An Anatomy of The Transfer Problem

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Abstract

This paper studies the transfer problem in a model featuring comparative advantage, monopolistic competition, trade costs, and firm biased heterogeneity. The results are very different from those of the previous literature. First, a transfer creates a secondary burden where the neoclassical version of the Heckscher-Ohlin model would not. Second, a transfer gives rise to changes in inequality. Third, a transfer is not neutral to world welfare. Fourth, the welfare effects are qualitatively insensitive to the exchange rate regime. Fifth, a simulation exercise show that the secondary burden for the U.S. derived from closing up the trade deficit is about one and a half times the welfare benefit from NAFTA.

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1 Introduction

"The more things change the more they are the same. After the First World War economists discussed the effects of a unilateral transfer - such as reparations - on the terms of trade. And in the 1950s, as the end of the Marshall Plan comes into sight, economists must once again consider an identical analytic problem - the possible effects of a cessation of unrequited imports on the terms of trade." Samuelson (1952, p. 278). And again, in the XXI century we are confronted with analytically similar problems such as the effects of rebalancing Asian trade surpluses, or the effects of debt reductions in the

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Euro-zone, or the effects of intra-European transfers or the effects of foreign aid. The contemporary observer will find similarities between the past and the present debate also in the evaluation of the merits of alternative adjustment mechanisms: "The easiest method would be to allow the exchange value of the German mark to fall by the amount required to give the necessary bounty to exports and then to resist any agitation to raise money-wages. But it is precisely this method which the Dawes scheme's device of 'transfer protection' expressly forbids." Keynes (1929, p. 6). In contrast, the advocates of the Dawes scheme insisted on the merit of deflation, not devaluation, as the appropriate method to generate enough savings to pay the debt. But "If [...] deflation is enforced, how will this help? Only if, by curtailing the activity of business, it throws men out of work, so that, when a sufficient number of millions are out of work, they will then accept the requisite reduction in their money-wages. Whether this is politically and humanly feasible is another matter." Keynes (1929, p. 7). It is amazing how closely related these words are to the current vicissitudes of the Euro-zone.

I reexamine the Transfer Problem in the light of models featuring factor proportions, monopolistic competition and heterogeneous firms and I discover new effects of the transfers on the economy. In particular, I find significant consequences of transfers on productivity, income distribution, factor allocation, country welfare and world welfare that do not arise in traditional models of international trade.

A transfer has two possible effects on the economy concerned: The primary effect, or primary burden, which consists in the resources to be transferred; the secondary effect, or secondary burden, which consists in the general equilibrium repercussions of the transfer on the endogenous variables and, especially, on welfare.[1] The existence of a primary burden is, of course, incontrovertible while the existence of the secondary burden has been the object of contention in the entire literature on the Transfer Problem. In most of this literature, the debate on the secondary burden has evolved around the terms of trade effects of the transfer. The focus on the terms of trade was natural since the conceptual framework was the one we now call the "neoclassical model" of trade. In this model, the only possible way a transfer creates

[1] Keynes, referring to the Dawes Committee, uses the term 'Budgetary Problem' to refer to the primary effect and 'Transfer Problem' to refer to the secondary effect. Samuelson (1952) uses the terms 'primary burden' and 'secondary burden'. Incidentally, Keynes' criticism of the 'transfer protection' device does not imply that he criticised the Dawes scheme overall. The scheme (better known as Dawes Plan) was praised by contemporary political commentators and got Dawes to share the Nobel Peace Prize in 1925 for having contributed with his plan to reducing the tension between Germany and France after the First World War.

a secondary burden is via an adverse change in the terms of trade. Samuelson makes this point very clearly in his two famous articles (1952, 1954), which provide a comprehensive analysis on the conditions under which a transfer impacts the terms of trade. Today we may reexamine the secondary burden armed with models featuring monopolistic competition and heterogeneous firms. The importance of such re-examination had not escaped Samuelson's crisp analysis when, in summing up the results of his study, he wrote:

> Only if one brings in Chamberlinian phenomena of monopolistic competition do substantive effects arise, ...
>
> Samuelson (1954, p. 288)

This line of research was not pursued by Samuelson and remained almost entirely unexplored even after the appearance and vast utilisation of monopolistic competition models in international trade theory. Re-examining the Transfer Problem in the light of monopolistic competition and heterogeneous firms models reveals new economic mechanisms and gives rise to new results. These new results are better appreciated after a brief review of the literature.

2 Brief review of the literature

The first debate on the transfer problem was hosted by The Economic Journal in a series of papers and comments published in the spring and summer 1929. The debate was sparked off by John Maynard Keynes (1929) and found remarkable commentators in Berthil Ohlin (1929) and Jacques Rueff (1929). The literature subsequently flourished with Pigou (1932), Metzler (1942, 1951), Samuelson (1952, 1954), Johnson (1956), Mundell (1960) to mention but a few of the great names that took part in that early debate. As already stated, most of these papers adopted neoclassical models of trade, except Metzler (1942) who, under the influence of the recent publication of the General Theory, experimented with the study of the transfer problem in a Keynesian macro model. Later works have studied the transfer problem taking into account elements such as the presence of non-traded goods (McDougall, 1965), multiple countries (Dixit, 1983; Yano,1983), many goods (Balasko, 1978), and non-identical preference (Jones, 1970, 1975). A common result of all these papers since the beginning is that in the case of identical and homothetic preferences and unity elasticity of substitution between goods a transfer has no effect whatsoever on the pre-transfer equilibrium. This result played the role of a conceptual benchmark for many of these papers. I show that this result is no longer valid in models featuring monopolistic competition, trade costs, and heterogenous firms.

While the literature on the transfer problem is immense, only a few papers adopts models of monopolistic competition. The only papers I have found are Brakman and Marrewijk (1995) and Corsetti, Martin and Pesenti (2013). Brakman and Marrewijk (1995) use a model of monopolistic competition to study the effect of tied aid to developing countries. Their model differ from mine especially in that they use a model without comparative advantage, with homogenous firms, non-identical preferences between countries, home biased expenditure and no-trade costs. Corsetti, Martin and Pesenti (2013) use a model of monopolistic competition, heterogeneous firms, and a partition of all firms in exporters and non-exporters. This partition allows them to distinguish between the intensive and extensive margin of trade as channels through which a transfer may affect welfare. They find that the presence of the extensive margin attenuates the repercussions of the transfer on the real exchange rate and on the terms of trade. This is because part of the demand changes induced by the transfer are absorbed by the extensive margin. Their research differ from mine especially in the fact that they focus on the terms of trade while I study also other effects. As a result of different research focuses, their model differs from mine in that it assumes no comparative advantage, no selection into entry, unbiased heterogeneity, and a partition between exporting and non-exporting firms that I dispose of since it is not necessary for my purposes. Very recently, new studies for the first time provided empirical evidence on the effect of transfers. Devereux and Smith (2007) provide an empirical study on the effects of Franco-Prussian reparation payments. Lane and Milesi-Ferretti (2004) provide evidence that countries with net external liabilities tend to have depreciated real exchange rates.[2]

The results of my study contrast sharply with those of the previous literature on the transfer problem. A transfer brings about adjustments in the terms of trade, in the degree of specialisation, in the skill premium, and in welfare even in situations where the previous literature found that a transfer is neutral on the equilibrium. All these effects are due, for the most part, to product differentiation, comparative advantage and trade costs. Biased heterogeneity is responsible for changes on average productivity whose sign depends on the relative factor abundance of the donor. Furthermore, while in the previous literature a transfer is neutral on world welfare, in my model it is not. Productivity changes induce world welfare gains or losses. Lastly, I revisit the deflation versus devaluation debate and find that which of these two

[2] In terms of the model structure a few other papers relate to the present article. In particular Bernard, Redding and Schott (2007), Costinot and Vogel (2010), Burstein and Vogel (2015) and Crozet and Trionfetti (2013) since they all use heterogenous firms and comparative advantage. Aside from the similarities and differences in the model structure, the most important difference is, of course, in the research objective.

adjustment mechanisms is allowed for is almost irrelevant for the secondary burden: the two mechanisms give qualitatively identical and quantitatively almost identical results. Lastly, a devaluation induced by monetary expansion may eliminate deflation in the donor country but cannot eliminate the secondary burden. All these results are new and some of the issues I address (such as productivity, skill premia and world welfare) have never been studied before in relation to the transfer problem.

