VARIETIES AND THE TRANSFER PROBLEM*

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Abstract

We revisit the classic transfer problem, accounting for two channels of adjustment: increased trade in existing goods and services (the intensive margin) and net creation and destruction of product varieties (the extensive margin). Over the medium term, the latter reduces the scope for real exchange rate and terms of trade variability in response to cross-border flows. We embed our transfer analysis in popular models of current account adjustment, where initial imbalances are driven by domestic demand for — or foreign supply of — net saving, possibly associated with over-optimistic expectations. Simulation exercises based on a calibration of the model to 2006 data suggest that a transfer of the size of the pre-crisis U.S. current account deficit may require only moderate trend depreciation in real terms, and that the aggregate welfare impact of the transfer is disconnected from the size of the relative price correction.

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1 Introduction

Economic analyses of the burden imposed by deteriorating international prices on debtor countries have a long intellectual history, going back at least to Keynes' (1919, 1929a,b,c) classic assessment of the macroeconomic effects of a transfer. Keynes' criticism of German international obligations after World War I stressed that the macroeconomic costs of any given amount of war reparations — the 'primary burden' of a transfer — were bound to be magnified by the adverse effects of deteriorating terms of trade and real exchange rates — the 'secondary burden' or 'double punishment'. Ohlin (1929a,b) criticized Keynes' emphasis on relative prices, arguing that the income effects from unilateral transfers could actually reduce terms of trade adjustment, or even make them redundant.[1]

Nowadays, the transfer-problem controversy is very much alive in the context of the ongoing debate on current account rebalancing at both regional and global levels. While there is considerable uncertainty about the timing and drivers of current account movements, the basic mechanism of adjustment requires a transfer of real resources from debtor countries such as the United States or the European periphery to surplus countries such as China or Germany. Such transfer involves a decrease in domestic spending relative to production in the debtor countries, accompanied by a simultaneous relative increase abroad. What remains open to debate is the role of relative prices in the adjustment process. Some authors have suggested that rebalancing may bring about only modest movements in real exchange rates. For instance, Dekle, Eaton and Kortum (2007, 2008) have argued that a transfer of the size of the U.S. deficit requires a very limited correction in international relative prices and labor costs.[2] Other authors have taken the opposite stance. For instance, early influential contributions by Obstfeld and Rogoff (2005, 2007) have revisited the Keynesian approach to the transfer problem by emphasizing how the unwinding of the U.S. current account deficit may be related to "the potential collapse of the dollar."[3] Similarly, significant 'internal' real devaluations have been highlighted as the most effective way to restore cost competitiveness in the high-deficit countries of the euro area periphery. As Stanley Black (2010) puts it, "the bulk of the adjustment must be in declining relative prices and wages, or productivity

[1] According to this view, there was no real reason to expect the overall macroeconomic burden to exceed the direct costs of the transfer itself, a point emphasized by Samuelson (1952). See Brakman and van Marrewijk (1998) for an overview of the Keynes-Ohlin debate.

[2] These authors consider a multilateral model calibrated to 40 countries using 2004 data on GDP and bilateral trade. In their exercise, wages in the country with the largest trade deficit (U.S.) only fall by 10 percent relative to wages in the country with the largest trade surplus (Japan). Within each of these countries, real wages hardly change because of the large component of nontradables consumption.

[3] See also Blanchard, Giavazzi and Sa (2005) and Edwards (2005).

gains."

The view we want to emphasize in this paper is that macroeconomic adjustment — over a sufficiently extended time horizon — occurs along a multiplicity of dimensions or margins, whose relative importance crucially affects the magnitude of real currency depreciation. This is because over the medium term there is substantial firm entry and exit across sectors and countries, and a large fraction of trade growth occurs at the extensive margin (exports of new varieties), as opposed to a rise in the volume of trade in existing goods and services (the intensive margin). If a large fraction of adjustment across sectors and borders occurs at the extensive margin, domestic and international relative prices should be expected to play only a contained role.

We develop a model of external transfer that accounts for different margins of rebalancing, and calibrate the model to the U.S. case. Our exercise suggests that a transfer of the size of the pre-crisis U.S. current account deficit may require only moderate trend depreciation in real terms, which could occur either through the exchange rate channel or an internal disinflationary process. However, from the vantage point of a debtor economy undergoing adjustment, our results also highlight that a limited terms of trade deterioration is not tantamount to a negligible macroeconomic burden of rebalancing. In this respect, and departing from the conventional view, our model suggests that the aggregate welfare impact of an unilateral transfer of resources may actually be disconnected from the size of the relative price correction. In the medium term, a rebalancing scenario under stable real exchange rates need not be less socially costly than an alternative scenario with large-scale wage and price corrections once we account for the welfare losses associated with reduced availability of consumption varieties.

The assumption that a significant fraction of adjustment across sectors and borders occurs at the extensive margin builds upon pervasive evidence. Over the past few decades, the strong expansion in the volume of international trade has been accompanied by a vast change in its composition, in favor of differentiated goods. Following the methodology by Rauch (1999), Tang (2006) reports that U.S. imports of differentiated products rose from 47.4 percent in 1975 to 75.5 percent in 2000 while the proportion of U.S. exports of differentiated goods increased from 61.3 to 78.6 percent between 1979 and 2000. Using highly disaggregated product-level data, Debaere and Mostashari (2005) report that, for around 80 percent of countries, over 40 percent of all goods categories exported to the United States in 1998-2000 were in newly traded goods, that is, goods that were not exported in 1989-91. Hummels and Klenow (2005) show that the extensive margin can account for about two thirds of the difference in trade across countries of different size.[4]

Conventional analyses of the international transfer problem abstract from the possibility of trade in new varieties as a potential engine of international adjustment.[5] For this reason, they provide an incomplete framework for the positive and normative assessment of international transfers. As emphasized by Broda and Weinstein (2004, 2006, 2007), welfare gains stemming from the increased number of imported varieties and enhanced consumer choice have been very large for the United States. Galstayn and Lane (2008) show that for several countries that run large and persistent trade imbalances, the role of the extensive margin in trade dynamics has been substantial. In the specific case of the United States, over a relatively short period of time (2000-2004) around half of trade growth has occurred at the extensive margin. Also, the conventional view is likely to provide a biased framework for the quantitative evaluation of the real currency depreciation associated with rebalancing. The evidence discussed by IMF (2007) suggests that economies with lower costs of starting and closing a firm, and of hiring and firing labor, have experienced smaller movements in real effective exchange rates during external adjustment episodes.[6]

Our model analyzes the transfer problem in an environment where new product varieties are created (at a cost) or destroyed as a consequence of a shift in aggregate demand from the home to the foreign country. Because of imperfect competition and economies of scale, a transfer that alters relative market size leads to firms' entry and exit. Labor supply is elastic, and labor can be reallocated between sectors, so that the level and composition of traded and nontraded output are endogenous. The model encompasses a number of features usually associated with 'Keynesian' transfer effects on the terms of trade (home bias in spending due to trade costs, market segmentation and nontradables, imperfect substitutability between home and foreign goods). Given our emphasis on medium-term adjustment, and consistent with the original literature on the transfer problem, we abstract from short-run costs due to frictions in the reallocation of resources across sectors or nominal rigidities.

In a quantitative exercise, our model is calibrated to 2006 U.S. data and used to assess the effects of a transfer offsetting a deficit as high as 6.5 percent of GDP — that is, the effects of an increase in net exports required to move the net external position from a deficit

[4] Yi (2003), Kehoe and Ruhl (2003), and Ruhl (2005) show that trade liberalization results in a significant increase of the extensive margin. The role of product varieties in international trade is also emphasized in Gagnon (2003) which — building on Krugman's (1989) notion that economic growth is channelled into product proliferation — provides evidence on the strong correlation between the growth of U.S. bilateral manufactured imports between 1972 and 2000 and the average growth rate of GDP of the exporting countries.

[5] An exception worth emphasizing is Brakman and van Marrewijk (1995). Their model has no trade costs and focuses on the effect of a tied transfer by a country specialized in manufacturing to a country specialized in food production. They find that a transfer decreases the number of varieties in the manufacturing sector.

[6] International Monetary Fund (2007), pp.103-104.

to zero. Results from our 'endogenous-variety' model are then compared with those from a more conventional 'fixed-variety' model in which there is no entry and adjustment to the transfer occurs exclusively at the intensive margin. According to the 'fixed-variety' model, such a transfer requires a fall in long-run consumption of around 5 percent, and an increase in employment of 3 percent. The terms of trade and the real exchange rate deteriorate sharply, by 38.2 and 30.1 percent respectively. This scenario is well in line with related exercises in the recent literature on global rebalancing.[7] Conversely, in our 'endogenous-variety' model movements in the terms of trade and the real exchange rate are only 17.6 and 8.3 percent, respectively. Yet, the possibility of adjustment at the extensive margin does not significantly affect the impact of the transfer on employment and consumption. Labor effort increases precisely as in the 'fixed-variety' scenario, and home consumption declines reflecting changes in the basket of products available to domestic households. In utility terms, the welfare costs of adjustment is quite comparable in the two models, although this result may not be robust to alternative parameterizations, as we address in sensitivity analysis.

