as relative labor costs (see (37)).¹⁷ Underlying the real depreciation is the fact that the Home welfare-based price index P unambiguously falls (see (38)), by more than the relative appreciation of ε — Home productivity gains in manufacturing unambiguously raises domestic consumption both in absolute terms and relative to Foreign consumption. Note that this result holds

¹⁶In our model, all firms supply goods to both the domestic and the foreign markets, hence entry and exit at national level correspond one-to-one to entry and exit in the export markets. If we allowed for firm-specific productivities and fixed export costs (as in Ghironi and Melitz (2005)), some goods could become endogenously non-traded in equilibrium, depending on prices and productivity levels. In this case, entry and exit in the export markets would differ from entry and exit of firms located in the Home country.

¹⁷Observe that, as our model does not include nontradables, there is no possibility of real appreciation according to well-known Harrod-Balassa-Samuelson effects.

Table 3: Comparative statics — Changes in productivity ν

$$\frac{dn/n}{d\nu/\nu} = \frac{1}{2[\psi + \gamma(1 - \psi)]} + \frac{(\sigma - 1)}{2(\sigma - \psi)} \left[1 + \frac{2\psi\phi(1 - \psi)}{\Delta} \right] > 0 \quad (42)$$

$$\frac{dn^*/n^*}{d\nu/\nu} = \frac{1}{2[\psi + \gamma(1 - \psi)]} - \frac{(\sigma - 1)}{2(\sigma - \psi)} \left[1 + \frac{2\psi\phi(1 - \psi)}{\Delta} \right] \quad (43)$$

$$\frac{d\varepsilon/\varepsilon}{d\nu/\nu} = \frac{dTOT/TOT}{d\nu/\nu} = -\frac{(\sigma - \psi)(1 - \phi) + (\sigma - 1)(1 + \phi)}{\Delta} < 0 \quad (44)$$

$$\frac{dRER/RER}{d\nu/\nu} = \frac{\psi(1 - \phi)}{\Delta} > 0 \quad (45)$$

$$\frac{dP/P}{d\nu/\nu} = \begin{cases} \frac{1}{1 - \psi} \left(\frac{dn/n}{d\nu/\nu} - 1 \right) < 0 & \psi \neq 1 \\ -\frac{1}{2}(\gamma - 1) - \frac{2\sigma - 1 - \phi}{2(2\sigma - 1 + \phi)(\sigma - 1)} < 0 & \psi = 1 \end{cases} \quad (46)$$

$$\frac{dP^*/P^*}{d\nu/\nu} = \begin{cases} \frac{1}{1 - \psi} \frac{dn^*/n^*}{d\nu/\nu} & \psi \neq 1 \\ -\frac{1}{2}(\gamma - 1) + \frac{2\sigma - 1 - \phi}{2(2\sigma - 1 + \phi)(\sigma - 1)} & \psi = 1 \end{cases} \quad (47)$$

whether or not the number of Home varieties increases (i.e., whether or not ψ is above or below one). In the Foreign country, the equilibrium effects of Home productivity gains on the level of consumption and real wages can actually have either sign — in general, the response of the welfare-based price index P^* to changes in α is ambiguous. The international transmission is however positive, so that Foreign consumption and real wages improve, in the logarithmic case with $\psi = 1$.¹⁸

4.2 Efficiency gains in creating new firms and new goods

How would our results change if productivity gains mainly affected firms' ability to develop new products, as captured by a rise in ν ? An analysis of these types of effects is obviously absent in standard models without entry. Our main results are reported in Table 3.

A higher ν reduces the costs of creating firms and introducing new varieties relative to the cost of manufacturing goods. From equations (32) and (26) in the previous section, we know that lower entry costs raise the number of varieties supplied at the global level and that the scale of Home firms production falls. The effects on the geographical location of

¹⁸If we used a constant-variety real exchange rate measure not adjusted for endogenous changes in n and n^* , the effect of a manufacturing productivity innovation would still be a depreciation, but at a lower rate.

production are given by equations (42-43). The response of Home varieties is unambiguously positive: more goods are produced by the Home country. In the log utility case, i.e., with $\psi = 1$, the number of varieties increases one to one with the reduction in entry cost. In the Foreign country, instead, the response of n^* is generally ambiguous — there is no response in the log-utility case.

Contrast the two types of productivity improvements. With a larger α , higher productivity translates into lower prices and a larger scale of production by each individual firm in the Home country, leaving profits (and varieties if $\psi = 1$) unchanged. With a larger ν , lower entry costs raise the array of varieties produced in a country but reduce the equilibrium profits and the scale of firms' production, leaving prices unchanged as marginal costs and therefore p and p^* are not affected by ν .¹⁹

Given product prices, the terms of trade move one-to-one with the relative labor costs ε , which appreciate (see (44)) with the upsurge of the relative demand for Home labor. Hence the Home terms of trade strengthen as the array of Home products increases. Nonetheless, as in the previous case, the welfare-based real exchange rate *RER* actually depreciates. A weaker real exchange rate reflects the unambiguous drop in the price of Home consumption P — thus the rise in Home consumption and real wages. A lower P is driven by two factors: higher availability of product varieties (which, other things equal, reduces the welfare-based CPI) and lower import prices (reflecting cheaper Foreign labor).²⁰

The response of the Foreign CPI to Home productivity gains is again ambiguous. In the log-utility case it is easy to see that the Foreign price index falls when trade costs and/or love for variety are sufficiently low. In these cases Foreign consumers face higher import prices, but these adverse terms of trade effects on the welfare-based price index P^* are more than compensated by the availability of a higher array of goods.