The remainder of the paper is as follows: Sect. 3 lays out the model, Sect. 4 discusses the general equilibrium and welfare effects of transfers while Sect. 5 revisits the deflation versus devaluation debate, Sect. 6 performs a simulation exercise, Sect. 7 concludes and the appendix Sect. 8 completes the paper.

3 The model

The world economy is composed of two countries, indexed by $c = A, B$; in which live two factors, indexed by $j = H, L$; which produce two differentiated goods, indexed by $i = Y, Z$.[3] Each country is endowed with a positive share ν_j^c of the world's endowments denoted $\overline{H}$ and $\overline{L}$. International trade is subject to iceberg trade costs by which for one unit of good shipped only a fraction $\tau_i \in [0, 1]$ arrives at its destination.

Technology. Production requires fixed and variable inputs in each period. The variable input technology takes the CES form here represented by the marginal cost which, for a firm in industry i of country c, is

$$mc_i^c = \left\{ (\lambda_i)^\sigma (w_L^c)^{1-\sigma} [a(\xi)]^{\sigma-1} + (1-\lambda_i)^\sigma (w_H^c)^{1-\sigma} [b(\xi)]^{\sigma-1} \right\}^{\frac{1}{1-\sigma}} \tag{1}$$

where $\lambda_i \in (0, 1)$ is a constant technology parameter of industry i, the variables w_H^c and w_L^c denote, respectively, the price of H and L in country c, and $\sigma \neq 1$ measures the elasticity of substitution between factors. The variable ξ is a random variable with cumulative distribution $G(\xi)$ and with support (ξ_0, ∞) where $\xi_0 > 0$. The continuous, positive, increasing, and differentiable functions $a(\xi)$ and $b(\xi)$ contribute to determining factor productivity. Let $\beta(\xi) \equiv b(\xi)/a(\xi)$ be monotonic. I will say that heterogeneity is *H-biased* if $\beta'(\xi) > 0$; is *L-biased* if $\beta'(\xi) < 0$; is *unbiased* if $\beta'(\xi) = 0$.

[3]Incidentally, in this paper product differentiation is based on Dixit-Stiglitz monopolistic competition but the role it plays could be played by other forms of product differentiations such as those in models à la Armington (1969) or those in models with complete specialisation in varieties à la Eaton and Kortum (2002).

Firms seeking to enter the market face fixed entry costs. Paying the fixed entry costs gives the right to draw ξ. Upon drawing ξ the firm is able to compute its profit and decides to stay in the market if such profit is non-negative or decides to exit otherwise.[4] If the firm decides to stay it remains attached to its value of ξ until death do them part. At any point in time any firm has a probability of death equal to ð. Let ξ_i^{*c} be the least value of ξ in industry i of country c such that profit is zero. A firm that decides to produce faces fixed production costs. We may assume that fixed costs are homogenous or heterogenous across firms. These alternative assumptions give qualitatively the same results. I assume homogeneous fixed costs since this assumption allows to be focused on heterogeneity in the production process (which is the heart of the matter). Incidentally, this is the assumption most commonly adopted in the literature (Melitz, 2003; Bernard, Redding and Schott, 2007; and many others). Specifically, I assume that the fixed input technology is represented by the cost function $\widetilde{mc}_i^c \equiv \left\{ \frac{1}{1-G\left(\xi_i^{*c}\right)} \int_{\xi_i^{*c}}^{\infty} \left(mc_i^c\right)^{1-\sigma} dG \right\}^{\frac{1}{1-\sigma}}$, which is the average marginal cost in the industry and may conveniently be written as

$$\widetilde{mc}_i^c = \left[\left(\lambda_i\right)^{\sigma} \left(w_L^c\right)^{1-\sigma} \left(\widetilde{a}_i^c\right)^{\sigma-1} + \left(1-\lambda_i\right)^{\sigma} \left(w_H^c\right)^{1-\sigma} \left(\widetilde{b}_i^c\right)^{\sigma-1} \right]^{\frac{1}{1-\sigma}} . \quad (2)$$

where $\widetilde{a}_i^c \equiv \left(\frac{1}{1-G\left(\xi_i^{*c}\right)} \int_{\xi_i^{*c}}^{\infty} \left(a\left(\xi\right)\right)^{\sigma-1} dG \right)^{\frac{1}{\sigma-1}}$ and analogously for $\widetilde{b}_i^c$. Thus, the fixed production cost is $F_i \widetilde{mc}_i^c$ where F_i is a positive constant and the fixed entry cost is $F_{ie} \widetilde{mc}_i^c$ where F_{ie} is a positive constant. This specification represents the fixed input as a homogenous, non-traded, composite good produced in a perfectly competitive market by assembling in a CES all the varieties of the domestic industry output (similarly to Ethier, 1980). But it may also be interpreted as in Yeaple (2005), who assumes that the fixed cost is represented by output that must be produced by the firm and that ultimately cannot be sold; with the difference that in the present model this output requires a unit cost function $\widetilde{mc}_i^c$.

Demand. The representative consumer has preferences represented by a Cobb-Douglas index, with shares $\gamma_i \in (0,1)$, $\gamma_Y + \gamma_Z = 1$, defined over CES aggregates whose elasticity of substitution between varieties is $\varsigma > 1$. Gross

[4] Given that $G(t)$ and δ are constant over time, it is irrelevant for the equilibrium value of the endogenous variables whether the firm decides to stay on the basis of expected profit or the basis of current profit.

domestic product is $I^c = w_L^c \nu_L^c \overline{L} + w_H^c \nu_H^c \overline{H}$. Factors of production are taxed for the sole purpose of raising the resources to be transferred. I assume per-capita taxation so as to rule out any direct distributional consequence of the transfer. Let e represents the units of A's currency needed to purchase one unit of B's currency. Thus, national disposable income is $\Delta^A = I^A - T$, and $\Delta^B = I^B + T/e$, where by convention T is the transfer from A to B denominated in the currency of A. When $T > 0$ country A is the donor and B the recipient, and vice-versa when $T < 0$.