Our baseline model builds on the traditional transfer-problem apparatus, which focuses on the effects of an exogenous cross-border transfer of resources on international prices and quantities relative to steady state, within a static analytical framework. Yet, its basic message carries through also in more complex, intertemporal analyses where the transfer emerges as the endogenous outcome of agents' borrowing and lending decisions in response to current and expected future fundamentals. We explore in some detail the link between transfer problem and current account adjustment in a specific section of the paper, by revisiting three 'popular' interpretations of global and regional imbalances, and by considering both their build-up and the subsequent unfolding in response to macroeconomic shocks. Under all scenarios, net creation of product varieties dampens the range of variability of international relative prices over time.

This paper is organized as follows. Section 2 introduces the model. Section 3 analyzes endogenous changes in consumption and output in response to a transfer, contrasting the 'endogenous-variety' case with the traditional 'fixed-variety' setup. Section 4 presents a quantitative assessment. Section 5 extends the model to an intertemporal framework under alternative scenario assumptions. Section 6 concludes.

[7] For instance, these figures are comparable with experiments by Obstfeld and Rogoff (2007) in which output of tradables is increased parametrically by 20 percent. Model-based simulations of global rebalancing and real currency adjustment appear in IMF (2006), Box 1.3., Faruqee et al. (2007), and Ferrero, Gertler and Svensson (2009).

2 A model of transfer with product varieties

We model a world economy consisting of two countries, Home and Foreign — Foreign variables are denoted with a star. In presenting the model below, we focus on the Home country with the understanding that the expressions characterizing the Foreign country can be readily derived from the ones shown in the text.

In each country, households consume all varieties of goods available in their domestic market, both domestically produced and imported, and supply labor to domestic firms in a competitive market. There are L households in the Home country and L^* households in the Foreign country.

In each country, firms operate either in the nontradables or in the tradables sector. Tradable goods are sold in the domestic markets — they are therefore import-competing goods — or exported. Markets are not perfectly integrated: we allow for trade frictions that cause market segmentation. Regardless of the sector in which it operates, a firm is assumed to manufacture a single product variety under conditions of monopolistic competition.

To start operating, firms face entry costs. With costly entry, the number of varieties supplied in the market is then endogenously determined in equilibrium. In the Home country, varieties in the nontradables sector N are defined over a continuum of mass n_N and indexed by $h_N \in [0,\, n_N]$. Home tradables (import-competing) varieties produced for the domestic market D are indexed by $h_D \in [0,\, n_D]$. Similarly, Home varieties produced for the export market X are indexed by $h_X \in [0,\, n_X]$. By the same token, in the Foreign country nontradables varieties are defined over the continuum $f_N \in [0,\, n_N^*]$, import-competing varieties are indexed by $f_D \in [0,\, n_D^*]$ and export varieties are indexed by $f_X \in [0,\, n_X^*]$.

Without loss of generality, we assume that in each country domestic labor units are the local numeraire in terms of which all domestic prices are measured. This amounts to assuming that unit wages in both countries, denoted w and w^*, are normalized to 1. Under this assumption, the exchange rate ε is expressed in units of Home labor per unit of Foreign labor.

2.1 Firms

Firms have access to a linear technology in labor, which is the only input in production. The production function of the representative Home firm producing a specific variety is:

$$Y(h_i) = \ell(h_i) \qquad i = N, D, X \tag{1}$$

where $Y(h_i)$ is the output of variety h_i, $\ell(h_i)$ is labor used in its production, and N, D, and X denote the sector in which the firm operate. Observe that, for analytical convenience, we treat export- and import-competing goods as different varieties. We also disregard productivity differentials across sectors and countries. Their introduction in the model would not lead to any benefit in terms of new insights, but instead would add to the cost of additional notational and algebraic complexity.

To start production, a firm needs to employ labor in order to setup the manufacturing line of a particular product variety. Namely, for the Home country, we posit:

$$q(h_i) \equiv wc_i n_i^{\gamma} = c_i n_i^{\gamma} \qquad i = N, D, X \tag{2}$$

where the wage rate w is equal to one by the choice of the numeraire, and $c_i n_i^{\gamma}$ are units of labor used in the activities required to introduce a variety h in the i sector. Note that the positive parameters c_i, indexing the level of the entry costs, may be different across countries and sectors.[8]

For $\gamma > 0$, the cost function is convex: the cost of creating an additional variety is an increasing function of the number of existing varieties in the sector. The idea underlying this specification is that a larger number of existing varieties on the market makes it more difficult for firms to differentiate their products relative to the competition, possibly reflecting higher costs of marketing and advertising associated with the introduction of a new variety or brand. The parameter γ measures the sensitivity of these costs to the number of sectoral varieties. In principle we could make the above specification analytically richer (e.g., by considering a function of domestic and foreign varieties in each market). For our purpose, we focus instead on a parsimonious parameterization allowing for asymmetry of the cost function across types of product varieties. As considered below, this feature pins down the calibration of the (possibly asymmetric) degrees of trade openness across countries.

An additional friction — causing market segmentation — consists of transportation costs. They are modelled as 'iceberg' costs, denoted by τ and expressed in units of the export good. The resource constraints for each variety of Home goods are therefore:

$$Y(h_N) \geq LC\left(h_N\right), \qquad Y(h_D) \geq LC\left(h_D\right), \qquad Y(h_X) \geq \left(1+\tau\right) L^* C^* \left(h_X\right) \tag{3}$$

where $C\left(h_N\right)$ is per-capita consumption of good h_N in the Home country, $C\left(h_D\right)$ is per-capita consumption of good h_D by the representative Home resident, and $C^*\left(h_X\right)$ is consumption of good h_X by the representative Foreign resident. As domestic households provide labor both for firms' start-up and production activities, the resource constraint in the Home labor market is:

$$L\ell \geq \sum_i \left(\int_0^{n_i} Y\left(h_i\right) dh_i + c_i n_i^{1+\gamma} \right) \tag{4}$$

[8] Corsetti, Martin and Pesenti (2007) discuss the case in which entry costs c_i are subject to shocks.

Let $p(h_N)$, $p(h_D)$ and $p(f_X)$ denote the Home prices of, respectively, Home nontradables, Home import-competing varieties and Home imports. Using the above notation and assumptions, the operating profits Π of Home firms h_i are, respectively:

$$\begin{aligned}
\Pi(h_N) &\equiv p(h_N) LC(h_N) - \ell(h_N) \leq (p(h_N) - 1) Y(h_N), \\
\Pi(h_D) &\equiv p(h_D) LC(h_D) - \ell(h_D) \leq (p(h_D) - 1) Y(h_D), \\
\Pi(h_X) &\equiv \varepsilon p^*(h_X) L^* C^*(h_X) - \ell(h_X) \leq \left(\frac{\varepsilon p^*(h_X)}{1+\tau} - 1 \right) Y(h_X)
\end{aligned} \tag{5}$$

2.2 Households

In the Home country the utility of the representative household is a positive function of consumption C and a negative function of labor effort ℓ:

$$U = \log C - \frac{1}{1+\xi} \ell^{1+\xi} \tag{6}$$

where ξ is the inverse of the Frisch elasticity. C is a Cobb-Douglas (or unit-elasticity) index of tradables and nontradables baskets of varieties sold in the country:

$$C = \frac{C_T^{\delta} C_N^{1-\delta}}{\delta^{\delta} (1-\delta)^{1-\delta}} \tag{7}$$

where $1-\delta$ is the share of nontradables in consumption, and the baskets C_T and C_N are defined as:

$$\begin{aligned}
C_T &= \left[\int_0^{n_D} C(h_D)^{1-\frac{1}{\sigma}} dh_D + \int_0^{n_X^*} C(f_X)^{1-\frac{1}{\sigma}} df_X \right]^{\frac{\sigma}{\sigma-1}}, \\
C_N &= \left[\int_0^{n_N} C(h_N)^{1-\frac{1}{\sigma}} dh_N \right]^{\frac{\sigma}{\sigma-1}}
\end{aligned} \tag{8}$$

In the expressions above σ denotes the elasticity of substitution across varieties, as well as the elasticity of substitution between import-competing goods h_D and imports f_X. We assume that this elasticity is higher than the elasticity of substitution between the tradables and nontradables baskets, that is $\sigma > 1$.

The budget constraint of the representative Home household is:

$$\int_0^{n_N} p(h_N) C(h_N) dh_N + \int_0^{n_D} p(h_D) C(h_D) dh_D + \int_0^{n_X^*} p(f_X) C(f_X) df_X + I \leq \ell + \Pi - F/L \tag{9}$$

Home households earn labor incomes ℓ (recall that wages are normalized to one) and spend on consumption goods. They finance the fixed costs of setting up firms and introducing goods varieties (I in our notation), receive dividends revenue from the firms they own (Π) and pay F/L to Foreign households, where F is the aggregate resource transfer to the rest of the world.