4.3 Productivity, GDP growth and terms of trade

Bringing the previous results together allows us to analyze in some detail the relation between output and international relative prices. While distinguishing between α -type and

¹⁹In our model goods price elasticities do not depend on the number of firms and varieties. One may consider an extension of the model establishing such a link for example with oligopolistic competition. Two effects would likely coexist in this case. On the one hand, Home entry would still occur, which, as long as goods are imperfect substitutes, would still push up terms of trade. On the other hand, the increase in the price elasticity would lead to lower prices because of stronger competition. However, the increased competition would affect both Home and Foreign producers and therefore Home and Foreign prices. It is therefore likely that the terms of trade effect would remain similar.

²⁰It follows that, when productivity affects the cost of creating new varieties, the sign of our comparative statics results does crucially depend on which measure of real exchange rate is used. In fact, a measure of the real exchange rate based on price indices that fail to account for changes in the number of varieties would move in the *opposite* direction relative to the welfare-based real exchange rate. In other words, it would point to a real appreciation.

ν -type productivity can be a difficult and challenging empirical task, the two sources of productivity have widely different implications for the size and sign of terms of trade movements and their correlation with GDP as defined in (27) above.

Consider for simplicity the log-utility case, $\psi = 1$. In this case we have:

$$\frac{dGDP/GDP}{d\alpha/\alpha} = 1 \qquad \frac{dGDP/GDP}{d\nu/\nu} = 0 \qquad (48)$$

Home real GDP grows in response to an increase in α . Changes in ν do lead to an increase in the number of products, but this is exactly offset by a reduction in the scale of production $Y(h)$.²¹

We have seen above that the terms of trade deteriorate in response to an increase in productivity that lowers marginal costs in production, while they improve if productivity gains reduce the cost of firms' entry. The latter effect dominates if productivity gains are sufficiently correlated: in the polar case $d\alpha = d\nu$ (corresponding to the restriction on productivity shocks implicit in Ghironi and Melitz 2005), terms of trade improve by $\psi(\sigma - 1)(1 - \phi)/\Delta$, where $\Delta > 0$ is defined in (40). This effect is stronger the higher the trade costs are, i.e., the lower is $\phi < 1$. It vanishes in the absence of trade frictions ($\phi = 1$). These results clearly challenge the standard prediction that higher growth rates should be associated with deteriorating terms of trade, and provide a theoretical framework to approach and conceptualize the empirical results surveyed in the introduction.

5 Market size and trade reforms

In its original formulation, which can be traced back to Krugman (1980) and Helpman and Krugman (1985), the 'home market effect' refers to a more-than-proportional increase in the number of varieties produced domestically following an increase in market size. Krugman (1980) also showed that, in the presence of trade costs, the larger market could sustain higher wages. Hence, market size can have both a quantity and a price effect. In what follows we reconsider this effect by analyzing market size asymmetries in the context of our general-equilibrium model. We first look at asymmetries in market size due to differences in population, then we allow for home-biased government spending; we finally look at the effect of reforms reducing the trade costs. One important difference with respect to the trade literature is that we model labor supply as endogenous. Another important difference — discussed in a later section — is that we vary the assets market structure.

²¹Observe that the measure of GDP employed in the above expressions does not account for terms of trade effects nor for changes in the availability of varieties. If we measured output in terms of consumption baskets rather than domestic units, real GDP would grow following an improvement in either α or ν .

Table 4: Comparative statics — Changes in population size L

$$\frac{dn/n}{dL/L} = \frac{1}{2[\psi + \gamma(1 - \psi)]} + \frac{(\sigma - 1)}{2(\sigma - \psi)} \left[1 + \frac{2\sigma\phi(1 - \psi)}{\Delta} \right] > 0 \quad (49)$$

$$\frac{dn^*/n^*}{dL/L} = \frac{1}{2[\psi + \gamma(1 - \psi)]} - \frac{(\sigma - 1)}{2(\sigma - \psi)} \left[1 + \frac{2\sigma\phi(1 - \psi)}{\Delta} \right] \quad (50)$$

$$\frac{d\varepsilon/\varepsilon}{dL/L} = \frac{dTOT/TOT}{dL/L} = \frac{-(1 - \phi)}{[2\sigma - \psi(1 - \phi)]} \left[1 - \frac{\sigma(1 - \phi)(1 - \psi)}{\Delta} \right] < 0 \quad (51)$$

$$\frac{dRER/RER}{dL/L} = \frac{(1 - \phi)}{(\sigma - \psi)(1 - \phi) + (\sigma - 1)(1 + \phi)} \left(1 - \psi \frac{d\varepsilon/\varepsilon}{dL/L} \right) > 0 \quad (52)$$

$$\frac{dP/P}{dL/L} = \begin{cases} \frac{1}{1 - \psi} \left(\frac{dn/n}{dL/L} - 1 \right) < 0 & \psi \neq 1 \\ -\frac{1}{2}(\gamma - 1) - \frac{(2\sigma - 1)(1 - \phi)}{2(2\sigma - 1 + \phi)(\sigma - 1)} < 0 & \psi = 1 \end{cases} \quad (53)$$

$$\frac{dP^*/P^*}{dL/L} = \begin{cases} \frac{1}{1 - \psi} \frac{dn^*/n^*}{dL/L} & \psi \neq 1 \\ -\frac{1}{2}(\gamma - 1) + \frac{(2\sigma - 1)(1 - \phi)}{2(2\sigma - 1 + \phi)(\sigma - 1)} & \psi = 1 \end{cases} \quad (54)$$

5.1 Labor force and private expenditure

In many dimensions, the macroeconomic implications of a larger Home market (a larger L) are similar to those of productivity gains in ν . First, an increase in L raises the number of varieties produced worldwide (see equation (32)) and at Home; however, its effects on the varieties produced abroad is ambiguous (see equations (49-50) in Table 4). Observe that, when the utility from consumption is logarithmic ($\psi = 1$), L raises n one-to-one, but leaves n^* unaffected. Home output correspondingly increases.