The demand emanating from domestic residents, s_{id}^A, and from foreign residents, s_{ix}^A, in local currency for the output of a firm in industry i of country A is:

$$s_{id}^A = \left(\frac{p_{id}^A}{P_i^A}\right)^{1-\varsigma} \gamma_i \Delta^A \; ; \qquad s_{ix}^A = \left(\frac{p_{ix}^A}{P_i^B}\right)^{1-\varsigma} \gamma_i \Delta^B \; , \tag{3}$$

where s stands for sales, d for domestic, and x for foreign; p_{id}^A and p_{ix}^A are the price faced by consumers and P_i^c is the price index. All prices are expressed in the currency of the country where they are consumed. Analogous functions obtain for s_{id}^B and s_{ix}^B. Total firm sales are represented by $s_i^A(\xi) = s_{id}^A(\xi) + e s_{ix}^A(\xi)$ and $s_i^B(\xi) = s_{id}^B(\xi) + s_{ix}^B(\xi)/e$.

Profit maximisation and zero profit. With monopolistic competition and under the large-group assumption, the profit-maximising prices for the domestic and the foreign market are:

$$p_{id}^c(\xi) = \frac{\varsigma}{\varsigma - 1} mc_i^c(\xi), \quad p_{ix}^A(\xi) = \frac{p_{id}^A}{e\tau_i}, \quad p_{ix}^B(\xi) = \frac{e p_{id}^B}{\tau_i} \tag{4}$$

The notation $mc_i^c(\xi)$ reminds us that firms with different ξ have different marginal costs; they therefore apply different prices and will have different sales as a result. Indeed, for any two firms with draws ξ' and ξ'' the relative sales are

$$\frac{s_i^c(\xi')}{s_i^c(\xi'')} = \left[\frac{mc_i^c(\xi')}{mc_i^c(\xi'')}\right]^{1-\varsigma}. \tag{5}$$

After drawing ξ a firm decides to stay in the market if $\pi_i^c(\xi) \geqslant 0$ and decides to quit otherwise. Thus, recalling that the firm's profit may be written as $\pi_i^c(\xi) = s_i^c(\xi)/\varsigma - \digamma_i \widetilde{mc}_i^c$, the zero profit condition is[5]

$$s_i^c(\xi_i^{*c}) = \varsigma \digamma_i \widetilde{mc}_i^c. \tag{6}$$

[5] Since mc_i^c is monotonic in ξ there is one and only one ξ_i^{*c}.

Aggregation. Applying equations (5) and (6) to $s_i^c(\xi)/s_i^c(\xi_i^{*c})$ gives the sales of any firm as function of the cut off value ξ_i^{*c}; then by aggregation we obtain average sales in any particular industry and country:

$$\overline{s}_i^c = \left[\frac{\widetilde{mc}_i^c}{mc_i^{*c}}\right]^{1-\varsigma} \varsigma F_i \widetilde{mc}_i^c \ . \tag{7}$$

And the average profit in industry i of country c is:

$$\overline{\pi}_i^c = \left[\frac{\overline{s}_{id}^c}{\varsigma} - F_i \widetilde{mc}_i^c\right]. \tag{8}$$

Using (4) we may compute the average domestic price, the average export price and the price indices:

$$\widetilde{p}_{id}^c = \frac{\varsigma}{\varsigma - 1}\widetilde{mc}_i^c, \quad \widetilde{p}_{ix}^A = \frac{\widetilde{p}_i^A}{e\tau_i}, \quad \widetilde{p}_{ix}^B = \frac{e\widetilde{p}_i^B}{\tau_i}, \tag{9}$$

$$P_i^A = \left[M_i^A \left(\widetilde{p}_{id}^A\right)^{1-\varsigma} + M_i^B \left(\widetilde{p}_{ix}^A\right)^{1-\varsigma}\right]^{\frac{1}{1-\varsigma}}, \tag{10}$$

$$P_i^B = \left[M_i^B \left(\widetilde{p}_{id}^B\right)^{1-\varsigma} + M_i^A \left(\widetilde{p}_{ix}^B\right)^{1-\varsigma}\right]^{\frac{1}{1-\varsigma}}, \tag{11}$$

where M_i^c is the mass of firms.

General Equilibrium. In addition to profit-maximising prices and to the zero profit conditions discussed above, there are five additional sets of equilibrium conditions. First, stationarity of the equilibrium requires the mass of potential entrants, M_{ei}^c, to be such that at any instant the mass of successful entrants, $[1 - G(\xi_i^*)]\, M_{ei}^c$ equals the mass of incumbent firms who die, $\eth M_i^c$:

$$[1 - G(\xi_i^*)]\, M_{ei}^c = \eth M_i^c. \tag{12}$$

Second, free entry ensures that the expected benefit from entry equals the entry cost:

$$[1 - G(\xi_i^{*c})]\, \overline{\pi}_i^c/\eth = F_{ei}\widetilde{mc}_i^c \ . \tag{13}$$

The left-hand-side is the present value - prior to entry - of the expected profit stream until death; the right-hand-side is the entry cost. Third, we need to ensure goods market equilibrium. Replacing (10)-(11) into (3) gives average demands as functions of average prices, $s_{id}^c(\widetilde{p}_{id}^c)$ and $s_{ix}^c(\widetilde{p}_{ix}^c)$, which allows writing the goods market equilibrium equations as

$$\overline{s}_i^A = s_i^A\left(\widetilde{p}_{id}^A\right) + e s_{ix}^A\left(\widetilde{p}_{ix}^A\right), \tag{14}$$

$$\overline{s}_i^B = s_i^B\left(\widetilde{p}_{id}^B\right) + s_{ix}^B\left(\widetilde{p}_{ix}^B\right)/e. \tag{15}$$

Fourth, equilibrium in factor market requires that factor demand inclusive of all fixed factors inputs, denoted L_i^c and H_i^c, be equal to factor supply

$$L_Y^c + L_Z^c = \nu_L^c \overline{L}, \quad (16)$$
$$H_Y^c + H_Z^c = \nu_H^c \overline{H}. \quad (17)$$

Lastly, two 'quantitative' money market equations assure that nominal money supply, $\mathfrak{M}^C$, equates nominal money demand for transitionary purposes.

$$\mathfrak{M}^A = I^A \quad (18)$$
$$\mathfrak{M}^B = I^B \quad (19)$$

After replacing equations (9) and (10)-(8) into (13)-(17) and remembering that each of these is required to hold for any i and any c we are able to count equations and unknowns for the two regimes of fixed and flexible exchange rate. **Fixed Exchange Rate.** Setting $e = 1$ we count 11 independent equilibrium conditions and 12 endogenous variables. The equations are the four free-entry conditions (13), any three out of the four goods market equilibrium conditions (14)-(15), and the four factor market equilibrium (16)-(17). The endogenous are $\{\xi_i^{*c}\}$, $\{w_L^c, w_H^c\}$ and $\{M_i^c\}$. The equilibrium value of all other endogenous variables can be computed from these. In particular under fixed exchange rate the money supply is endogenous and simply adjusts to accommodate any change in money demand. The choice of a numéraire makes the model determined. This is, after all, a pure trade model. **Flexible Exchange Rate.** Setting $\mathfrak{M}^A$ and $\mathfrak{M}^B$ equal to exogenous constants and letting e be endogenous we count 13 independent equilibrium conditions and 13 endogenous variables. The equilibrium conditions are the same as in the fixed exchange rate regime plus the two money market equations (18)-(19). The 13 endogenous are the same as in the fixed exchange rate regime plus, obviously, the exchange rate e.

Incidentally, note that a transfer leaves the money market unaffected regardless of the exchange rate regime. Take for instance the donor country. The reduction in money demand due to the fall in the disposable income is matched by the fall in money supply due precisely to the transfer of money abroad. As a matter of facts, the money market equations, regardless of the exchange rate regime, are : $\mathfrak{M}^A - T = I^A - T$ and $\mathfrak{M}^B + T/e = I^B + T/e$ thus boiling down to equations (18) and (19).