Without loss of generality, we posit that households are endowed with a well-diversified international portfolio of claims on firms' profits, so that they finance the same fraction of the cost of creating new varieties in each country.[9] Formally, Home households invest in a portfolio of firms worldwide:

$$I \equiv \frac{1}{L+L^*}\left(\sum_i \int_0^{n_i} q\left(h_i\right) dh_i + \varepsilon \sum_i \int_0^{n_i^*} q^*\left(f_i\right) df_i\right) \tag{10}$$

and in return receive an equal share of profits:

$$\Pi \equiv \frac{1}{L+L^*}\left(\sum_i \int_0^{n_i} \Pi\left(h_i\right) dh_i + \varepsilon \sum_i \int_0^{n_i^*} \Pi^*\left(f_i\right) df_i\right) \tag{11}$$

Optimal consumption demand satisfies:

$$C(h_N) = \left(\frac{p\left(h_N\right)}{P_N}\right)^{-\sigma} C_N, \quad C(h_D) = \left(\frac{p\left(h_D\right)}{P_T}\right)^{-\sigma} C_T, \quad C\left(f_X\right) = \left(\frac{p\left(f_X\right)}{P_T}\right)^{-\sigma} C_T, \tag{12}$$

$$PC = \frac{P_T C_T}{\delta} = \frac{P_N C_N}{1-\delta}$$

where P, P_T and P_N are the utility-based consumer price indexes, defined as the minimum expenditures required to purchase one unit of the respective baskets:

$$\begin{aligned} P &= P_T^{\delta} P_N^{1-\delta}, \qquad (13)\\ P_N &= \left[\int_0^{n_N} p\left(h_N\right)^{1-\sigma} dh_N\right]^{\frac{1}{1-\sigma}}, \\ P_T &= \left[\int_0^{n_D} p\left(h_D\right)^{1-\sigma} dh_D + \int_0^{n_X^*} p\left(f_X\right)^{1-\sigma} df_X\right]^{\frac{1}{1-\sigma}} \end{aligned}$$

Recent literature has emphasized the potential problems that arise from the fact that, in practice, statistical consumption price indexes are not properly constructed so as to account for changes in the number of product varieties, thus failing to capture fully the welfare changes associated with changes in goods prices *and* varieties (see Feenstra (1994) and Broda and Weinstein (2004a,b) among others).[10] In our framework, we can actually distinguish between the correct (welfare-based) price index and a proxy for its statistical counterpart, evaluating the expressions in (13) either treating the number of varieties as endogenously determined in the model, or holding them exogenously fixed. Similar considerations hold

[9] Under the assumption of free entry, profits are identically equal to entry costs. Hence positing complete home bias in equity portfolio would not alter our results. This is in contrast with the standard assumption that households only own and finance domestic firms. In other words, in our analysis we abstract from a specific financial channel through which a transfer could potentially affect the world economy — via differences in net profit rates across countries.

[10] Because the definition of the price index affects the real wage, this issue is also related to an older literature on the impact of trade on wage inequality (see Leamer (2000) and Krugman (2000)).

below in our analysis of the real exchange rate, RER, customarily defined as the relative price of consumption across border or $RER \equiv \varepsilon P^*/P$.

With competitive labor markets and free labor mobility across sectors (but not across borders), optimal labor supply implies:

$$w = 1 = \ell^{\xi} PC \tag{14}$$

Note that, as a result of our choice of numeraire, P is the price of consumption in terms of labor. In equilibrium, consumption increases when its price falls (with unit elasticity) and when leisure increases (with elasticity ξ).

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:

$$\begin{aligned} p\left(h_N\right) &= p\left(h_D\right) = \frac{\sigma}{\sigma-1} \equiv p, \\ \varepsilon p^*\left(h_X\right) &= \frac{\sigma}{\sigma-1}\left(1+\tau\right) = p(1+\tau) \end{aligned} \tag{15}$$

Given that the two countries have identical labor productivity and demand elasticity, it must be the case that $p = p^*$. It follows that the terms of trade — conventionally defined as the price of imports in terms of the price of exports — is simply equal to ε.

Using the above expressions, then, the equilibrium price indexes are:

$$\begin{aligned} P_N &= p n_N^{\frac{1}{1-\sigma}}, \qquad & P_T = p\left[n_D + n_X^* \phi \varepsilon^{1-\sigma}\right]^{\frac{1}{1-\sigma}}, \\ P_N^* &= p^* n_N^{*\frac{1}{1-\sigma}}, \qquad & P_T^* = p^*\left[n_D^* + n_X \phi \varepsilon^{\sigma-1}\right]^{\frac{1}{1-\sigma}} \end{aligned} \tag{16}$$

where, borrowing a notation convention commonly adopted by the trade literature, trade costs are indexed by

$$\phi \equiv \left(1+\tau\right)^{1-\sigma}. \tag{17}$$

The index of trade costs ϕ is positive and, for $\sigma > 1$, defined between 0 and 1 — the case $\phi = 0$ corresponds to infinite trade costs, the case $\phi = 1$ to zero trade costs.

2.4 Free entry, balance of payments and equilibrium

To characterize the equilibrium in our model, we first rewrite the operating profits earned by Home firms (gross of entry costs) as follows:

$$
\begin{aligned}
\Pi\left(h_N\right) &= p\frac{L}{\sigma}C(h_N) = \frac{1-\delta}{\sigma}\frac{L\ell^{-\xi}}{n_N}, \\
\Pi\left(h_D\right) &= p\frac{L}{\sigma}C(h_D) = \frac{\delta}{\sigma}\frac{L\ell^{-\xi}}{n_D + n_X^{*}\phi\varepsilon^{1-\sigma}}, \\
\Pi\left(h_X\right) &= p\left(1+\tau\right)\frac{L^{*}}{\sigma}C^{*}\left(h_X\right) = \frac{\delta}{\sigma}\frac{\phi L^{*}\ell^{*-\xi}\varepsilon^{\sigma}}{n_D^{*} + n_X\phi\varepsilon^{\sigma-1}}
\end{aligned}
\tag{18}
$$

Other things being equal, a higher number of firms (and varieties) in a sector reduces the profits of each firm operating in that sector. In the tradables sector, transportation costs both reduce export profitability and partially shield local firms' profits from foreign competition: if ϕ is close to zero, the denominators of $\Pi\left(h_D\right)$ and $\Pi\left(h_X\right)$ depend only on the number of import-competing firms, n_D and n_D^{*} respectively. When $\phi > 0$, a Home depreciation affects relative profits raising $\Pi\left(h_D\right)$ over $\Pi\left(h_N\right)$, and $\Pi\left(h_X\right)$ over $\Pi\left(h_D\right)$.

With free entry, however, the value of operating profits is pinned down by the cost of creating a specific variety:

$$\Pi\left(h_i\right) = c_i n_i^{\gamma} \qquad i = N, D, X \tag{19}$$

The expressions above define the *free entry conditions*. With no asymmetry in the entry costs across sectors, there can be no difference in operating profits. Note that, from (18) and (15) it follows immediately that operating profits for all firms are proportional to sales. Thus, using (19) the level of entry costs also pins down firms' size:

$$Y\left(h_i\right) = \left(\sigma - 1\right) c_i n_i^{\gamma} \qquad i = N, D, X \tag{20}$$

Combining these expressions with (4),[11] (9), and (19), the aggregate budget constraint can be written as:

$$PC = \ell - F/L \tag{21}$$

Together with the equilibrium wage rate (14), the previous expression implies that Home labor effort is determined as a function of the transfer:

$$\ell^{-\xi} = \ell - F/L \tag{22}$$

The aggregate budget constraint (21) corresponds to the Home aggregate balance of payments:

$$\phi\delta\left[\frac{n_X L^{*}\ell^{*-\xi}\varepsilon^{\sigma}}{n_D^{*} + n_X\phi\varepsilon^{\sigma-1}} - \frac{n_X^{*} L\ell^{-\xi}\varepsilon^{1-\sigma}}{n_D + n_X^{*}\phi\varepsilon^{1-\sigma}}\right] - F = 0 \tag{23}$$

[11] Note that Home per-capita employment is $\ell = \sigma\left(c_N n_N^{\gamma+1} + c_D n_D^{\gamma+1} + c_X n_X^{\gamma+1}\right)/L$.

The first two terms are Home exports less Home imports measured in Home labor units, both inclusive of trade costs.

The expressions for labor (22), profits (18), the free entry conditions (19), and their Foreign analogs, together with the balance of payments (23) identity jointly determine the exchange rate ε, the number of varieties n_N, n_D, n_X, and their Foreign analogs (n_N^*, n_D^*, n_X^*,), as functions of exogenous variables (L, c_N, c_D, c_X and their Foreign analogs, as well as F). The price indexes are then determined according to (13) and Foreign analogs, and the consumption levels is determined according to (22) and its Foreign analog.

In a symmetric equilibrium with $L = L^*$ and $F = 0$, our model is solved by $\ell = \ell^* = 1$ and $\varepsilon = 1$. Aggregate GDP is therefore equal to $L = L^*$. It is convenient to define a synthetic measure of trade openness θ such as:

$$\theta \equiv \left(\frac{c_D}{c_X}\right)^{\frac{1}{\gamma}} \phi^{\frac{1+\gamma}{\gamma}}. \tag{24}$$

Observe that θ depends on both transport costs and the relative fixed cost of entry in the export market. It is straightforward to show that in a symmetric equilibrium with balanced trade, the ratio of exports (or imports) to GDP is equal to $\delta\theta/(1+\theta)$, and the ratio of exportable varieties to import-competing varieties in the tradables sector is $n_X/n_D = \theta/\phi$.[12]

3 Domestic and international implications of a transfer

In this and the next section we use our model to analyze the macroeconomic impact of a transfer F from the Home to the Foreign country. The analysis is along similar lines as Dekle, Eaton and Kortum (2007) and Obstfeld and Rogoff (2007).[13]

The equilibrium implications of the adjustment are shown synthetically in Table 1. In this table, as well as in the text below, we make use of the fact that, for sufficiently small values of F/L, one can approximate the effects of the transfer with the equilibrium multipliers in the neighborhood of the symmetric equilibrium. For any generic variable x, we adopt the notation:

$$\widehat{x} = \frac{dx/x}{dF/L} \tag{25}$$

[12] Note that in the tradables sector, the ratio of export profits to domestic profits $\Pi(h_X)/\Pi(h_D)$ is equal to ϕ in the symmetric equilibrium. Similarly, $\Pi(h_N)/\Pi(h_D) = \frac{1-\delta}{\delta}\frac{1+\theta}{n_N/n_D}$, and the ratio n_N/n_D is equal to $\left[\frac{1-\delta}{\delta}\frac{c_D}{c_N}(1+\theta)\right]^{1/(1+\gamma)}$ in the symmetric equilibrium.