Second, a larger Home market appreciates the price of Home labor relative to its Foreign counterparts, thus improving the Home terms of trade (see equation (51)). Hence, the ‘home market effect’ here takes the form of a terms of trade appreciation, as in the Krugman (1980) model. However, note that the TOT effect vanishes when trade costs approach zero (ϕ goes to 1), in which case PPP holds and the terms of trade and relative factor prices are constant: the increase in imports due to a larger market is exactly compensated — at unchanged prices — by the increase in Home exports following the creation of new varieties.

Last, as was the case with changes in ν , a larger market size unambiguously depreciates the Home real exchange rate. The international price of consumption thus moves in the

opposite direction relative to the international price of products (a weaker real exchange rate corresponds to stronger terms of trade).²² Because of the wider array of goods available to consumers and the Home currency appreciation, the Home welfare-based CPI falls and the Home consumption rises. The impact on the Foreign price index and consumption is ambiguous in general. It is negative in the log-utility case, provided trade costs are low enough and/or consumers have a strong taste for variety. In this case, the increase in the global number of varieties more than compensates for the deterioration of the Foreign country's terms of trade.

In sum, by enlarging the domestic market size, faster demographic dynamics not only boosts growth of aggregate output, but also stimulates product diversification and appreciates the country's terms of trade.

5.2 Government spending

A variety of models predict that government spending strengthens the terms of trade. Our stylized general-equilibrium model singles out the specific role of endogenous varieties effects in driving this result.²³ The main idea is that, as government spending is biased towards Home goods, public demand strengthens the competitive position of domestic producers by creating a larger market for their products. Table 5 summarizes our main findings.

Equations (55-56) show that, under standard assumptions on elasticities, larger government spending is associated with a higher number of goods varieties produced in the Home country. The number of goods varieties in the Foreign country can either fall or increase. As discussed above, when trade costs are low enough (ϕ is high enough), firms will profitably locate production in the high-demand country and export to the other market.

Changes in government spending have qualitatively similar implications for output growth and the terms of trade as do changes in ν or L . Overall, countries with higher (home-biased) government spending tend to produce more varieties, have stronger terms of trade, and experience higher employment. Interestingly, Home consumption does not necessarily fall: in the log case, for instance, Home households enjoy a fall in the price of consumption.²⁴

²²If we computed the real exchange rate ignoring changes in the number of available varieties, a larger market size would result in a real appreciation. Once again, to the extent that actual price indices are not adjusted for varieties effects, the available statistics may provide misleading evidence.

²³Note that the effects of public spending are qualitatively different from the effects of asymmetric country sizes discussed above, in at least two important respects. First, differences in L affect both goods demand and the labor force — the latter effect is obviously absent in an analysis of government spending G . Second, we assume that public consumption falls entirely on domestically produced goods, while the (endogenous) home bias in private consumption expenditure associated with an increase in L is much less pronounced.

²⁴The sign of the impact of higher government demand on the welfare-based CPI is generally ambiguous both at Home and in the Foreign country (see equations 59-60). In the log-utility case, however, the CPI unambiguously falls in both countries. In fact, the Home price index falls relative to the Foreign index

Table 5: Comparative statics — Changes in government spending G

$$\frac{dn/n}{dG} = \frac{1 + 2\phi\psi(1 - \psi)}{2(\sigma - \psi)} + \frac{1}{2(\sigma - 1)[\psi + \gamma(1 - \psi)]} > 0 \quad (55)$$

$$\frac{dn^*/n^*}{dG} = -\frac{1 + 2\phi\psi(1 - \psi)}{2(\sigma - \psi)} + \frac{1}{2(\sigma - 1)[\psi + \gamma(1 - \psi)]} \quad (56)$$

$$\frac{d\varepsilon/\varepsilon}{dG} = \frac{dTOT/TOT}{dG} = -\frac{(\sigma - \psi)(1 - \phi) + (1 + \phi)(\sigma - 1)}{\Delta(\sigma - 1)} < 0 \quad (57)$$

$$\frac{dRER/RER}{dG} = \frac{-\psi(1 - \phi)}{(\sigma - \psi)(1 - \phi) + (\sigma - 1)(1 + \phi)} \frac{d\varepsilon/\varepsilon}{dG} > 0 \quad (58)$$

$$\frac{dP/P}{dG} = \begin{cases} \frac{1}{1 - \psi} \left(\frac{dn/n}{dG} - \frac{1}{\sigma - 1} \right) & \psi \neq 1 \\ -\frac{1}{2} \frac{\gamma - 1}{\sigma - 1} - \frac{2\sigma - 1 - \phi}{2(2\sigma - 1 + \phi)(\sigma - 1)^2} < 0 & \psi = 1 \end{cases} \quad (59)$$

$$\frac{dP^*/P^*}{dG} = \begin{cases} \frac{1}{1 - \psi} \frac{dn^*/n^*}{dG} & \psi \neq 1 \\ -\frac{1}{2} \frac{\gamma - 1}{\sigma - 1} + \frac{2\sigma - 1 - \phi}{2(2\sigma - 1 + \phi)(\sigma - 1)^2} < 0 & \psi = 1 \end{cases} \quad (60)$$

The same is true for Foreign households. Government spending unambiguously weakens the welfare-based real exchange rate (see (58)).²⁵

Our analysis predicts a positive association of public consumption with both private consumption and GDP — a result that is reminiscent of the Mundell-Fleming model, however reflecting a different transmission mechanism. The Mundell-Fleming model under flexible exchange rates predicts that government spending raises incomes and the transaction demand for real balances, thus appreciating the exchange rate in both nominal and real terms. In our model, the creation of additional firms and varieties in response to public demand translates into stronger demand for Home labor, raising its price relative to Foreign labor. Higher public demand thus improves the terms of trade (raising the purchasing power of domestic income), but depreciates the real exchange rate (driving up domestic consumption).²⁶

because of lower import prices and the higher number of varieties.