4 General Equilibrium Effects of Transfers

The key elements in the model above are differences in factor proportions, product differentiation, and heterogeneous firms. I will study the role played by each of this elements in giving rise to the effects of a transfer. I will begin, however, by discussing the effect of a transfer in the neoclassical version of the factor proportions model of trade since this will be the benchmark from which our model departs. Throughout this section the exchange rate is fixed to unity.

4.1 The neoclassical benchmark

The neoclassical version of the factor proportions model features homogeneous goods, homogenous firms and perfect competition. With regard to the transfer problem the neoclassical model gives rise to the following result:

Proposition 1 *: **"Samuelson neutrality proposition"**. In the neoclassical model of trade with identical Cobb-Douglas preferences a transfer has no impact on any endogenous variable. Therefore, there is no terms of trade effect and there is no secondary burden.*

Proof. See appendix Sect. 8.1. ■

The logic of this result is that the transfer leaves demand for goods unchanged. Thus, relative prices remain unchanged and so do all other endogenous variables. Samuelson obtains this result first in a model without trade costs (Samuelson, 1952) and then in the model with trade costs (Samuelson, 1954).[6] In both cases he obtains the result in a model with fixed output but argues with crystal clear logic that the same result should obtain when output may vary. The reason is that in neoclassical models no change in output may occur without change in relative prices. Thus, if a transfer leaves relative prices unchanged it also leaves output unchanged even when output may vary. Indeed, this is confirmed formally in Mundell's famous paper on the pure theory of international trade (1960, Sect. IV); however he only proves it for the case of free trade. To complete the picture I prove in Sect. 8.1 that Proposition 1 is valid also in the case of variable output and costly trade. My fundamental contribution so far (if I am allowed to be facetious) is to dub the result in Proposition 1 the 'Samuelson neutrality proposition'. This proposition is an excellent starting point for our study because it ensures that any effect we find when using our model will be due exclusively to its features; namely, product differentiation, biased heterogeneity, and their interactions with factor proportions.

[6]Samuelson (1954), Table IV (p. 286), cell at the intersection of the row "Basic convention of unitary income elasticity and identical tastes" and the column "Real transport costs"; cell sub-case of elasticity of substitution between goods equal to 1 (Cobb-Douglas).

4.2 Product differentiation and the terms of trade

In this section I study the role of product differentiation. I do not need to abandon the assumption of firm heterogeneity but I do so since I prefer to cover firm heterogeneity separately in the next sub-section. To eliminate firm heterogeneity all I need to do is to assume that $G(\xi)$ is degenerate.

By its very nature a transfer reduces expenditure in the donor country and increases it in the recipient country thereby operating an international reallocation of expenditure. Such reallocation may give rise to excesses of demand and supply which are the only channels through which a transfer can affect the initial equilibrium. Indeed, the analysis of the transfer problem may be posed as the study of the changes in endogenous variables required to eliminate the excess demand and supply created by the transfer. As we have seen above, in the neoclassical benchmark the transfer leaves demands unchanged. Instead, when product differentiation and trade costs are introduced into the model a transfer gives rise to excess demand and excess supply. This is why I begin my analysis by studying the effect of a transfer on the excess demand and supply for any variety. This can be done by differentiating equations (14) and(15) with respect to T only and around $T = 0$ so as to obtain the following expressions and signs for the percentage changes in demand, denoted $\widehat{D}_i^c$:

$$\widehat{D}_i^A = \frac{-\left(1-\theta^2\right) M_i^B \left(\widetilde{p}_{id}^B\right)^{1-\varsigma} \quad dT}{\theta M_i^A \left(\widetilde{p}_{id}^A\right)^{1-\varsigma} + \left(\theta^2 \iota^B + \iota^A\right) M_i^B \left(\widetilde{p}_{id}^B\right)^{1-\varsigma}} \lesseqgtr 0 \Leftrightarrow dT \gtreqless 0, \quad (20)$$

$$\widehat{D}_i^B = \frac{\left(1-\theta^2\right) M_i^A \left(\widetilde{p}_{id}^A\right)^{1-\varsigma} \quad dT}{\theta M_i^B \left(\widetilde{p}_{id}^B\right)^{1-\varsigma} + \left(\theta^2 \iota^A + \iota^B\right) M_i^A \left(\widetilde{p}_{id}^A\right)^{1-\varsigma}} \gtreqless 0 \Leftrightarrow dT \gtreqless 0, \quad (21)$$

where ι^c is country c's share in world disposable income and $\theta \equiv \tau^{\sigma-1}$. Thus,

Proposition 2 . *A transfer creates an excess demand (excess supply) for any variety of both goods produced by the recipient (donor).*

Proof. Expressions (20)-(21). ■

To understand Proposition 2 consider, for instance, a transfer from A to B. The proposition states that the transfer will create an excess demand for any variety produced in B and an excess supply for any variety produced in A. The reason is that - in any equilibrium with trade costs - foreign expenditure on any domestic variety is smaller than domestic expenditure on that same variety because the price paid by foreign residents is higher than the price paid by domestic residents; the price difference being due to trade costs. A transfer gives rise to an increase in total expenditure in B

and a decline in A of equal magnitude, but the share of the transfer spent on any A's variety by residents of B is smaller than the share spent on any A's variety by residents of A. Thus the transfer creates an excess supply for all A's varieties and an excess demand for all B's varieties. In other words, for any symmetric expenditure shock between countries the effect of the domestic shock on domestic varieties dominates the effect of the foreign shock on domestic varieties except in the case of free trade ($\theta = 1$) where the net effect is zero. We now understand a crucial difference between the neoclassical benchmark and our model with respect to the effects of transfers: in the former the international reallocation of expenditure does not give rise to excess demand and supply while in the latter does. A direct consequence of excess demand and supply on the endogenous variables is that the price of all varieties will decline in the donor country and will increase in the recipient country.

Proposition 3 . *A transfer gives rise to a deterioration (improvement) of the terms of trade of the donor (recipient).*

Proof. Direct consequence of Proposition 2. ■

Unlike in the neoclassical benchmark, a transfer affects the terms of trade when product differentiation and trade costs are in the model. Note that Propositions 2 and 3 rest only on product differentiation and trade costs; they needs neither comparative advantage nor firm heterogeneity but they remain valid when we take these features on board. Thus, Samuelson was right if we slightly amend his sentence by saying that bringing in Chamberlinian monopolistic competition *and trade costs* brings about substantive effects.[7] The substantive effects consist only of the terms of trade effect if factor proportions are identical but more effects occur if factor proportions are not identical.

