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Real Adjustment of Current Account Imbalances with Firm Heterogeneity

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In this paper, a standard model of international transfer is augmented by the introduction of firm heterogeneity. The increase in aggregate exports in response to the transfer reflects extensive and intensive adjustments, as the sales of new exporting firms (extensive margin) contribute to the current account adjustment along with the sales of existing exporting firms (intensive margin). The relative size of the intensive and extensive margins of the adjustment is determined by the size dispersion of firms. The model calibrated to the observed distribution of firm sizes shows that the intensive margin is the predominant channel of the current account adjustment. The dampening effect of the extensive margin has therefore very little impact on the exchange rate adjustment. [JEL F32, F41]

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The assessment of the macroeconomic effects of a transfer dates back to the debate between Keynes and Ohlin about the German international obligations after World War I. Keynes pointed out that the macroeconomic costs of any given amount of war reparations, the "primary burden" of a

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transfer, were magnified by the adverse effects of deteriorating terms of trade and real exchange rates, the "secondary burden" of a transfer. Ohlin criticized Keynes' emphasis on relative prices, arguing that the income effects from unilateral transfers were the predominant ones, leading to small terms-of-trade adjustment.

The transfer-problem controversy has gained renewed interest in the current debate over the macroeconomic effects of the adjustment of global current account imbalances. Whatever the drivers of global rebalancing, the basic mechanism of the adjustment results in a transfer of real resources from debtor countries such as the United States to the rest of the world, leading to a decrease in domestic spending relative to production, and to a simultaneous relative increase abroad. The macroeconomic costs of global rebalancing due to the decrease in U.S. domestic spending and welfare (the primary burden of a transfer) could be magnified by the depreciation of the U.S. dollar (the secondary burden of a transfer). As Obstfeld and Rogoff (2001 and 2005), point out in a series of papers, a real adjustment of the U.S. current account deficit could lead to a large depreciation of the U.S. dollar and imply a sharp reduction in U.S. consumption and welfare. While the need of a depreciation of the U.S. dollar for the rebalancing of the U.S. current account has found a large consensus in the literature, the size of this depreciation is subject to more debate.

Corsetti, Martin, and Pesenti (2008) explore the possibility that the U.S. current account can adjust with a limited change in international relative prices. They take into account the extent of the net creation and destruction of new varieties, the so-called extensive margin of trade, over the U.S. current account adjustment. Recent empirical contributions by Hummels and Klenow (2005) and Galstyan and Lane (2008) have indeed highlighted the quantitative importance of the extensive margin on aggregate trade flows.[1] In their model with representative firms, Corsetti, Martin, and Pesenti (2008) find that the extensive margin of trade dampens the required depreciation of the exchange rate as new varieties are exported and the adjustment occurs for a lower change in terms of trade. In the same vein, Dekle, Eaton, and Kortum (2008) have shown that a transfer of the size of the U.S. current account deficit requires a small adjustment in the relative wages of surplus countries vs. deficit countries.[2]

This paper emphasizes how the dispersion of firm sizes may affect the global rebalancing and the size of the secondary burden of a transfer. The macroeconomic effects of a transfer of resources are studied in a standard

[1]Hummels and Klenow (2005) find that larger countries trade more and the extensive margin can account for 60 percent of the difference in trade flows. Galstyan and Lane (2008) show that around half of U.S. trade growth has occurred at the extensive margin over a relatively short period of time (2000–2004).

[2]In their multilateral model calibrated to 40 countries using 2004 data on GDP and bilateral trade, Dekle, Eaton, and Kortum (2008) show that the wage of the largest deficit country (United States) falls by 10 percent relative to the largest surplus country (Japan).

two-country general equilibrium model with a tradable and a nontradable sector. In both sectors, firms are heterogeneous in terms of their productivity. In the tradable good sector, trade flows are determined by the sales of heterogeneous exporting firms as in Chaney (2008). As it focuses on the real adjustment of current account imbalances, this paper leaves aside other margins of adjustment like the financial adjustment channel.[3] The transfer of resources associated with the current account adjustment increases the demand of exports of the deficit country, while decreasing its demand of imports. The higher relative demand for tradable goods produced by the deficit country leads to a decrease in the productivity threshold of exporting firms, and a simultaneous increase abroad. The changes in aggregate exports in response to the transfer therefore reflect extensive and intensive adjustments, as the sales of new heterogeneous exporting firms (extensive margin) contribute to the current account adjustment along with the sales of existing exporting firms (intensive margin). In particular, the extensive margin may constitute an important channel of current account adjustment when the dispersion of firm sizes is low. The exchange rate movement associated with the correction of the current U.S. trade imbalance is analyzed in the model calibrated to the observed distribution of firm sizes. The results show that the intensive margin represents the predominant channel of the current account adjustment, and the dampening effect of the extensive margin on the exchange rate adjustment is not very large.