²⁵We again observe that measuring the real exchange rate without allowing for changes in the number of varieties would lead to the opposite result.

²⁶The macroeconomic effects of spending however may depend on how it is financed. We leave to future work the analysis of distortionary taxation, introducing trade-offs between market size and possible negative effects of a higher tax burden on investment and production.

5.3 Trade reforms

In our analysis above we have defined ϕ as a synthetic index of the impact of barriers to worldwide trade. What would be the macroeconomic implication of symmetric trade liberalization, corresponding to a fall in τ and thus a rise in ϕ ? In general, trade liberalization has a positive direct effect on firms' profitability: stronger global demand for each good increases sales and profits. For given entry costs, higher sales and profits foster entry of new firms and products. However, when symmetric across countries, trade liberalization also has an important indirect effect, inducing more competition by firms located abroad. Moreover, there can be general equilibrium effects on labor supply and aggregate demand from a fall in the price level.

Consider the number of varieties in the symmetric equilibrium (31). It is apparent that Home varieties fall with trade liberalization when $\psi < 1$, and increase otherwise. What is crucial for this result is the response of labor supply to a change in trade costs. With trade liberalization, the price of consumption goods falls, raising real wages and consumption. Depending on the relative strength of the income and substitution effects, such increase in purchasing power may have different effects on the households' demand for leisure. When $\psi < 1$ the income effect is dominant: labor supply falls as agents demand more leisure, and freer trade actually reduces the number of varieties supplied at the world level.²⁷ This is an example which clearly contrasts with the prediction of the standard Krugman model — without labor supply effects — in which trade always induces variety expansion.²⁸ The role of labor supply is further analyzed below.

6 Model extensions

The model analyzed so far has been solved assuming financial autarky (balanced trade), and an infinite Frisch elasticity of labor supply (linear disutility of labor effort). However, the international transmission mechanism is not invariant to changes in the structure of the assets market and/or the specification of labor supply. In this and the next subsection, we reconsider our main results in a world economy characterized by full consumption risk-sharing; then we contrast complete and incomplete markets allocations allowing for alternative values of the labor elasticity.

²⁷Notice that if $\psi > 1$, trade liberalization would have a negative impact on the number of varieties only if $\gamma > \psi/(\psi - 1)$, violating the condition on firms' entry discussed above.

²⁸Recently, Baldwin and Forslid (2004) have discussed a similar result in a model based on Melitz (2003). They however analyze a different channel, operating via the exit of less productive firms due to higher competition.

6.1 The role of asset markets

When markets are complete, the ratio of Home to Foreign marginal utility of consumption is linked to the real exchange rate by the following, familiar condition:

$$\frac{\partial U^*/\partial C^*}{\partial U/\partial C} = \frac{(C^*)^{-\frac{1}{\psi}}}{C^{-\frac{1}{\psi}}} = \kappa RER \quad (61)$$

where κ is a constant that is equal to one if the two countries are *ex-ante* symmetric. The above condition restricts both price and terms of trade movements: because of perfect insurance, any change in parameter values that raises domestic consumption relative to foreign consumption must be associated with a real depreciation.

In our model, taking the ratio of the first order conditions for labor supply we have:

$$\frac{(C^*)^{-\frac{1}{\psi}}}{C^{-\frac{1}{\psi}}} = \frac{P^*}{P} \quad (62)$$

The two expressions above imply $RER = P^*/P$. It follows that, in a complete markets allocation, the relative price of labor is constant at $\varepsilon = 1$.²⁹ A fall in the cost of firms' entry leaves the terms of trade constant, while *TOT* would appreciate in the case of financial autarky discussed above; by the same token, a fall in production costs depreciates the terms of trade by more than in the case of financial autarky. Similar considerations apply to changes in government spending and population size.

Mirroring these differences in the equilibrium price movements, there are striking differences in the international allocation of production. While the global number of varieties (32) does not change with the structure of asset markets, the geographical distribution of firms markedly differs depending on the degree of consumption risk-sharing. For simplicity, focus on the log-utility case ($\psi = 1$). Linearizing our model under complete markets we obtain:

$$\frac{dn}{n} = \frac{2\phi(\sigma-1)}{(1-\phi)^2} \frac{d\alpha}{\alpha} + \frac{1+\phi^2}{(1-\phi)^2} \frac{d\nu}{\nu} + \frac{1+\phi^2}{(1-\phi)^2} \frac{dG}{(\sigma-1)} + \frac{1}{1-\phi} \frac{dL}{L} \quad (63)$$

$$\frac{dn^*}{n} = -\frac{2\phi(\sigma-1)}{(1-\phi)^2} \frac{d\alpha}{\alpha} - \frac{2\phi}{(1-\phi)^2} \frac{d\nu}{\nu} - \frac{2\phi}{(1-\phi)^2} \frac{dG}{(\sigma-1)} - \frac{\phi}{1-\phi} \frac{dL}{L} \quad (64)$$