4.3 Factor proportions and asymmetric effects

Factor proportions make that the excess demand and supply are in general different for varieties of different goods. This can be seen by using (20)-(21)

[7] Did Samuelson (1954) mean "monopolistic competition" or "monopolistic competition and trade costs"? He wrote the sentence quoted in the introduction in his 1954 paper dedicated to the transfer problem and trade costs but he did it in Sect. XII, which is dedicated to various model extensions where he does not mention trade costs.

to take ratios $\widehat{D}_Y^c / \widehat{D}_Z^c$ and observing that

$$\text{If } T \;>\; 0 \text{ , then } \frac{M_Y^A}{M_Z^A}\frac{\left(\widetilde{p}_{Zd}^B\right)^{1-\varsigma}}{\left(\widetilde{p}_{Yd}^B\right)^{1-\varsigma}} \gtreqless \frac{M_Y^B}{M_Z^B}\frac{\left(\widetilde{p}_{Zd}^A\right)^{1-\varsigma}}{\left(\widetilde{p}_{Yd}^A\right)^{1-\varsigma}} \Longrightarrow \begin{cases} \frac{\widehat{D}_Y^A}{\widehat{D}_Z^A} \lesseqgtr 1 \\ \frac{\widehat{D}_Y^B}{\widehat{D}_Z^B} \gtreqless 1 \end{cases} \tag{22}$$

$$\text{If } T \;<\; 0 \text{ , then } \frac{M_Y^B}{M_Z^B}\frac{\left(\widetilde{p}_{Zd}^A\right)^{1-\varsigma}}{\left(\widetilde{p}_{Yd}^A\right)^{1-\varsigma}} \gtreqless \frac{M_Y^A}{M_Z^A}\frac{\left(\widetilde{p}_{Zd}^B\right)^{1-\varsigma}}{\left(\widetilde{p}_{Yd}^B\right)^{1-\varsigma}} \Longrightarrow \begin{cases} \frac{\widehat{D}_Y^A}{\widehat{D}_Z^A} \gtreqless 1 \\ \frac{\widehat{D}_Y^B}{\widehat{D}_Z^B} \lesseqgtr 1 \end{cases} \tag{23}$$

Thus, for instance, the inequalities and implications in (22) tell us that a transfer from A to B (i.e. $T > 0$) when A has the comparative advantage in Y (as a consequence of which the second inequality would hold as $>$) causes a smaller excess supply for Y than for Z in A (i.e., $\widehat{D}_Y^A < 0$ and $\widehat{D}_Z^A < 0$ but $\widehat{D}_Y^A/\widehat{D}_Z^A < 1$) and a bigger excess demand for Y than for Z in B (i.e., $\widehat{D}_Y^B > 0$ and $\widehat{D}_Z^B > 0$ but $\widehat{D}_Y^B/\widehat{D}_Z^B > 1$). Analogously, a transfer from B to A ($T < 0$) when B has the comparative advantage in Y causes $\widehat{D}_Y^A > 0$ and $\widehat{D}_Z^A > 0$ but $\widehat{D}_Y^A/\widehat{D}_Z^A > 1$ and $\widehat{D}_Y^B < 0$ and $\widehat{D}_Z^B < 0$ but $\widehat{D}_Y^B/\widehat{D}_Z^B < 1$. All the other cases may be read analogously. This leads to the following proposition.

Proposition 4 . *A transfer causes in both countries an increase of the relative demand for the good in which the donor country has the comparative advantage. This has three consequences:*

1. *An increase in both countries in the relative price of the good in which the donor country has the comparative advantage.*

2. *An increase in both countries in the relative price of the factor intensively used in the good in which the donor country has the comparative advantage.*

3. *An increase in both countries in the relative mass of varieties of the good in which the donor country has the comparative advantage.*

Proof. Direct consequence of (22)-(23). ■

The second item in Proposition 4 is directly implied by the first through the Stolper-Samuelson relationship between goods and factor price. Thus, a transfer not only changes disposable income but also gives rise to changes in the relative income of different factors. For instance, a transfer from an *H-abundant* country increases the skill premium in all countries thereby creating more inequality. The importance of comparative advantage in giving rise to Propositions 3 and 4 is best assessed by removing it from the model while keeping monopolistic competition.

Proposition 5 *In the absence of comparative advantage a transfer is neutral on specialisation and on the skill premium.*

Proof. Direct consequence of (22)-(23). ■

The logic of Proposition 5 is that in the absence of a comparative advantage $M_Y^A/M_Z^A = M_Y^B/M_Z^B$ and $\widetilde{p}_{Yd}^A/\widetilde{p}_{Zd}^A = \widetilde{p}_{Yd}^B/\widetilde{p}_{Zd}^B$ therefore the excess demand is identical for all varieties of all goods in the same country as we see by inspection of (22)-(23). Naturally, the effect of a transfer on the terms of trade stated in Proposition 3 remains.

4.4 Biased heterogeneity and productivity

When firms are heterogeneous and entry is endogenous a transfer may affect productivity but, as we shall see in the next two propositions, the effects on productivity arise only when heterogeneity is biased. To see this it is convenient to use (7) and (8) to write the free entry condition (13) as follows:

$$\Upsilon_i^c \equiv \int_{\xi_i^*}^{\infty} \left\{ \left[\frac{mc_i^c}{mc_i^{*c}} \right]^{1-\varsigma} - 1 \right\} g(\xi)\, d\xi = \frac{\eth F_{ei}}{F_i} \ . \tag{24}$$

We see from equation (24) that when heterogeneity is unbiased a transfer has no impact on productivity. Unbiased heterogeneity means $a(\xi) = b(\xi)$ which implies that the marginal cost ratio mc_i/mc_i^* reduces to $a(\xi)/a(\xi_i^*) = b(\xi)/b(\xi_i^*)$. Therefore, equation (24) determines ξ_i^* independently of the rest of the model and, in particular, independently of T. This implies that a transfer, though it impacts goods prices, factor prices, and masses, has no impact on productivity. This is readily understood and it is the reflection of the well known result in the literature that a heterogeneous firm model without fixed exporting costs is - on average - identical to a model with homogenous firms. When heterogeneity is biased, instead, factor prices do not cancel out from the marginal cost ratio mc_i/mc_i^* and the free entry condition (24) relates ξ_i^* and factor prices in the following way (see Sect. 8.2 for the mathematical passages):

$$\frac{d\widehat{\xi_i^{*c}}}{d\widehat{\omega^c}} \lesseqgtr 0 \text{ as } \beta'(\xi) \gtreqless 0 \quad \forall \sigma \neq 1 \tag{25}$$

where $\omega^c \equiv w_H^c/w_L^c$ and $\hat{}$ represent percentage changes. Expression (25) shows the channel through which a transfer affects productivity: a transfer affects the relative factor price, ω^c, - recall Proposition 4 - and the change in ω^c affects productivity. We may state the effect of a transfer on productivity in the following way:

Proposition 6 *A transfer causes a decline (increase) in average productivity of both industries in both countries if the donor is abundant (scarce) in the factor towards which heterogeneity is biased.*

Proof. Expression (25) ■

It is interesting to understand the economic logic of expression (25). Consider, for instance a transfer from A to B when A is H-abundant, which gives rise to an increase in the skill premium in both countries (i.e., an increase ω^c). Since firms are heterogeneous in skill intensity they are affected differently even when they face the same increase in the skill premium. Specifically, highly skill intensive firms will lose competitiveness with respect to the least skill intensive firms since the former use more intensively the factor whose relative price has increased. Now, if heterogeneity is skill-biased ($\beta'(t) > 0$) then the least skill intensive firms will also be the least productive firms. Their relative position improves and some previously unprofitable firms will become profitable and decide to stay in the market (i.e. ξ_i^{*c} declines). Proposition 6 rests on factor proportions and biased heterogeneity; in the absence of either one there is no effect on productivity.[8]

4.5 Welfare effects

The welfare effects of transfers derive directly from the propositions above. Contrary to the neoclassical benchmark, the donor country bears a secondary burden and the recipient enjoys a secondary benefit. It is easy to understand the reason for these welfare changes. In the donor country all prices and wages fall but part of expenditure goes to foreign varieties whose increase in price causes a reduction in overall purchasing power of donor country residents. Likewise, mutatis mutandi, for the welfare effects of the transfer on the recipient country welfare. For the same reasons all factors bear a secondary burden in the donor country and enjoy a secondary benefit in the recipient country. These welfare changes do not leave world welfare unchanged, however, unless countries have identical factor proportions. The reason is that when factor proportions are not identical a transfer brings about a fall or an increase in productivity in both countries in accordance to Proposition 6. World welfare declines in the case of a productivity loss and increases in the case of a productivity gain.