[13] As in the latter paper, we also assume that prices are flexible. However we do not assume a fixed output. This specification allows us to study the endogenous response of labor effort to the transfer, both across sectors and countries.

Table 1: Comparative statics

$$
\begin{aligned}
\widehat{C} &= -\widehat{C^*} = -\delta\frac{\theta\widehat{\varepsilon}}{1+\theta} - \xi\widehat{\ell} + (1-\delta)\frac{\widehat{n_N}}{(\sigma-1)} + \delta\frac{\widehat{n_D}-\theta\widehat{n_X}}{(\sigma-1)(1+\theta)} < 0 && (26)\\
\widehat{\ell} &= \widehat{GDP} = -\widehat{\ell}^* = \frac{1}{1+\xi}. && (27)\\
\widehat{n_N} &= -\widehat{n_N^*} = -\frac{\xi}{(1+\xi)(1+\gamma)} < 0 && (28)\\
\widehat{n_X} &= -\widehat{n_X^*} = \frac{(1+\theta)}{\Gamma(1+\gamma)\theta}\left\{[\sigma(1+\gamma)+\gamma\theta][1+\xi(1-\delta)] + \sigma\xi\delta(1+\gamma)\right\} && (29)\\
\widehat{n_D} &= -\widehat{n_D^*} = \frac{(1+\theta)}{\Gamma(1+\gamma)}\left\{[\sigma+\gamma(\sigma-1)][1+\xi(1-\delta)] - \sigma\xi\delta(1+\gamma)\right\} && (30)\\
\widehat{n_D}+\widehat{n_X} &= \frac{\sigma(1+\theta)}{\theta\Gamma}[(1+\theta)(1+\xi)-2\delta\xi\theta] && (31)\\
\widehat{\varepsilon} &= \frac{\gamma(1+\theta)}{\theta\Gamma}[(1+\theta)(1+\xi)-2\delta\xi\theta] = \frac{\gamma}{\sigma}(\widehat{n_D}+\widehat{n_X}) && (32)\\
\Gamma &\equiv \delta[2\sigma+\gamma(2\sigma-1+\theta)](1+\xi) > 0 && (33)\\
\widehat{RER} &= \frac{1+\theta-2\delta\theta}{1+\theta}\widehat{\varepsilon} + \frac{2\delta}{\sigma-1}\frac{\widehat{n_D}-\theta\widehat{n_X}}{1+\theta} + \frac{2(1-\delta)}{\sigma-1}\widehat{n_N} && (34)
\end{aligned}
$$

3.1 Decomposing the effects of a transfer

As shown in Table 1, adjustment to a transfer requires some combination of falling Home consumption (26) and increasing Home production (27) — in our linearized model changes in these variables are perfectly mirrored, with a different sign, in the Foreign economy. Indexing the domestic macroeconomic cost of a transfer with the utility of the national representative agent, it follows that a transfer unambiguously worsens domestic welfare:

$$\frac{dU}{dF/L} = \widehat{C} - \widehat{\ell} < 0 \tag{35}$$

raising Foreign welfare in the same proportion. Observe that the extent of adjustment in employment (27) depends on the elasticity of labor supply: a very high elasticity ($\xi \to 0$) makes domestic employment move one-to-one with the transfer. Vice-versa, a highly inelastic labor supply ($\xi \to \infty$) implies that all the adjustment takes place via the fall in consumption.

The response of aggregate consumption demand (26) in turn depends not only on the adjustment in employment, but also on changes in the terms of trade *and* the number of product varieties in the different sectors of the economy. For illustration purposes, it is convenient to focus on the case in which labor supply is very inelastic, ($\xi \to \infty$), so that

$\widehat{\ell} = 0$, and welfare changes are completely indexed by changes in domestic consumption. The response of consumption to a transfer can be then broken down into three different components — conveniently related to the points stressed in the controversy between Ohlin and Keynes, as well as to the main arguments in this paper:

$$\widehat{C}\mid_{\xi\to\infty} = \underbrace{-1}_{\text{Ohlin-Samuelson effect}} - \underbrace{\frac{\delta\theta\widehat{\varepsilon}}{1+\theta}}_{\text{Keynes' effect}} + \underbrace{(1-\delta)\frac{\widehat{n_N}}{(\sigma-1)} + \delta\frac{\widehat{n_D}-\theta\widehat{n_X}}{(\sigma-1)(1+\theta)}}_{\text{Extensive margin effect}} < 0 \tag{36}$$

With no change in the terms of trade and/or the extensive margin, consumption falls one to one with the size of the transfer (first term on the right-hand side) — see the discussion of Ohlin's argument by Samuelson (1952). One could observe that this is indeed the *only* effect if goods are homogeneous ($\sigma \to \infty$). When goods are imperfect substitutes, but the number of varieties is fixed, the Keynes' effect (second term on the right-hand side) lowers consumption further, proportionally to the deterioration of the Home terms of trade. Samuelson (1952) refers to this effect as the secondary burden of adjustment. In equilibrium, the exchange rate movement is a function of all parameters in the model; yet observe that, for a given change in ε, the drop in consumption is increasing in openness, as captured jointly by the size of the tradable sector (δ) and the home bias in consumption of tradables (a function of θ).

Behind the curtain of these two effects — Ohlin and Keynes — there is active sectoral adjustment, with reallocation of labor away from the nontradables sector and toward the production of tradables. Reallocation of resources across sectors is driven by the real depreciation of ε, affecting the profitability of firms operating in the export and in the import-competing sectors according to (18). Note that in our framework, the price of domestic import-competing goods relative to nontradables does not move in response to a depreciation — see (15). This is a feature of the model that stems directly from the simplifying assumptions of our framework, although it is supported by empirical evidence of contained movements in domestic relative prices unrelated to productivity developments.

The main lesson from (36), however, is that the overall consumption — and welfare — impact of a transfer is a function of additional factors, essentially capturing adjustment at the *extensive* margin (third term on the right-hand side). Observe that in all the expressions for $\widehat{n_i}$ in Table 1, the magnitude of entry or exit crucially depends on γ, i.e. the convexity of the cost function, indexing the degree of flexibility at the extensive margin. All else equal, the higher γ, the lower the response at the extensive margin.

3.2 Net creation of product varieties across sectors

We can now consider how the transfer affects the supply of product varieties in each sector of the economy, N, X and D in turn. The transfer unambiguously causes Home nontraded varieties n_N to contract according to (28). According to the mechanism discussed at length in the classic transfer-problem controversy, resources are freed from the nontraded good sector in favor of the tradables sector. With adjustment at the extensive margin, however, a key dimension of reallocation consists in the contraction of the array of nontraded goods available to consumers. As preferences exhibit 'love for variety', this is clearly bad news for welfare.

Home exports varieties n_X invariably rise according to (29). It should be emphasized that the transfer of income abroad raises the relative size of the market for Home exports, and, because of economies of scale, the operating profits of domestic exporters. This in turn creates a clear incentive for firms to enter the export market with new goods. For essentially the same reason, the transfer reduces the Home market for imports n_X^*, once again translating into welfare losses for Home residents.

The number of import-competing goods n_D may go either way. Specifically, n_D rises under either of the following two conditions. First, the size of the nontradables sector is large relative to the tradables sector (δ is close to zero) — intuitively, the amount of resources released by the nontradables sector is large enough to sustain an equilibrium expansion in the varieties produced by both the export and the import-competing sector. Second, the labor supply is sufficiently elastic (ξ is close to zero), so that the variety expansion is not constrained by a shortage of labor. When these conditions fail, exit from the nontradables sector n_N and the equilibrium contraction in leisure are not sufficient to compensate for the expansion of the tradables sectors: the number of import-competing varieties n_D has to shrink as well. These considerations make it clear that, even abstracting from the welfare implications of terms of trade movements, adjustment at the extensive margin brings new arguments in favor of the 'double punishment' view of transfers championed by Keynes. Essentially, in Keynes' view, the transfer rises the price of consumption in terms of labor because it increases the price of imported goods in terms of exports. In our framework, the price of consumption can rise independently of the terms of trade, because of the shrinking number of goods varieties in the Home markets.[14]

[14] As we observe below, this effect would not be detected by statistical measures of the Consumer Price Index that do not account for changes in the basket of varieties available for consumption.

3.3 Varieties and international relative prices

The expression (32) in Table 1 sheds light on the equilibrium interaction between extensive margin and terms of trade adjustment. Namely, as long as $\gamma > 0$ (and goods are not perfect substitutes, that is, $\sigma < \infty$), the terms of trade depreciation is proportional to the change in the number of total varieties produced in the Home tradables sector $(n_X + n_D)$.[15] As discussed above, exchange rate movements affect relative operating profits across sectors. In our specification with free entry and a common demand elasticity across sectors — arguably suitable in a world with a large volume of intra-industry trade — differences in the costs of entry must be matched by differences in operating profits. Since entry raises the cost of setting up new varieties to the extent that $\gamma > 0$, the latter parameter effectively indexes the extent to which operating profits can vary at different rates across types of goods.