The coefficients on the first two terms on the right hand side of the above expressions are unambiguously positive. Hence, the allocation of production is now in line with a simple efficiency principle: production of new varieties is located in the most productive country,

²⁹It is worth noting that in leading trade models of the Home market effects, such as Helpman and Krugman (1985), the terms of trade are constant, but for a different reason. These models feature a perfectly competitive sector without trade costs, along with the imperfectly competitive sector with expanding varieties. The sector with zero trade cost and constant returns equates wages across countries, and absorbs any trade imbalances caused by home market effects operating on the industry with increasing returns.

whether productivity gains affect manufacturing (α) or entry costs (ν).³⁰

To highlight the difference relative to the balanced-trade case, consider the macroeconomic effects of changes in α . Under complete markets, relative wealth is insured against asymmetric shocks, and the relative price of labor remain constant. This is why, relative to our financial autarky economy, gains in Home manufacturing productivity are now matched by a higher Foreign demand for Home goods, sold at a lower international price. As a result, we have entry in the Home country and exit in the Foreign country in a symmetric fashion. Under financial autarky with logarithmic utility, instead, any change in the geography of production is instead prevented by the relative appreciation of Home labor relative to Foreign.

The above result provides insights on the ‘home market effect’ from a general-equilibrium perspective. The effects of a change in L can be summarized as follows:

$$\frac{dn}{n} - \frac{dn^*}{n^*} = \frac{1 + \phi}{1 - \phi} \frac{dL}{L} \quad (65)$$

which is the result discussed by Baldwin et al. (2003). With complete markets ε is constant: our model predicts that the response of Home varieties to a change in L is more than proportional and increases as trade costs fall. This is different from the financial autarky case analyzed in Section 5.1. There, L and n moved one-to-one as ε appreciated, leaving n^* unaffected.

6.2 The role of labor supply elasticity

With relatively low trade costs, the reallocation of varieties into the more productive country under complete markets can be very large — as the denominator of the terms on the right hand side of (63-64) vanishes as ϕ goes to one. In this section we study to what extent these results are sensitive to the parameterization of labor supply. Posit that preferences are now in the form:

$$U = \frac{C^{1-\frac{1}{\psi}}}{1 - \frac{1}{\psi}} - \frac{\ell^{1+\xi}}{1 + \xi} \quad (66)$$

where ξ is the reciprocal of the Frisch elasticity of labor supply. The first order conditions for labor supply in the two countries now imply:

$$\frac{(C^*)^{-\frac{1}{\psi}}}{C^{-\frac{1}{\psi}}} = \frac{P^*}{P} \left(\frac{\ell^*}{\ell} \right)^\xi \quad (67)$$

In a complete-market allocation, perfect risk-sharing no longer constrains the relative price of labor ε to be constant. Combining the above with the efficient risk-sharing condition

³⁰The intensive margin is unaffected by the asset market structure: the equilibrium scale of production by individual firms rises in response to an increase in α and falls in response to an increase in ν .

Table 6: Comparative statics — Numerical simulations

		α		ν		G		L	
		$\xi = 0$	$\xi = 3$	$\xi = 0$	$\xi = 3$	$\xi = 0$	$\xi = 3$	$\xi = 0$	$\xi = 3$
n	Fin. Autarky	0.00	0.00	1.00	1.00	0.25	0.06	1.00	1.00
	Complete Mkt.	2.40	0.11	1.62	1.03	0.40	0.04	1.25	1.01
n^*	Fin. Autarky	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Complete Mkt.	-2.40	-0.11	-0.61	-0.03	-0.15	0.62	-0.25	-0.01
ε	Fin. Autarky	-0.86	-0.86	-0.22	-0.22	-0.05	-0.04	-0.09	-0.09
	Complete Mkt.	0.00	-0.65	0.00	-0.16	0.00	-0.07	0.00	-0.07
TOT	Fin. Autarky	0.13	0.13	-0.22	-0.22	-0.05	-0.04	-0.09	-0.09
	Complete Mkt.	1.00	0.34	0.00	-0.16	0.00	-0.07	0.00	-0.07
RER	Fin. Autarky	0.09	0.09	0.02	0.02	0.01	-0.02	0.11	0.11
	Complete Mkt.	1.50	0.27	0.37	0.07	0.09	-0.05	0.25	0.13
C	Fin. Autarky	0.98	0.98	0.24	0.24	0.06	-0.17	0.22	0.22
	Complete Mkt.	1.25	0.63	0.31	0.16	0.08	-0.11	0.25	0.19
C^*	Fin. Autarky	0.02	0.02	0.01	0.01	0.00	0.00	0.03	0.03
	Complete Mkt.	-0.24	0.37	-0.06	0.09	-0.02	-0.06	0.00	0.06
ℓ	Fin. Autarky	0.00	0.00	0.00	0.00	0.25	0.06	0.00	0.00
	Complete Mkt.	2.44	0.11	0.61	0.03	0.40	0.04	0.24	0.01
ℓ^*	Fin. Autarky	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Complete Mkt.	-2.44	-0.11	-0.61	-0.03	-0.15	0.02	-0.25	-0.01

(61) we obtain:

$$\varepsilon = \left(\frac{\ell^*}{\ell} \right)^\xi \quad (68)$$

In equilibrium, an increase in Home employment raising the marginal disutility of domestic labor leads to an appreciation of Home labor relative to Foreign. With a finite elasticity of labor supply, the adjustment in the relative price of labor tends to mute the reallocation of varieties production across countries following changes in technology, population and government spending. However, the response of prices is magnified to some extent.³¹

In contrast, the role played by the curvature of labor disutility in the financial autarky allocation is much less pronounced. For instance, it is easy to verify that, if consumption preferences are logarithmic and government spending is zero, the equilibrium level of employment ℓ is constant, and identically equal to 1, irrespective of the Frisch elasticity.