[8] A subtlety may be worth mentioning. In this model the relative price of a factor relates negatively to its relative abundance (see appendix Sect. 8.4). Proposition 6, however, does not rest on such relationship. It rests on the effect that a transfer has on relative factor prices and, thereby, on productivity.

5 Deflation versus Devaluation

In this section we go back to the deflation versus devaluation debate recalled in the introduction. We have seen in the previous sections how deflation works in a fixed exchange rate regime: by imposing a secondary burden on the donor country's resident and a secondary benefit on the recipient country's residents. We now switch to the flexible exchange rate regime and resume e as an endogenous variable. Consider the case of a transfer from A to B. I will distinguish between depreciation - a rise in e due to market forces in the absence intervention by the central bank - and devaluation - a rise in e due to market forces and/or to the intervention by the central bank. A depreciation or a devaluation diverts demand from B's to A's varieties thus countering the excess demand for B's varieties and the excess supply of A's varieties created by the transfer from A to B.

Can depreciation clear all markets? The answer is positive if countries are identical and negative otherwise. This result is understood by recalling that only in the case of identical countries the excess demand and supply are identical in all markets. In such case the depreciation of the exchange rate that clears **all** excess demand and supply is:[9]

$$de = \frac{(1-\theta^2)}{\theta(2\sigma - 1 + \theta)} \frac{dT_{AB}}{I^A} \tag{26}$$

If, instead, factor proportions are not the same then the excess demand and supply differ for different countries and goods and therefore a depreciation cannot clear **all** markets. Said it differently, in the case of different factor proportions we are short of exchange rates; we need a different exchange rate for every market to absorb the different excess demand and supply. Depreciation of the donor country currency will occur nevertheless because a transfer creates an excess demand for the varieties of the recipient and an excess supply of varieties of the donor country but such depreciation will not clear all markets; a change in relative prices is necessary. Such changes in relative prices will bring about qualitatively the same general equilibrium repercussions we have already seen in the case of fixed exchange rate.

Can depreciation eliminate the secondary burden? The answer is negative in all cases. When countries are identical a depreciation clears all markets, keeps all prices and wages unchanged and therefore eliminates all general equilibrium repercussions of the transfer except, obviously, the depreciation itself. But the depreciation makes all foreign varieties more expensive for the donor and less expensive for the recipient. Thus, the donor country bears

[9] See appendix Sect. 8.3.

a secondary burden (due to depreciation) and the recipient country enjoys a secondary benefit of equal magnitude. The transfer is a zero sum affair, however. When countries are not identical a transfer gives rise to changes in the skill premium and to the associated changes in productivity, thereby affecting country welfare and world welfare in the same way as in the fixed exchange rate case.

Proposition 7 *Deflation and depreciation give qualitatively the same results.*

Proof. See appendix Sect. 8.3. ■

If deflation and depreciation are equivalent why did Keynes stand against the Dawes's 'transfer protection' device that did not allow for changes of the exchange rate? A reason might be that it is politically easier to erode purchasing power by a price increase (depreciation or devaluation) than by a decrease in nominal wages (deflation). But eliminating the wage decline requires a devaluation that goes beyond depreciation. To achieve such devaluation the intervention of the central bank is necessary. A "helicopter drop" type of monetary expansion operated by the donor country's central bank equal in magnitude of the transfer would eliminate the excess supply in the donor country and would increasing excess demand in the recipient country. The resulting devaluation exceeds the depreciation that would occur without monetary expansion. As a result of such devaluation all factors will experience a welfare loss in the donor country and a welfare gain in the recipient country, world welfare is affected, but wages do not decline in the donor country. Devaluation may be politically more feasible than deflation especially if consumers are affected by monetary illusion but is, obviously, as hard as deflation in real terms.

6 Quantitative simulation

In this section I simulates the effects of the transfer required to close up the U.S. trade deficit.[10] I take parameter values from the literature when they are available and I set the remaining parameters to replicate the basic facts of the world economy; namely, the U.S. GDP is about 23 per cent of the world GDP, its trade deficit is about three per cent of its GDP and the U.S.

[10] The U.S. trade deficit in the last ten years has declined from 5.8 to 2.6 per cent of GDP and I simulate the effects of a transfer that eliminates a trade deficit of 3 per cent of GDP

is an *H-abundant* country.[11] Closing up the trade deficit requires a transfer from the U.S. to the rest of the world. Table 1 shows the simulation results. Average productivity (AP_i^c) declines in both countries and both industries but the productivity fall is larger in Z than in Y. All factors bear a secondary burden in the donor country and enjoy a secondary benefit in the recipient but H is hurt less than L in A and benefits more than L in B; which means an increase in the skill premium in both countries. The nominal exchange rate depreciates but, interestingly, the fixed and flexible exchange rate regime give not only qualitatively but also quantitatively very similar results; the changes in average productivity in the two regimes are indistinguishable up to the fourth decimal digit and those of welfare are indistinguishable up to the second decimal digit. Furthermore, the depreciation of the exchange rate alleviates the secondary burden only by a tiny 0.042 per cent for H and 0.039 per cent for L.

Table 1: Simulation Results

Closing up the U.S. Trade Deficit Transfer from A (the U.S.) to B (Rest of the World)		
	Fixed Exchange Rate	Flexible Exchange Rate
AP_Y^A	-0.0006408	-0.0006402
AP_Z^A	-0.0068130	-0.0068063
AP_Y^B	-0.0003801	-0.0003797
AP_Z^B	-0.0040307	-0.0040269
H's secondary burden (A)	0.1235	0.1183
L's secondary burden (A)	0.1399	0.1346
H's secondary benefit (B)	0.0443	0.0452
L's secondary benefit (B)	0.0346	0.0355
Nominal Exchange Rate	0	0.1791

All figures represent percentage changes
AP_i^c = Average productivity in industry i of country c
The neoclassical benchmark predicts no changes

By looking at these figures one may have the impression that redressing macroeconomic imbalances has little impact on welfare. However, when comparade to the welfare effects of other events such as large trade agreements the secondary burden and benefit look rather big. As an example, a

[11] See appendix Sect. 8.5 for the other parameter values used in the simulations.

recent study by Caliendo and Parro (2015) estimated that as a consequence of NAFTA Mexico's welfare increased by a spectacular 1.31%, U.S.'s welfare increased by a thrilling 0.08%, and Canada's welfare declined by a worrying 0.06%; these are cumulative welfare changes over the period 1993-2005. If we take the simulation results at face value, closing up the current trade deficit will cost U.S. residents one and a half times the benefit enjoyed from NAFTA. And if the U.S. trade deficit keeps the current trend this may happen in only three years. The per-year impact of reducing a trade deficit would then be six times that of NAFTA.