When γ is close to zero (constant entry costs), free entry ensures that, in equilibrium, firms' operating profits do not change with the transfer.[16] In this case there is no need for terms of trade adjustment in order to switch demand in favor of Home exports, and only the extensive margin of trade is at work: as long as there is 'love for variety', new product varieties can be sold and exported without a fall in relative prices.[17]

Conversely, when γ is strictly positive, adjustment at the extensive margin is relatively difficult and induces asymmetries in entry costs, thus in operating profits across sectors. The terms of trade of the Home country necessarily worsen. Observe that the rate of depreciation tends to be large when trade costs are high (ϕ and therefore θ goes to zero), or the Frisch elasticity is low, making employment less responsive to the transfer.

The last line of Table 1 shows the response of the real exchange rate. In the table, we report the welfare-based real exchange rate, defined in terms of the ratio of price indexes (13) derived in Section 2. Even if the terms of trade depreciate in equilibrium, the real exchange rate may in principle move either way following a transfer, depending on how the price indexes are affected by changes in the availability of varieties according to (34). This is because a fall in the number of varieties available to domestic consumers translates into an increase in the welfare-based Consumer Price Index P, reducing the equilibrium

[15] Note (see equation 31) that the sign of the change in the terms of trade and of $(n_X + n_D)$ depends on the sign of expression: $(1+\theta)(1+\xi) - 2\delta\xi\theta$. A sufficient condition for this is $\theta < 1$ or $n_X/n_D < 1/\phi$ (see equation 24) where $\phi < 1$. We assume this is the case.

[16] The case of a constant or even decreasing fixed cost is standard in endogenous growth models with expanding product variety, as analyzed for example in Grossman and Helpman (1991) and Barro and Sala-i-Martin (1995).

[17] The same is true if $\gamma > 0$ but the cost function in the tradables ector is assumed to be symmetric across goods types, say, it depends on $n_D + n_X^*$ and $n_D^* + n_X$. In this case, operating profits are constrained to move proportionally with the common cost, leaving no room for relative price adjustment.

depreciation rate for any given change in product prices.[18]

As already mentioned, the choice-theoretic price indexes we derive do not necessarily correspond to the statistical indexes adopted in practice, as these typically do not account for changes in the number of market-available varieties. To shed light on the behavior of 'statistical' measures of the real exchange rate in the context of our model, we can examine (34) conditional on keeping constant the number of varieties — i.e. by setting the two last terms on the right-hand side equal to zero. For convenience, we reproduce the expression below:

$$\widehat{RER}\Big|_{\widehat{n_i}=0} = \frac{1+\theta-2\delta\theta}{1+\theta}\widehat{\varepsilon} \tag{37}$$

Ignoring the extensive margin, the statistical measure of the real exchange rate would unambiguously record a depreciation, i.e. it would move proportionally to the terms of trade, with the constant of proportionality depending on the degree of home bias. The rate of depreciation according to the statistical measure of the real exchange rate thus falls somewhere between the rate of depreciation of the terms of trade ε and the rate of change of the welfare-based real exchange rate RER.[19]

3.4 Adjustment margins and trade flows

To shed additional light on the interaction between adjustment at the extensive and the intensive margin, we rewrite Home exports X and imports M as follows:

$$X = n_X \cdot \left(\frac{\delta\phi L^* \ell^{*-\xi}\varepsilon^{\sigma}}{n_D^* + n_X\phi\varepsilon^{\sigma-1}}\right) \qquad\qquad M = n_X^* \cdot \left(\frac{\delta\phi L \ell^{-\xi}\varepsilon^{1-\sigma}}{n_D + n_X^*\phi\varepsilon^{1-\sigma}}\right) \tag{38}$$

Strictly speaking, the extensive margin of exports is given by the change in the number of exportable varieties n_X (the first term on the right hand side). However, changes in the volume of exports of a given variety (i.e. the intensive margin, corresponding to the terms in parenthesis on the right-hand side) also depend on the number of Foreign import-competing varieties, as well as the number of Home exported varieties themselves. These affect the size of the sales by each individual exporter, via their endogenous effect on total demand for Home products in the Foreign market.

[18] In the simulations reported in Section 4 below, RER typically depreciates, i.e. expression (34) is positive. This is due to the fact that, under the assumed parameters' values, weaker terms of trade and net entry in the tradables sector more than compensate for the drop in the number of nontraded varieties. However, an appreciation scenario is not implausible. For parameters' values that downplay the size of the terms of trade adjustment, the rise in the welfare-based price index of Home consumption (16) can easily result in an overall real appreciation.

[19] Similarly, Ghironi and Melitz (2005) carry out an extensive 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.

To provide insight on the general-equilibrium interaction between extensive and intensive margins, in what follows we write the response of Home exports and imports to a transfer distinguishing between the two margins, labelled 'extensive' and 'intensive' according to standard conventions:

$$\widehat{X} = \underbrace{\widehat{n_X}}_{extensive} + \underbrace{\frac{1}{1+\theta}\left[\widehat{n_D} - \theta\widehat{n_X} + (\sigma+\theta)\widehat{\varepsilon} + \xi(1+\theta)\widehat{\ell}\right]}_{intensive} \tag{39}$$

$$\widehat{M} = \underbrace{-\widehat{n_X}}_{extensive} - \underbrace{\frac{1}{1+\theta}\left[\widehat{n_D} - \theta\widehat{n_X} + (\sigma-1)\widehat{\varepsilon} + \xi(1+\theta)\widehat{\ell}\right]}_{intensive} \tag{40}$$

As apparent from the expression above, the term in square brackets on the right hand side of (39) can be further decomposed into different multipliers. These consist of the change in the level of competition on the export market (captured by $\widehat{n_D} - \theta\widehat{n_X}$), the change in the terms of trade, and the wealth effect of the transfer on labor supply.

The above expression suggests that a theory-consistent definition of the extensive margin of trade adjustment should actually encompass both direct and indirect effects from entry and exit of new varieties. Namely, the label 'extensive' should include the first two terms in square brackets on the right-hand side of (39), while the label 'intensive' should residually include only the last two terms.[20] Such classification would fully account the general-equilibrium implications of changes in the number of varieties as predicted by the theory — but its implementability in empirical studies would be highly demanding.

4 Quantitative simulations

In this section we calibrate our model as a first pass toward a quantitative assessment of the macroeconomic adjustment associated with global or regional rebalancing. In the previous section, for the sake of simplicity we posited a symmetric balanced equilibrium and studied the effects of a transfer from Home to Foreign, requiring the latter's external position to move to a surplus equal to the size of the transfer itself. In this section we account for asymmetries across countries, and the initial conditions are such that the Home country runs a trade deficit. We then consider the effects of a transfer that restores the balanced equilibrium over a sufficiently extended time horizon in which firms can enter and exit the product market — abstracting from changes in productivity and government policies. We analyze the response of the economy under different assumptions about the degree of economic 'flexibility' in creating new product varieties, and discontinuing existing ones.

[20] It is worth stressing that adjustment at the intensive margin also comes in two parts: exports of each variety increase because of the terms of trade depreciation, and expenditure in the Foreign country rises due to the effect of the transfer.

4.1 Calibration

The size of the world economy is normalized to 200 and we choose $L = 54$ and $L^* = 146$ so that the Home country roughly approximates the weight of the U.S. economy in world GDP, about 27 percent in 2006. Consistently, we consider the effects of a transfer $F = 3.5$ as the Home country deficit moves from slightly below 6.5 percent of GDP (as was the U.S. deficit in 2006) to zero. This is of course an extreme adjustment scenario, deliberately chosen to facilitate the comparison between our results and the Obstfeld-Rogoff calculations.

In our baseline calibration (denoted *Benchmark* in what follows) the elasticity of substitution between product varieties σ is set equal to 2, a value consistent with macro studies of current account adjustment. We also experiment with $\sigma = 5$, a value suggested by trade studies. Following Obstfeld and Rogoff (2007) we take the share of tradables to be 25 percent of consumption (e.g. $\delta = 0.25$), although in sensitivity analysis we consider the implications of values as high as $\delta = 2/3$.

We normalize c_N and c_N^* to one, and set c_X and c_X^* such that the ratio of exports to GDP is 11 percent in the Home country and 6.6 percent in the Foreign country (corresponding to 2006 values).[21] The specific values of c_D and c_D^* only affect the ratios n_X/n_D and n_X^*/n_D^* without modifying relative profits across sectors, thus leaving unchanged the equilibrium allocation of resources and agents' response to macroeconomic shocks. We normalize these values to one.

Trade costs τ are set at 20 percent based on the estimate of transport costs in Anderson and van Wincoop (2004). The authors find that a rough estimate of the tax equivalent of representative trade costs for industrialized countries is 170 percent, the product of transportation costs (21 percent), border-related trade barriers (44 percent), and retail and wholesale distribution costs (55 percent). It is important to observe that if we modify both the value of *iceberg* trade costs τ and the fixed export costs c_X and c_X^* while maintaining unchanged the trade openness ratios, the results of the simulations remain unaffected. Thus, in sensitivity analysis we consider the case in which the iceberg trade costs increase while the export fixed costs are the same as in the *Benchmark* calibration, and analyze how our results are affected by changes in trade openness. Specifically, we rely on the Anderson and van Wincoop joint estimate of transportation costs and border-related trade costs, suggesting a 74 percent overall *iceberg* cost τ (where $1.74 = 1.21 * 1.44$).