In Table 6 we report numerical experiments contrasting the comparative statics multipliers under different assumptions about the structure of the asset markets (Financial Autarky versus Complete Markets) and the Frisch elasticity of labor supply. We report the percent-

³¹Note that the terms of trade appreciate in response to gains in productivity that cut the costs of entry. In light of this result, the negative association between TOT and ν can be consistent with both a very high and a very low degree of risk-sharing at international level — provided that the Frisch elasticity is sufficiently small.

age responses of n , n^* , ε , TOT , RER , C , C^* , ℓ and ℓ^* to a 1 percent shock in α , ν , L or 1 percentage point shock to G .³² The Table shows that, for identical parameter values, the behavior of these endogenous variables is quite similar across different asset market specifications, if the labor elasticity is low enough ($\xi = 3$). It varies markedly if the labor elasticity is very high ($\xi = 0$, corresponding to an infinite Frisch elasticity).

7 Welfare and international spillovers

In this section we analyze the welfare dimensions of international transmission. Specifically, we are interested in assessing the net benefits of trade reforms and the sign of international spillovers from productivity gains, changes in market size, and government spending. We explore this issue by complementing our analytical results with numerical examples.

In our baseline economy with financial autarky and infinite Frisch elasticity, welfare analysis is quite tractable. The indirect utility (10) can be written as:

$$U = \frac{P^{1-\psi}}{1 - 1/\psi} - \frac{\sigma n}{L\nu} = \frac{-P^{1-\psi}}{1 - \psi} - pG \frac{n}{L} \quad (69)$$

Consider first the welfare implications of trade liberalization and economic integration. A fall in trade costs τ has two effects: a direct effect on prices, which is obviously positive, and an indirect effect via the number of varieties. These effects are captured by the two terms in square brackets in the expression below:

$$\frac{dU}{d(1 + \tau)} = -P^{1-\psi} \frac{(1 + \tau)^{-\sigma}}{1 + \phi} \left[1 - \frac{(\gamma - 1)(1 - \psi)}{\gamma + \psi - \psi\gamma} \right] < 0 \quad (70)$$

Note that if n falls when τ decreases (as is the case with $\psi < 1$), the contraction in the number of varieties is clearly welfare-reducing for variety-loving agents ($\gamma > 1$). Echoing skeptical criticisms of globalization, one may wonder whether the disappearance of goods variety associated with trade integration could result in an overall loss of world welfare. According to our model, the answer is ‘no.’ As the expression above shows, the direct effect of liberalization via falling prices always dominates the indirect effect for any value of γ . Trade integration is always welfare improving — even if it leads to a loss of goods variety. Observe that with logarithmic utility there is no change in varieties: welfare rises with lower consumption prices.

The welfare implications of changes in productivity and demand fundamentals are sum-

³²Model parameters are set at $\sigma = 5$, $\psi = 1$, $\tau = 0.5$ and $\gamma = \sigma/(\sigma - 1)$.

marized by the following expressions:

$$\frac{dU}{d\alpha/\alpha} = \frac{-P^{1-\psi}}{1-\psi} \frac{dn/n}{d\alpha/\alpha} > 0, \quad \frac{dU^*}{d\alpha/\alpha} = \frac{-P^{1-\psi}}{1-\psi} \frac{dn^*/n^*}{d\alpha/\alpha} \quad (71)$$

$$\frac{dU}{d\nu/\nu} = \frac{-P^{1-\psi}}{1-\psi} \left(\frac{dn/n}{d\nu/\nu} - 1 \right) > 0, \quad \frac{dU^*}{d\nu/\nu} = \frac{-P^{1-\psi}}{1-\psi} \frac{dn^*/n^*}{d\nu/\nu} \quad (72)$$

$$\frac{dU}{dL/L} = \frac{-P^{1-\psi}}{1-\psi} \left(\frac{dn/n}{dL/L} - 1 \right) > 0, \quad \frac{dU^*}{dL/L} = \frac{-P^{1-\psi}}{1-\psi} \frac{dn^*/n^*}{dL/L} \quad (73)$$

$$\frac{dU}{dG} = \frac{-P^{1-\psi}}{1-\psi} \left(\frac{dn/n}{dG} - \frac{\psi}{\sigma-1} \right), \quad \frac{dU^*}{dG} = \frac{-P^{1-\psi}}{1-\psi} \frac{dn^*/n^*}{dG} \quad (74)$$

whereas in the log-utility case ($\psi = 1$), the change in utility is simply given by the negative of the change in the CPI.

The Home country always gains from a larger market size and higher domestic productivity (although the latter result is not robust to alternative specifications of the asset market structure, as we discuss below). Somewhat surprisingly, domestic welfare does not necessarily fall with wasteful (home-biased) government expenditure. Even when public spending has no utility value, it may be possible that welfare improves, provided consumers value goods variety enough. Namely, with a high γ , relatively closed economies (i.e., with high trade costs) experience a welfare improvement because of the indirect effect of government spending on the supply of domestic goods varieties (for a numerical example see Table 9 below).