7 Summary and Conclusion

This paper revisits the transfer problem in the light of models featuring monopolistic competition and biased heterogeneity. I have found results that are very different from those in the previous literature and I have explored issues never discussed before in the context of the transfer problem.

The first set of results show the synergy between biased heterogeneity and factor proportions in giving rise to the effects of transfers on specialisation, on factor prices, and on productivity. The second set of results concerns the consequences of a transfer on country, factor, and on world welfare, and on inequality. The third set of results concerns the irrelevance of the exchange rate regime for the secondary effects of transfers. The paper brings to light that deflation and depreciation give qualitatively identical and quantitatively almost identical results. Furthermore, the secondary burden is inevitable because a devaluation, however big, will not eliminate it. The last set of results shows that he magnitude of the secondary effects arising from closing up the U.S. trade deficit is comparable to the welfare effects of large large trade agreements. Furthermore, letting the currency fluctuate alleviates only very marginally the secondary burden.

If we now turn our eyes to current vicissitudes of the Eurozone we may argue that debt convergence will create secondary effects regardless of the exchange rate regime. Looking instead at global imbalances the model suggests that the closing up of American trade deficit or Asian trade surpluses (that is, a transfer from *H-abundant* to *L-abundant* countries) will push towards an increase in skill premia and towards a decline in productivity in all countries; and will give rise to a secondary burden for the deficit-reducing countries and to a secondary benefit for the surplus-reducing countries.

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8 Appendix

8.1 Transfers in the neoclassical benchmark

To obtain the neoclassical model from ours let Y and Z be homogeneous goods and let firm be homogeneous $\beta(\xi) = 1$ for any ξ. To fix ideas, and without loss of generality, assume that factor intensities and factor proportions are such that country A is the exporter of Y. To avoid notational confusion let $\mathfrak{p}_{ic}$ be the price of good i in country c in the neoclassical model. Transport costs and the export pattern imply the following price relationships:

$$\mathfrak{p}_{YB} = \frac{1}{\tau}\mathfrak{p}_{YA} \ , \qquad \mathfrak{p}_{ZA} = \frac{1}{\tau}\mathfrak{p}_{ZB} \ , \tag{27}$$

The general equilibrium system is composed of the following nine equations

$$\frac{(Y_A + Y_B/\tau)\,\mathfrak{p}_{YA}}{\left(Y_A + \frac{Y_B}{\tau}\right)\mathfrak{p}_{YA} + \left(\frac{Z_A}{\tau} + Y_B\right)\mathfrak{p}_{ZB}} = \frac{\gamma_Y(I_A - T) - \gamma_Y(I_B + T)}{I_A + I_B} \tag{28}$$

$$\mathfrak{p}_{ic} = mc_i^c \ , \quad i = Y, Z \ ; \quad c = A, B \ . \tag{29}$$

$$\frac{\partial mc_Y^c}{\partial w_L^c} Y_c + \frac{\partial mc_Z^c}{\partial w_L^c} Z_c = \nu_L^c \overline{L} \ , \quad c = A, B \ . \tag{30}$$

$$\frac{\partial mc_Y^c}{\partial w_H^c} Y_c + \frac{\partial mc_Z^c}{\partial w_H^c} Z_c = \nu_H^c \overline{H} \ , \ \ c = A, B \ . \tag{31}$$

Equation (28) ensures goods market clearing, equations (29) results from profit maximisation, equations (30)-(31) ensure equilibrium in factor market. This system and the choice of a numéraire determine the ten endogenous variables: four factor prices $\{w_j^c\}$, two commodity prices $\{\mathfrak{p}_{YA}, \mathfrak{p}_{ZB}\}$, and four output quantities $\{Y_c, Z_c\}$. The important thing to notice is that the two T representing the transfer cancel each other out, see equation (28). Thus, the transfer has no impact on any endogenous variable. The crucial assumptions for this result are identical preferences and unitary elasticity of substitution between goods. This is the Samuelson neutrality proposition and our benchmark.

8.2 Mathematical passages for inequality (25)

Total differentiation of the free entry condition (24) gives

$$0=\underbrace{\left\{(\sigma-1)(\Lambda_i)^{\sigma}\omega^{1-\sigma}\int\limits_{\xi_i^*}^{\infty}\frac{(b_i/b_i^*)^{\sigma-1}-(\alpha_i/a_i^*)^{\sigma-1}}{\left[\omega^{1-\sigma}/b_i^{*\sigma-1}+\Lambda_i^{\sigma}/a_i^{*\sigma-1}\right]^2}dG\right\}}_{\Upsilon_{i,\omega}^c}\hat{\omega}+$$

$$\underbrace{\left\{-(\sigma-1)\left(\frac{a_i^{*\sigma-1}}{\omega^{\sigma-1}}\varepsilon_{\alpha_i^*}+\Lambda_i^{\sigma}b_i^{*\sigma-1}\varepsilon_{\beta_i^*}\right)\int\limits_{\xi_i^*}^{\infty}\frac{\frac{a_i^{\sigma-1}}{\omega^{\sigma-1}}+\Lambda_i^{\sigma}b_i^{\sigma-1}}{\left[\frac{a_i^{*\sigma-1}}{\omega^{\sigma-1}}+\Lambda_i^{\sigma}b_i^{*\sigma-1}\right]^2}dG\right\}}_{\Upsilon_{i,\xi_i^*}^c}\widehat{\xi_i^*} \tag{32}$$

where $\varepsilon_{\alpha_i}\equiv\alpha_i'(\xi)\,\xi/\alpha_i(\xi)$ and $\varepsilon_{\beta_i}\equiv\beta_i'(\xi)\,\xi/\beta_i(\xi)$. The signs of $\Upsilon_{i,\xi_i^*}^c$ and $\Upsilon_{i,\omega}^c$ are

$$\Upsilon_{i,\omega}^c \gtreqless 0 \text{ as } \beta'(\xi)\gtreqless 0 \quad \forall\sigma\neq 1 \tag{33}$$

$$\Upsilon_{i,\xi_i^*}^c \lesseqgtr 0 \text{ as } \sigma\gtreqless 1. \tag{34}$$

From which (25) follows directly.

8.3 Depreciation

The objective is to find out whether there exist an exchange rate change that absorbs the excess demand generated by the transfer in all markets. To this purpose we differentiate equations (14) and (15) with respect to T and e only (at $T=0$ and $e=1$) and obtain the excess demand generated by the transfer and by the exchange rate change:

$$\frac{dD_i^A}{(\widetilde{p}_{id}^A)^{1-\sigma}}=-\frac{(1-\theta^2)(\widetilde{p}_{id}^B)^{1-\sigma}M_i^B\gamma_i}{(P_i^A)^{1-\sigma}(P_i^B)^{1-\sigma}}dT+ \left[\frac{\theta\sigma\gamma_i I_B}{(P_i^B)^{1-\sigma}}+\left(\frac{(\widetilde{p}_{id}^B)^{1-\sigma}M_i^B I_A}{(P_i^A)^{2(1-\sigma)}}-\frac{\theta(\widetilde{p}_{id}^A)^{1-\sigma}M_i^A I_B}{(P_i^B)^{2(1-\sigma)}}\right)\theta(\sigma-1)\gamma_i\right]de \tag{35}$$

$$\frac{dD_i^B}{(\widetilde{p}_{id}^B)^{1-\sigma}}=\frac{(1-\theta^2)(\widetilde{p}_{id}^A)^{1-\sigma}M_i^A\gamma_i}{(P_i^A)^{1-\sigma}(P_i^B)^{1-\sigma}}dT+ -\left[\frac{\theta\sigma\gamma_i I_A}{(P_i^A)^{1-\sigma}}+\left(\frac{(\widetilde{p}_{id}^A)^{1-\sigma}M_i^A I_B}{(P_i^B)^{2(1-\sigma)}}-\frac{\theta(\widetilde{p}_{id}^B)^{1-\sigma}M_i^B I_A}{(P_i^A)^{2(1-\sigma)}}\right)\theta(\sigma-1)\gamma_i\right]de \tag{36}$$