The parameter γ, measuring the convexity of the cost function for the creation of new varieties, is directly related to the relative importance of extensive margin adjustment.

[21] The latter value is equal to U.S. imports from the rest of the world in 2006 (about \$2,280 billion) divided by world GDP excluding the U.S. in 2006 (\$47,800 billion minus \$13,000 billion).

Hummels and Klenow (2005) show that the extensive margin accounts for two-thirds of the greater exports of larger economies. In our model, the latter effect is equal to the share of $\widehat{X}/\widehat{L}$ that stems from the creation of new varieties, that is $1/(1+\gamma)$. If the latter is equal to 2/3, then γ should be 0.5 in the long run. However, Galstayn and Lane (2008) show that in the case of the United States, over the time period 2000-2004 around half of the growth in international trade occurred along the extensive margin. This suggests a higher γ, around unity (i.e. a quadratic cost function). In addition, Bernard, Redding and Schott (2010) consider production levels in the U.S. manufacturing sector across 5-digit U.S. SIC categories — within a 5-year census period, they find that 93 percent of firms (weighted by output) change their product mix, and 87 percent both add and drop products. Product creation over the 5-year horizon (both by existing firms and new firms) is equal to 46.6% of output, a stylized fact that also implies a value of γ around unity. In light of these considerations we choose $\gamma = 1$ as our *Benchmark* case. In sensitivity analysis we experiment with the calibration suggested by Hummels and Klenow ($\gamma = 0.5$) as well as a more conservative parameter value ($\gamma = 2$).[22] In addition, we consider a calibration with smaller levels of γ (0.25 and 0), to emphasize the differences between a model in which all adjustment occurs at the extensive margin, and the conventional 'fixed-variety' models in which all adjustment occurs at the intensive margin.[23]

Finally, micro studies using data on wages, hours worked and various household characteristics suggest a low value for the Frisch elasticity ($1/\xi$), with most estimates in the range of 0 to 0.5 (see for example Heckman and MaCurdy (1980), MaCurdy (1981), Altonji (1986), Blundell and MaCurdy (1999)). However, these micro estimates are incompatible with macroeconomic models that use values in the range of 3 or higher (see e.g. Browning, Hansen and Heckman (1999)). In our benchmark parameterization we choose $\xi = 1$, following Gali, Gertler and López-Salido (2007). In sensitivity analysis we consider the cases $\xi = 0$ (or infinite elasticity, corresponding to the Hansen (1985) and Rogerson (1988) model of indivisible labor) and $\xi = 5$.

[22] Not surprisingly, estimates of γ are highly sensitive to the time horizon under consideration. Berman, Martin and Mayer (2011) consider French firm-level data and show that the probability that exporters enter a specific destination market increases significatively following a euro depreciation with respect to this destination. This is a short-term effect as it takes place in the year following the depreciation. Over such a short horizon, the extensive margin is around 10% of the total increase of exports.

[23] Note that when we consider alternative values for γ, we keep the openness ratios invariant (c_X and c_X^* adjust endogenously). This implies that the post-transfer openness ratio in a balanced-trade steady state will change as a function of γ: to wit, the higher the level of γ, the lower the Home country export/GDP ratio in steady state.

4.2 Simulation results

Table 2 reports the simulation results under alternative parameterizations. The Table contrasts our 'endogenous-variety' model (columns 1 through 8) with a 'fixed-variety' specification in which product varieties remain unchanged and current account adjustment only occurs at the intensive margin (columns 9 through 12). For each variable in the Table 2, we report the changes associated with a transfer F as a percentage of the balanced-trade equilibrium levels.

Our baseline parameterization is displayed in the first row of the table (*Benchmark*). A transfer from the Home country to the rest of the world is associated with a 1.6 percent contraction in the nontradables sector n_N, a 4.4 percent increase in the (varieties produced by the) import-competing sector n_D,[24] and a 24.9 percent expansion in the export sector n_X (abroad, the export sector n_X^* contracts by 24.5 percent). The terms of trade (and the relative price of labor ε) depreciate by 17.6 percent, while the CPI-based real exchange rate RER depreciates by only 8.3 percent, reflecting the interaction between intensive and extensive margins. In the fixed-variety model (see the last four columns of the Table) the adjustment relies exclusively on movements in relative prices: the terms of trade depreciate by more than twice the endogenous-variety model (38.2 versus 17.6 percent), and the extent of RER depreciation is almost four times larger.

The transfer is associated with an expansion of employment and GDP in the Home country (labor effort ℓ increases by 3.3 percent), but external demand crowds out internal demand and Home consumption C falls by 6.1 percent. As a result, welfare unambiguously falls in the Home country. Welfare also falls in the fixed-variety model, as consumption falls and labor effort rises. It is straightforward to compare welfare losses across models, since labor movements are identical whether or not the extensive margin is operational. Thus, what matters is the fall in consumption, which is slightly larger in the endogenous-variety model (6.1 percent) than in the fixed-variety model (5.2 percent).

When varieties are relatively more substitutable in global consumption ($\sigma = 5$), the welfare loss is almost the same in the fixed-variety model as in the endogenous-variety setup. The parameterization of σ does not influence the response of labor effort, but affects the change in consumption (the higher is σ, the smaller is the equilibrium contraction of C). When we increase σ from 2 to 5, the fall in consumption shrinks from 6.1 to 4.0 percent in the endogenous-variety model, mainly because consumers get less utility from varieties when

[24] As previously discussed, it is possible to consider scenarios in which n_D actually *falls* due to the effect of the transfer. For instance, in our case this happens when the Frisch elasticity is sufficiently low *and* the share of tradables is particularly (and implausibly) high: see the results reported in row $\xi = 5, \delta = 2/3$.

Table 2: Numerical simulations

	Endogenous-Variety Model								Fixed-Variety Model			
	n_N	n_D	n_X	n_X^*	ε	RER	ℓ	C	ε	RER	ℓ	C
Benchmark	−1.6	4.4	24.9	−24.5	17.6	8.3	3.3	−6.1	38.2	30.1	3.3	−5.2
$\sigma = 5$	−1.6	5.7	21.5	−22.8	6.5	4.1	3.3	−4.0	13.8	11.1	3.3	−3.9
$\xi = 0$	0.0	6.6	23.9	−23.8	18.3	12.9	6.5	−1.6	37.9	30.1	6.5	−2.2
$\xi = 5$	−2.7	2.9	25.7	−24.9	17.1	4.9	1.1	−9.2	38.5	30.3	1.1	−7.3
$\xi = 5, \delta = 2/3$	−2.7	−1.2	27.6	−22.4	12.8	2.3	1.1	−8.9	31.8	25.4	1.1	−6.9
$\gamma = 0$	−3.2	13.4	42.7	−38.7	0.0	−7.2	3.3	−6.2	34.3	27.2	3.3	−5.2
$\gamma = .25$	−2.5	9.2	36.6	−33.9	6.5	−1.8	3.3	−6.3	35.7	28.3	3.3	−5.2
$\gamma = .5$	−2.1	6.9	31.8	−30.1	11.2	2.4	3.3	−6.2	36.8	29.1	3.3	−5.2
$\gamma = 2$	−1.1	2.5	17.3	−17.8	24.6	15.1	3.3	−5.9	39.7	31.3	3.3	−5.2
$\tau = .74$	−1.6	2.8	43.2	−34.7	25.5	16.3	3.3	−5.8	57.3	49.4	3.3	−4.7

goods become more homogeneous. The same variable declines from 5.2 to 3.9 percent in the fixed-variety model: the terms of trade depreciate less if goods are more substitutable. Obviously, with a high elasticity of substitution σ, both our argument stressing loss of utility from product varieties and the Keynesian argument stressing adverse movements in the terms of trade become less consequential — the welfare losses converge across different versions of the model. At the same time, with a large σ, small equilibrium movements in relative prices can have a large impact on trade values.[25]

These results suggest that real exchange rate movements, much emphasized in the traditional literature on current account rebalancing, are highly imperfect gauges of the social costs associated with the adjustment process. It is certainly possible to envision scenarios of current account rebalancing involving small exchange rate depreciations, and nevertheless associated with welfare losses as large as the ones that occur in alternative scenarios whereas relative prices play a much more conspicuous role.

Observe that, for a given σ, adjustment at the extensive margin effectively raises the trade elasticity over the medium run, thus dampening the price movements required to redirect world demand away from domestic importables and toward domestic exportables. In this respect, both our endogenous-variety model with a relatively low elasticity of substitution (say $\sigma = 2$) and a fixed-variety model with a high elasticity of substitution (say $\sigma = 5$) similarly predict a small change in relative prices. However, the overall macroeconomic response to a transfer across these two specifications is quite different: the fall in consumption in the endogenous-variety model is much larger *vis-à-vis* the fixed-variety model, -6.1 percent versus -3.9 percent. Again, these results suggest that relative price changes associated with a given transfer need not be a reliable measure of social welfare loss.

An economy in which welfare worsens more in the fixed-variety model than in the endogenous-variety model is one in which the Frisch elasticity is high (that is, ξ is low). Consider the row corresponding to $\xi = 0$ in Table 2. As labor supply is infinitely elastic, the transfer does not require any contraction in the nontradables sector ($\widehat{n_N} = 0$). Exchange rates adjust more than in the *Benchmark* cases in the endogenous-variety model. In both model specifications, labor effort increases almost twice as much as in *Benchmark*. Consumption falls 2.2 percent in the fixed-variety model, but only 1.6 percent in the endogenous-variety model. With a Frisch elasticity lower than in the *Benchmark* case ($\xi = 5$), more of the adjustment falls on consumption, and less on employment.