The spillovers on the Foreign economy are all ambiguous. In general, the Foreign welfare multipliers increase (i.e., become more positive or less negative) with trade integration (a higher ϕ). Net welfare effects are also heavily influenced by the parameter γ , summarizing love for variety. For instance, when $\psi < 1$ and γ is high enough, Home productivity gains in manufacturing can actually reduce Foreign welfare, as the global loss of variety can overturn gains from lower import prices. The same considerations apply to spillovers from Home efficiency gains reducing entry costs. Since the global number of varieties rises in this case, with a high γ spillovers may be positive for Foreign agents — despite higher import prices.

We carry out numerical exercises for three configurations of parameters. We take the standard Dixit-Stiglitz case $\gamma = \sigma/(\sigma - 1)$ as our benchmark case in Table 7. Relative to this benchmark, in Table 8 we analyze a case in which the marginal taste for additional variety is lower — making it so low that the number of varieties in the market equilibrium is too high. In Table 9 we analyze a case in which the marginal taste is higher — so that n is too low.

In the baseline case, the elasticity of substitution between goods σ is set equal to 5. We also experiment with 3 and 10, values that are suggested by macro and trade studies,

Table 7: The Dixit-Stiglitz case with love for variety tied to the elasticity of substitution ($\gamma = \frac{\sigma}{\sigma-1}$)

	α		ν		G		L	
	dU	dU^*	dU	dU^*	dU	dU^*	dU	dU^*
Base case: $\sigma = 5; \psi = 1$ $\tau = 0.5; \gamma = 1.25$ Cons. equivalent	.979	.024	.244	.006	-.193	.003	.222	.026
Sensitivity analysis Cons. equivalent	dU	dU^*	dU	dU^*	dU	dU^*	dU	dU^*
$\sigma = 3$	.916	.076	.458	.041	-.276	.020	.377	.125
$\sigma = 10$	.999	.007	.112	.000	-.107	-.007	.107	.003
$\psi = 0.9$	.957	.013	.238	.004	-.192	.001	.217	.025
$\psi = 1.1$	1.001	.020	.249	.006	-.189	.001	.227	.028
$\tau = 0.2$	.948	.052	.236	.011	-.195	.005	.185	.063
$\tau = 0.7$	.987	.013	.246	.003	-.187	.001	.232	.017
Base case + Complete + $\xi = 0$	-1.190	2.229	-.303	.552	-.331	.144	.003	.245
Base case + Complete + $\xi = 3$	.525	.476	.131	.119	-.151	-.081	.177	.073

respectively³³. The elasticity ψ is set equal to 1, but we also experiment with 0.9 and 1.1. Trade costs τ are set at 50% — this is to be interpreted as including both transport costs and the costs of policy-induced trade barriers, but not retail and wholesale margins. We experiment with a low value of 20% and a high value of 70%. The latter value reflects evidence reported in the survey by Anderson and van Wincoop (2004), who estimate trade costs for the U.S. as high as 74%.³⁴

In the last two rows of Tables 7-9 we also report results based on the equilibrium allocation under complete markets, for alternative values of the Frisch elasticity $1/\xi$ in (66) (namely $\xi = 0$, the base case value, and $\xi = 3$, a value in the range of estimates from micro studies). All shocks are a 1 percentage point increase in the Home variable relative to the symmetric equilibrium. Welfare results are reported in consumption equivalent terms.

Table 7 reports our results for our baseline case with $\gamma = \sigma/(\sigma - 1)$. The table shows that gains in Home manufacturing productivity raise welfare at Home and abroad. Home agents benefit from a fall in the price of domestically produced goods. Abroad, the fall in the price of consumption is entirely due to cheaper imports, as Foreign terms of trade improve. Observe that international spillovers are stronger when goods markets are more integrated. Lower trade costs (from $\tau = 0.7$ to $\tau = 0.2$) raise the welfare gains in the Foreign country,

³³See also Bernard et al. (2003) who argue for an elasticity of substitution around 3.8.

³⁴The breakdown is 21% transportation costs and 44% border-related trade barriers ($1.74 = 1.21 * 1.44$).

Table 8: The case with low love for variety ($\gamma = 1.1$)

	α		ν		G		L	
Base case								
Cons. equivalent	dU	dU^*	dU	dU^*	dU	dU^*	dU	dU^*
	.979	.012	.170	-.065	-.208	-.016	.149	-.048
Sensitivity analysis								
Cons. equivalent	dU	dU^*	dU	dU^*	dU	dU^*	dU	dU^*
$\psi = 0.9$	.964	.020	.166	-.068	-.210	-.018	.145	-.047
$\psi = 1.1$	.993	.013	.171	-.072	-.208	-.019	.150	-.050
Base case + Complete + $\xi = 0$	-1.199	2.229	-.366	.476	-.350	.126	-.070	.172
Base case + Complete + $\xi = 3$	.526	.471	.057	.043	-.149	-.079	.103	-.001

while reducing the welfare gains in the Home country. Conversely, the Home country welfare rises with a higher elasticity σ and a lower elasticity ψ .

The implications of gains in efficiency reducing entry costs are quite similar: welfare tends to improve everywhere, through higher consumption. The benefits for the Foreign country are however contained relative to the case of a change in α .

Both countries benefit from a larger Home market size L , simultaneously increasing expenditure and labor supply. However, disregarding utility from public goods, higher Home government spending G clearly reduces Home welfare (it is *beggar-thyself*): even though higher spending raises the number of varieties produced in the country and raises private consumption, the extra effort required to satisfy total demand dominates the welfare results. International spillovers tend to be marginally positive.