A depreciation that absorbes *all* excess demand is a de such that $dD_i^c=0$ for all i and c. It is clear by inspection of (35)-(36) that such single de does not exists unless countries have identical factor endowments (proportions and size). If factor proportions are identical then $M_i^A = M_i^A \equiv M_i$, $\widetilde{p}_{id}^A = \widetilde{p}_{id}^B \equiv \widetilde{p}_{id}^B$, and $P_i^A = P_i^B \equiv P_i$; thus expressions of (35)-(36) collapse to

$$\frac{M_i}{\gamma_i} dD_i^A = -\frac{(1-\theta)}{(1+\theta)} dT + \frac{\theta\left[I_A(\sigma-1) + I_B(\sigma+\theta]\right)}{(1+\theta)^2} de \tag{37}$$

$$\frac{M_i}{\gamma_i} dD_i^B = \frac{(1-\theta)}{(1+\theta)} dT + \frac{\theta\left[I_A(\sigma+\theta) + I_B(\sigma-1]\right)}{(1+\theta)^2} de \tag{38}$$

but this is not enough for the depreciation to absorb all excess demand and supply. If factor endowment are absolutely identical then $I^A = I^B \equiv I$ and then a single de equal to expression (26) clears all markets. If factor endowments are not identical a change in the skill premium and relative goods prices is necessary to absorb all excess demand and supply. The direction of change in relative factor price depends exclusively on the terms multiplying dT and de and not on the magnitude of dT and de. Therefore whatever change in the exchange rate will push relative prices and wages to change in the same direction as in the case of fixed exchange rate. This proves Proposition 7.

8.4 Factor proportions and relative factor prices

In this model the relative price of a factor relates negatively to its relative abundance in costly trade, in our notation:

$$\omega^A \gtreqless \omega^B \Leftrightarrow \nu_H^A \lesseqgtr \nu_L^A \qquad \forall \tau \in (0,1). \tag{39}$$

While total differentiation shows this unequivocally it nicer to show that this is indeed the case by the following thought experiment. Assume that factors price equalised in costly trade. Then, from (32) and its derivatives we have $\beta_i^{*A} = \beta_i^{*B}$, $\forall i$. Therefore,

$$mc_i^{*A} = mc_i^{*B} \Rightarrow \widetilde{mc}_i^A = \widetilde{mc}_i^B \Rightarrow \widetilde{p}_{di}^A = \widetilde{p}_{di}^B. \tag{40}$$

Under factors price equalisation goods markets equilibrium equations (14)-(15) become

$$\left[\frac{\widetilde{mc}_i^A}{mc_i^{*A}}\right]^{1-\varsigma} \varsigma F_i \widetilde{mc}_i^A = \frac{\gamma_i I^A}{M_i^A + \tau^{\sigma-1} M_i^B} + \frac{\tau^{\sigma-1}\gamma_i I^B}{\tau^{\sigma-1} M_i^A + M_i^B}, \quad \forall i \tag{41}$$

$$\left[\frac{\widetilde{mc}_i^B}{mc_i^{*B}}\right]^{1-\varsigma} \varsigma F_i \widetilde{mc}_i^B = \frac{\tau^{\sigma-1}\gamma_i I^A}{M_i^A + \tau^{\sigma-1} M_i^B} + \frac{\gamma_i I^B}{\tau^{\sigma-1} M_i^A + M_i^B}, \quad \forall i \tag{42}$$

Let $\widetilde{L}_i^c$ and $\widetilde{H}_i^c$ be average factors demand in each country and industry. As we know they obtain by applying Shepherd's lemma to the cost function. Under factors price equalisation equalities (40) hold, therefore $\widetilde{L}_i^A = \widetilde{L}_i^B = \widetilde{L}_i$ and $\widetilde{H}_i^A = \widetilde{H}_i^B = \widetilde{H}_i$ and equilibrium in factors markets is

$$\left(\widetilde{L}_Y M_Y^c + \widetilde{L}_Z M_Z^c\right) = v_L^c \bar{L}; \qquad c = A, B. \tag{43}$$

$$\left(\widetilde{H}_Y M_Y^c + \widetilde{H}_Z M_Z^c\right) = v_H^c \bar{H}; \qquad c = A, B. \tag{44}$$

Using (40) in equations (41)-(42) and solving gives $M_Y^A/M_Z^A = M_Y^B/M_Z^B$. This solution in the goods market equilibrium is inconsistent with equilibrium in the factors market. Indeed, $M_Y^A/M_Z^A = M_Y^B/M_Z^B$ implies from (43)-(44) that the relative demand for L is the same in both countries, but relative supply is not. Therefore, $\omega^A = \omega^B$ is inconsistent with equilibrium in all markets. In which direction should factors price move to assure equilibrium in all markets? This is easily answered by observing from (43)-(44) that under factor price equalisation relative demand for L falls short of relative supply in B and exceeds relative supply in A. Therefore ω^A/ω^B must increase. This will make all industries become more *H-intensive* in A and less *H-intensive* in B thus pushing towards the equilibrium in factors markets. Naturally, a change in factors price alone is not sufficient to assure equilibrium, as a matter of facts and increase in ω^A/ω^B pushes marginal costs in different and requires $M_Y^A/M_Z^A > M_Y^B/M_Z^B$ for the goods market equilibrium to be satisfied. Thus, a costly trade equilibrium is necessarily one in which $\omega^A > \omega^B$ and $M_Y^A/M_Z^A > M_Y^B/M_Z^B$, which is the canonical Heckscher-Ohlin outcome and it occurs in our model for exactly the same reasons as in Heckscher-Ohlin. After all, this is intuitive since our model structure does not violate any of the key assumptions of the Heckscher-Ohlin model.

8.5 Parameter values

Bernard et al. (2003) estimate the Pareto shape parameter to 3.7. The empirical literature on the gravity equation finds the elasticity of substitution to range between 2 and 5 (see, for instance, Bernard et al. 2003 or Head and Mayer, 2006). Thus, I run simulations adopting values in this range (Table 1 uses $\sigma = 2$). I take trade costs to be 25% of value shipped (i.e., $\tau = 0.8$). The technology parameters are $\lambda_Y = 3/10$ and $\lambda_Z = 1 - \lambda_Y$, which make Y skill intensive. World endowments are set at $\overline{H} = \overline{L} = 1000$. U.S. (country A) endowments of H and L are respectively 300 and 200 which makes the U.S. about 1.5 times more *H-intensive* than the rest of the world (country B). These proportions are in line with those found, for instance, in Romalis

(2004, Table 4) where the highest and smallest skill intensity in the world economies are in a ratio of three to one; I took a central value of 1.5. These endowments also make that the U.S. GDP is about 23 per cent of the world economy. Other parameters are: $F = F_e = 2$, $\eth = 0.025$.