The parameter γ is key to our numerical simulations and welfare comparisons, as it

[25] Pappada (2008) analyzes the impact of the elasticity of substitution on the terms of trade adjustment required by a transfer. He finds that when firms are heterogenous a higher elasticity of substitution increases the role played by the extensive margin and reduces the extent of the required depreciation.

determines the importance of the extensive margin. When $\gamma = 0$ the exchange rate does not move at all in the endogenous-variety model ($\widehat{\varepsilon} = 0$) and all adjustment occurs through the reallocation of product varieties, in strong contrast with the traditional view captured by the fixed-variety model (see last four columns). If we set the parameter γ equal to .5 — consistent with the estimate of the extensive margin by Hummels and Klenow (2005) — the relative price changes are smaller than in the *Benchmark* case. In contrast, raising the value of γ brings our model progressively closer to the fixed-variety model. Interestingly, the welfare difference across the two models is non-monotonic in γ: when $\gamma = 0.25$ the difference between the welfare losses is maximized. The gap between the two welfare losses is the same when either γ falls to 0 or increases to 0.5. The gap eventually disappears when γ is sufficiently high.[26]

The last row of Table 2 considers a change in the parameter τ, the *iceberg* trade cost, affecting trade openness in both the Home country and the rest of the world. Specifically, an increase in τ (from 0.2 to 0.74 as described above) reduces the export to GDP ratio from 11 percent to 8.5 percent in the Home country and from 6.6 percent to 2.9 percent in the Foreign country. In this case, quite intuitively, a larger increase in exports and a larger decrease in imports must take place in equilibrium, requiring a larger exchange rate adjustment. This is the case both in the endogenous- and the fixed-variety models.

5 Endogenous transfers

So far, we have analyzed the transfer problem tracing the effects of a cross-border lump-sum payment on international prices, consumption and the sectoral composition of output. This analytical framework (widely adopted in the classical controversy) takes the transfer as an exogenous shock, whose size and direction are left unexplained. In what follows we embed the results from this approach within a framework that accounts explicitly for current account dynamics. To this end, we specify a stylized framework in which the 'transfer problem' emerges endogenously in terms of the financial cross-border flows associated with agents' optimal intertemporal decisions in response to current and expected future fundamentals. As shown below, the main insights from the previous section carry through to this new framework. There are nonetheless a few important new results, worth commenting upon in some detail.

Consider an intertemporal version of our two-country model. Starting from a steady

[26] As highlighted above, the openness ratios in steady state are a function of γ. When we compare the endogenous-variety and the fixed-variety results, we keep the steady state variables unchanged across the two exercises. This explains why in the fixed-variety model an increase of γ — that lowers the Home country steady-state openness ratio — is associated with larger adjustment of both RER and ε.

state with no net foreign assets, we analyze current account dynamics over two periods: in period 0 the Home country runs an external deficit; in period 1 it closes its external imbalance. In what follows, a period represents a sufficiently extended time horizon, to capture the dynamics associated with the build-up and subsequent stabilization of external debt.[27]

Relative to the approach adopted in the previous section, it is now necessary to specify how the Home economy comes to face the transfer problem in period 1, that is, we need to take a stand on the determinants of the Home current account deficit in period 0. For illustrative purposes, we focus on three hypotheses echoing popular views of global imbalances. One attributes the Home imbalance to a temporary contraction of Home savings. We refer to this as the *Demand shock* scenario. Another view considers a temporary increase in output and saving in the Foreign country. This is the *Supply shock* scenario. Both these views are based on a rational (i.e. certainty-equivalence) assessment of current and future fundamentals. On the contrary, a third possibility focuses on misperceptions about future fundamentals and over-optimistic beliefs. This can be thought of as 'news' inducing expectations of higher future Home output in period 1, and leading in equilibrium to an expectations-driven boom in period 0. Ex post, expectations turn out to be wrong. We refer to this as the *News shock* scenario. A parsimonious way to model these hypotheses consists of assuming either a temporary fall in the discount rate of Home consumers (raising their desire to spend in period 0), or a temporary decrease in the disutility of labor in the Foreign country (raising the supply of output and exports in the rest of the world in period 0), or expectations in period 0 of a decrease in Home labor disutility in period 1.

For consistency with the previous section, we calibrate these fundamentals shocks such that the Home country deficit in period 0 increases the country's external debt by the same amount F as above, discounted at the equilibrium world interest rate, and assume that principal and interests are entirely paid back to the Foreign country by the end of period 1: under these conditions, the transfer in period 1 is exactly the same as in our previous static simulations. Different from the previous section, however, in the *Demand* and *Supply shock* scenarios the dynamics of adjustment in period 1 is perfectly anticipated by markets already in period 0. Instead, in the *News shock* scenario, agents in period 1 realize that their previous expectations were biased to the upside. This unanticipated discovery requires a modification of the previous exports plans based on the 'wrong' productivity parameters, and thus entails an unexpected payment from Home to Foreign on top and above the previously projected

[27] The model abstracts from medium-term investment dynamics and capital accumulation. However, within a time period firms invest in the creation of new varieties.

dynamics of current account unwinding.

The setup of the model is amended as follows. At the beginning of period 0, the Home country representative household's utility is:

$$U = \log C_0 - \frac{\kappa_0}{1+\xi}\ell_0^{1+\xi} + \beta\left(\log C_1 - \frac{\kappa_1}{1+\xi}\ell_1^{1+\xi}\right) \tag{41}$$

where subscripts 0 and 1 denote time periods, β is the discount factor and κ indexes the disutility of labor — the Foreign country's utility function being analogously defined. As already mentioned, the shocks we will focus on consist of an unexpected temporary fall in β (the Home discount rate of period 1 utility), an unexpected temporary fall in κ_0^* (the disutility of labor in the Foreign country in period 0), and an expected (but not realized) fall in κ_1.

Maintaining the notational conventions of the previous sections, the Home flow budget identities are:

$$\begin{aligned} P_0C_0 + I_0 &\leq \ell_0 + \Pi_0 + \frac{1}{1+r}F/L \\ P_1C_1 + I_1 &\leq \ell_1 + \Pi_1 - F/L \end{aligned} \tag{42}$$

where F/L is Home per-capita borrowing from Foreign households at time 0, and r is the world interest rate in terms of Home labor units. The intratemporal first-order conditions are identical as in the previous section, with the exception of the optimal labor supply that now responds to labor disutility parameters. Maintaining the normalization $w_t = w_t^* = 1$, this implies $1 = \kappa_0\ell_0^{\xi}P_0C_0 = \kappa_0^*\ell_0^{*\xi}P_0^*C_0^*$. In addition, we now have the Euler equations linking current and future marginal utilities of consumption:

$$\begin{aligned} C_1/C_0 &= \frac{\beta(1+r)P_0}{P_1} \\ C_1^*/C_0^* &= \frac{\beta^*(1+r)\varepsilon_0 P_0^*}{\varepsilon_1 P_1^*} \end{aligned} \tag{43}$$

In equilibrium, the following relations hold:

$$\kappa_0^{-1}\ell_0^{-\xi} = \ell_0 + \frac{1}{1+r}F/L; \qquad \kappa_1^{-1}\ell_1^{-\xi} = \ell_1 - F/L \tag{44}$$

and the Home aggregate balance of payment equations (in Home labor units) are now:

$$\phi\delta\left[\frac{n_{0X}L^*\kappa_0^{*-1}\ell_0^{*-\xi}\varepsilon_0^{\sigma}}{n_{0D}^* + n_{0X}\phi\varepsilon_0^{\sigma-1}} - \frac{n_{0X}^*L\kappa_0^{-1}\ell_0^{-\xi}\varepsilon_0^{1-\sigma}}{n_{0D} + n_{0X}^*\phi\varepsilon_0^{1-\sigma}}\right] + \frac{1}{1+r}F = 0 \tag{45}$$

$$\phi\delta\left[\frac{n_{1X}L^*\kappa_1^{*-1}\ell_1^{*-\xi}\varepsilon_1^{\sigma}}{n_{1D}^* + n_{1X}\phi\varepsilon_1^{\sigma-1}} - \frac{n_{1X}^*L\kappa_1^{-1}\ell_1^{-\xi}\varepsilon_1^{1-\sigma}}{n_{1D} + n_{1X}^*\phi\varepsilon_1^{1-\sigma}}\right] - F = 0 \tag{46}$$

Results from our numerical simulations are shown in Table 3. These exercises are carried out under the same parameterization as for the *Benchmark* case in the previous section.