Observe that welfare movements under complete markets are qualitatively similar to the case of financial autarky, provided labor supply is sufficiently inelastic ($\xi = 3$ in the last row of Table 7). When $\xi = 0$, instead, changes in productivity (of both types) have a large ex-post *beggar-thyself* impact at Home and a sizable positive spillover to the rest of the world. As is well known, what drives this result is the large increase in Home labor efforts (and the corresponding fall in Foreign labor disutility) associated with the reallocation of varieties across countries when markets are complete and ε remains constant. Also worth noticing is the fact that fiscal spillovers to the rest of the world are positive when labor supply is highly elastic, but becomes negative as the labor supply elasticity falls (i.e. for a sufficiently high ξ).

Further insight can be obtained by studying economies where the love for variety can be distinguished from the elasticity of substitution — moving away from the Dixit-Stiglitz

Table 9: The case with high love for variety ($\gamma = 3$)

	α		ν		G		L	
	dU	dU^*	dU	dU^*	dU	dU^*	dU	dU^*
Base case								
Cons. equivalent	.978	.020	1.113	.891	.0031	.221	1.093	.911
Sensitivity analysis								
Cons. equivalent	dU	dU^*	dU	dU^*	dU	dU^*	dU	dU^*
$\psi = 0.9$	.886	-.052	.952	.716	-.013	.179	.931	.738
$\psi = 1.1$	1.114	.133	1.377	1.132	.093	.283	1.355	1.154
Base case + Complete + $\xi = 0$	-1.191	2.229	.573	1.443	-.109	.359	0.880	1.127
Base case + Complete + $\xi = 3$	.526	.479	1.000	1.000	-.101	-.027	1.051	.954

benchmark. Table 8 considers a case of low love for variety, or $\gamma = 1.1$. A notable difference relative to Table 7 is that improvements in ν have now a *beggar-thy-neighbor* spillover to the rest of the world. The reason is that Foreign agents do not particularly value the increase in the number of goods varieties due to Home lower entry costs. Foreign agents are thus worse off because of higher import prices. Conversely, Foreign agents benefit from lower goods prices associated with higher manufacturing productivity.

A different picture emerges in Table 9, where we experiment with a high coefficient of love for variety. In this case, gains in Home productivity in innovation are beneficial to Foreign agents because of the highly valued positive effect on variety. By the same token, spillovers from a larger Home market are positive. For the same reason, however, Home manufacturing productivity improvements can now reduce Foreign welfare. When $\psi < 1$, the global number of varieties decreases with α . For the Foreign country, this global loss of diversity more than offsets the gains from better terms of trade.

Financial markets matter. Compare the above results with the allocations under complete markets in Tables 8-9. Under complete markets, first, the welfare effects of a change in α are substantially unaffected by differences in the love for variety. Second, the welfare effects of a change in ν increase with γ , both domestically and abroad. Interestingly, international spillovers are never negative, not even when γ is low. Third, the Foreign country gains more than under financial autarky from an expansion of L — note that welfare spillovers are increasing in γ and decreasing in ξ . With perfect consumption insurance, demographic growth can actually make the Home country worse off — if labor supply is elastic, and love for variety is low. In this case, as a larger market size tends to concentrate production of varieties in the Home market, consumption gains from a wider array of goods does not

compensate the higher Home labor effort.

8 Conclusion

Understanding the determinants of international relative prices and their links with output and consumption growth is a key challenge to international macroeconomics and policy making. National wealth depends not only on the quantity of goods and services that a country can produce now and in the future, but also on the relative prices such goods and services can command in the international markets. Productivity innovations that raise a country's output may raise national welfare abroad to the extent that they drive down import prices. However, when innovations also change the attributes of consumption goods, leading to product diversification, a correct assessment of the value of output, consumption and imports to consumers requires an assessment of consumers' preferences for goods variety. In this paper we have provided a stylized framework to address these issues.

Our results can contribute to the current debate on the international adjustment process, vis-à-vis the large current account imbalances run by the U.S. since the 1990s and the unprecedented surpluses of many industrializing countries. According to the standard macroeconomic model, current account stabilization by the U.S. requires a large real depreciation of the dollar, corresponding to both a fall in the price of U.S. nontradables and a worsening in the price of U.S. exports (see e.g., Obstfeld and Rogoff (2004)).³⁵ Productivity and output growth are relevant to closing the current account deficit only to the extent that they raise the volume of tradable output in the U.S. (with an adverse effect on the U.S. terms of trade), or affect demand for U.S. tradables abroad by raising domestic income. But one may expect that large international price movements also have endogenous effects on tradability. In fact, as new products are traded internationally, they can contribute to closing the external imbalance without necessarily adding to real currency depreciation.³⁶ Similar effects can stem from productivity gains leading to product diversification and innovation in high value-added sectors.

Our results also underscore the need to reconsider deep parameters underlying open-economy macro policy models. Not only do the effects of productivity improvements on the equilibrium allocation depend on the nature of such gains (whether they are concentrated in manufacturing or affect the cost of firms' entry and innovation). The sign of international

³⁵In the estimates by Obstfeld and Rogoff (2004), for instance, the order of magnitude of the fall in the real exchange rate required to close the US current account deficit ranges between 10 and 35 per cent, corresponding to a worsening in the terms of trade between 3.5 and 15 percent.

³⁶We address this point in detail in Corsetti, Martin and Pesenti (2006).

spillovers also depends on the relative strength of different effects of productivity gains, from their impact on the terms of trade to the utility gains from making additional goods varieties available to consumers. In this light, an important direction for future research will indeed consist of enriching the model specification by modelling the introduction of new varieties and firms' entry as investment activities (e.g., Ghironi and Melitz (2005) and Bergin and Corsetti (2005)), while at the same time accounting for financial or nominal price rigidities that would motivate stabilization policies.

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