Table 3: Numerical simulations with endogenous transfers

	n_N	n_D	n_X	n_X^*	ε	RER	ℓ	C
Demand shock								
β falls relative to β^*								
t_0	1.0	−4.3	−15.9	19.5	−10.5	−5.1	−2.1	4.6
t_1	−1.6	4.4	24.9	−24.5	17.6	8.3	3.3	−6.1
Supply shock								
κ_0^* falls relative to κ_0								
t_0	1.6	−12.1	−10.7	46.4	−22.5	−34.9	−3.1	8.7
t_1	−1.6	4.4	24.9	−24.5	17.6	8.3	3.3	−6.1
News shock								
κ_1 wrongly expected to fall								
t_0	0.9	−4.1	−15.0	18.4	−9.9	−4.9	−1.9	4.3
expected t_1	23.6	33.5	33.9	−15.0	25.3	42.5	59.2	85.2
actual t_1	−1.6	4.4	24.9	−24.5	17.6	8.3	3.3	−6.1

With the discount rates β and β^* set at a common level in both countries (we choose $\beta = \beta^* = 1/1.1$) and $\kappa_0 = \kappa_0^* = \kappa_1 = \kappa_1^*$ all set equal to 1, the world allocation at both time 0 and time 1 thus coincides with the end-of-period (balanced trade) allocation of the *Benchmark* case. As before, the Table reports the percentage deviations in eight variables of interest relative to this steady state allocation. The first two rows consider the *Demand shock* case in which β at time 0 falls below $\beta^* = 1/1.1$. The next two rows consider the *Supply shock* scenario in which κ_0^* falls below $\kappa_0 = 1$. As already mentioned, to facilitate the quantitative comparison with the previous simulations, in both exercises we set the size of the shocks so that the endogenous transfer F in period 1 has the same size as the exogenous transfer in the *Benchmark* simulations, that is, $F = 3.5$ in terms of Home labor units, or slightly below 6.5 percent of Home GDP.

Since results from the first two experiments are quite similar, we can focus our discussion on the effects of an unanticipated fall in κ_0^* (by about 66 percent in the simulation), causing a large equilibrium expansion in employment, output and net saving in the Foreign country in period 0, and a drop in the world real interest rate (not included in the Table). As the Foreign economy experiences a transitory surge in growth, Foreign residents are willing to lend to Home residents: more goods are exported to the Home country, which runs a current account deficit while benefitting from stronger terms of trade (ε_0 appreciates by 22.5 percent and RER_0 by 34.9 percent). Home and Foreign residents optimally smooth consumption of goods and leisure: at Home, ℓ_0 falls by 3.1 percent and C_0 rises by 8.7 percent.[28] The fall in Foreign goods prices causes a large increase in the number of Foreign varieties imported by Home (n_X^* increases by 46.4 percent), and crowds out the Home export and import-competing sectors. The high level of Home consumption nonetheless sustains a moderate expansion of the Home nontraded good sector (n_N increases by 1.6 percent).

When the Home country unwinds its external obligations in period 1, macroeconomic adjustment occurs exactly along the lines of the transfer mechanism analyzed in the previous section. The equilibrium responses are the same as in the *Benchmark* simulations of the previous section (compare the fourth row of Table 3 with the first row of Table 2). To support the transfer, Home country resources move from the nontradables to the tradables sectors, the terms of trade and the real exchange rate depreciate, labor supply expands in the Home country and contracts abroad, consumption falls in the Home country and rises abroad.

By making transitional dynamics explicit in our analysis, however, the two-period framework makes it clear that macroeconomic volatility may be pronounced along the long-term adjustment path. As shown in Table 3, prices and quantities swing considerably between period 0, when the external imbalances are built up, and period 1, when the imbalances are closed. Home consumption shrinks by about 15 percentage points between the two periods, employment rises by more than 6 percentage points. Both the terms of trade and the real exchange rate worsen by more than 40 percent, and the cumulative expansion of exportables at the extensive margin is as high as 35 percent. The reason for the large volatility in low-frequency time series is straightforward: relative to steady state, all the macro variables and prices adjust in different directions along the different phases in which the large-scale external imbalance is built up at first, then corrected. It is worth emphasizing that the magnitude of the exchange rate adjustment in this and the other exercises reported in Table 3 is comparable to the required trend depreciation as discussed by Obstfeld and Rogoff (2005, 2007).

Relative to the case of shocks to κ_0^*, the impact of a *Demand shock* driven by Home time preferences (first two rows of Table 3) is quite similar. Keeping in mind that adjustment in period 1 is identical by construction, observe that the response of prices and quantities in period 0 is somewhat milder, with the exception of n_X.

A different intertemporal profile emerges within the *News shock* scenario (last three rows of Table 3). In period 0 Home agents raise their consumption of goods and leisure financed

[28] Note that optimal smoothing here occurs subject to the terminal condition that the external debt is entirely paid back in period 1.

through external borrowing, their purchasing power boosted by significant real appreciation. Underlying the build-up of the Home current account deficit in period 0 is the expectation of a massive productivity boost in period 1. In period 0, agents anticipate that the rate of employment will substantially increase in period 1 (ℓ_1 is expected to increase 59.2 percent relative to steady state); the economy will produce many new varieties of both tradables and nontradables; households will enjoy major consumption gains (C_1 is expected to increase no less than 85.2 percent). In period 1, when eventually (and regrettably) the anticipated productivity bonanza does not materialize, agents unexpectedly realize they are now forced to repay their Foreign creditors without any help from nature or technology. The pattern of adjustment ("actual t_1" in the last row) is exactly the same as in the other transfer scenarios above. The comparison between realized and expected changes in varieties, labor effort and especially consumption at time t_1 (last two rows of Table 3) conveys quite dramatically the scale and extent of this expectational illusion, and its welfare dimensions. In time series terms, nonetheless, the actual changes in quantities and prices are quantitatively and qualitatively similar to the *Demand shock* scenario.

Richer models could of course provide more detailed insights on adjustment dynamics and the effect of the transfers. However, a key conclusion from our exercises is arguably robust to changes in model specification. Namely, low-frequency swings of the real exchange rate and the terms of trade may be substantial across phases of growing and falling deficits, but these movements should be expected to be wider if there were obstacles to free entry and net creation of product varieties, that is, if the whole adjustment took place exclusively at the intensive margin. Consider in fact adjustment in an economy hit by the same *Supply, Demand* and *News* shocks as above, but where the number of varieties remains unchanged over time (as in the fixed-variety model of Table 2). Not surprisingly, the main message of the previous section still holds: the change in real exchange rate and terms of trade is much larger than in Table 3. For example, in the case of the *Supply shock* scenario with fixed varieties, the real exchange rate first appreciates by 33 percent in period 0 but then depreciates by 66 percent in period 1. In comparison, when product varieties adjust endogenously the real exchange rate first appreciates by a comparable amount but next depreciates by only 8.3 percent (see table 3). For the terms of trade, under fixed varieties the appreciation in period 0 is 39 percent and the subsequent depreciation is a massive 87 percent. Again, this is much larger than the range of fluctuation under endogenous varieties, namely an initial 22.5 percent appreciation followed by a 18 percent depreciation.

6 Conclusion

In this paper we have revisited the classic model of international transfer to account (realistically) for the role of firms' entry and exit. In contrast with the conventional view that predicts large currency declines as a required dimension of the rebalancing process, our model suggests that real exchange rate deviations from long-run trends may be quite contained once net creation and destruction of product varieties are brought centerstage. This result is consistent with the stylized facts on recent episodes of trade and current account adjustment in industrialized countries. Freund and Warnock (2007) consider 26 episodes between 1980 and 2003 in which the current account deficit was at least 2 percent of GDP before going through a reversal. These countries on average experienced a real depreciation. But the resolution of large deficits did not require a more extensive depreciation, nor was more likely to be associated with an exchange rate crisis. If anything, large and persistent deficits involved less depreciation than average. Focusing on the U.S. case, Fratzscher, Juvenaly and Sarno (2007) show that shocks to the real exchange rate have been a relatively minor driver of past current account developments, accounting for only about 7 percent of the movements of the U.S. trade balance at a horizon of 20 quarters. The conclusion is that a large real exchange depreciation is neither a sufficient nor a necessary condition for resolving global and regional imbalances.

In practice, it is fair to acknowledge that exchange rates have vastly erred on either side of purchasing power parity across the main currency areas of the world, and large and persistent swings have systematically eluded theoretical explanations. Nevertheless, while in real effective terms the movements of the dollar in the pre-crisis period (between 2002 and 2007) have been quite significant, their impact on global current account balances has been limited. Real dollar depreciation has been large relative to countries without a significant current account surplus vis-à-vis the United States (such as the European countries), but very contained relative to countries with large bilateral surpluses (such as China and the Gulf countries), that is, relative to the main counterparts of the large U.S. imbalance. Since late 2008 the contraction of world activity and the collapse of oil and commodity prices associated with the meltdown of global financial markets have partially contributed to closing the U.S. net saving gap, at the same time the U.S. dollar has somewhat appreciated in effective terms, due to safe-haven considerations in international markets.

At the regional level, the conventional diagnosis for the structural ills of the European periphery includes real depreciations — led by large-scale wage and price disinflations — to regain cost competitiveness and close trade gaps with respect to its trade partners. While our model is too stylized to deal with the complexities and nuances of the ongoing European scenarios, it nevertheless suggests that policies that reduce obstacles to firms' entry, lower start-up costs, and provide incentives for product differentiation, would allow European rebalancing to proceed along a different path in which net creation of new varieties of tradables plays a more conspicuous role.

But these considerations come with a caveat. From a welfare perspective, a final implication of our model is that fluctuations in real currency values, much emphasized in the traditional literature on current account reversals, are important but only imperfect gauges of the social costs associated with the long-term adjustment process. Rebalancing driven by extensive margin adjustment and thus associated with a moderate real depreciation would not necessarily be the scenario associated with lower welfare losses. The 'secondary burden' of the transfer would simply shift from adverse movements in the terms of trade onto adverse movements in the basket of goods available to consumers. This would lead to utility losses stemming from a reduced number of product varieties in the domestic markets, and indexed by higher welfare-based consumption prices, rather than the more traditional sources of welfare deterioration stressed in the classic Keynes-Ohlin debate.

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