In Obstfeld and Rogoff (2005), terms-of-trade movements are amplified by the fall in the relative price of nontradable goods. This result has its counterpart in this paper. However, the mechanism is once again affected by extensive margin adjustments. In particular, since the demand of households in the debtor country shifts from imports to domestic tradable goods, new firms find it profitable to produce domestic tradable goods while the incentive for firms to produce nontraded goods decreases. The reallocation of demand between the traded and the nontraded sectors emphasized in Obstfeld and Rogoff (2005) also induces a reallocation of firms at the extensive margin. This intranational extensive margin limits movements in prices associated with the current account adjustment. The dampening effect of the extensive margin of trade (sales by new exporting firms) on the exchange rate depreciation is therefore reinforced by the effect of the intranational extensive margin (between the nontradable and tradable goods).

When the productivity dispersion across firms is low and goods are highly differentiated, firm sizes get less dispersed. The market share of new exporting firms is large, thus the extensive margin represents an important channel for current account adjustment and the required exchange rate depreciation is relatively low. This result casts new insights on the sensitivity of exchange rate movements to the degree of substitutability among goods.

[3]This channel has been widely analyzed in Lane and Milesi-Ferretti (2007), Gourinchas and Rey (2007a and 2007b), and Curcuru, Dvorak, and Warnock (2008).

Until now, the literature on transfers and global imbalances has focused the attention on the elasticity of substitution between home and foreign-produced goods. Obstfeld and Rogoff (2005) and Corsetti, Martin, and Pesenti (2008) find that the adjustment of the U.S. current account deficit requires a lower depreciation of the U.S. dollar when tradable goods are more substitutable. In such standard models, a higher elasticity of substitution makes trade volumes respond more to a given change in international relative prices, thus implying a lower adjustment of the exchange rate for a given transfer. This paper shows that this classical emphasis may be incomplete when the entry of heterogeneous firms is accounted for. There are two opposite effects associated with a higher elasticity of substitution. On the one hand, as in standard models, a higher elasticity of substitution leads to a higher sensitivity of exports to price changes at the intensive margin. On the other hand, when the elasticity of substitution is higher, the sales of firms that enter the export market in response to the current account adjustment are more sensitive to the productivity gap between incumbents and new exporting firms. As new exporting firms are less productive and smaller than incumbent exporting firms, a higher elasticity of substitution increases the weight of the intensive margin on the current account adjustment, thus leading to higher exchange rate depreciation. For reasonable values of productivity distribution and elasticity of substitution among goods, the second mechanism is the predominant one.

This paper is related to the international macroeconomics literature which studies the effect of a transfer on exchange rate movements, and the recent literature on the extensive margin of trade. Firms are heterogeneous in terms of their productivities in the same way as in Chaney (2008). However, this paper differs from Chaney (2008) both in its scope and its modeling. While Chaney (2008) considers the response of the extensive and intensive margins of trade to a trade liberalization, this paper analyzes the impact of a change in relative aggregate demand on trade flows. The transfer of resources has a positive direct impact on Home net exports (because of the increase in Foreign aggregate demand), which is reinforced by an indirect impact through the adjustment of relative wages. The endogenous response of relative wages is a key element to assess the macroeconomic costs of global rebalancing. Since Foreign aggregate demand increases relative to Home demand, Home wage decreases relative to Foreign wage to clear labor markets. By contrast, in Chaney (2008), wages do not adjust in response to trade liberalization, since wages are exogenously pinned down in a homogeneous good sector.

As in Corsetti, Martin, and Pesenti (2008), this paper finds that the extensive margin of trade dampens the required depreciation of the exchange rate associated to a transfer. Nevertheless, Corsetti, Martin, and Pesenti (2008) do not capture the impact of new exporting firms' productivity on the extensive margin channel of the current account adjustment. In their paper, the size of the extensive margin depends uniquely on the convexity of the cost function in the creation of new varieties. Dekle, Eaton, and Kortum (2008) also analyze the implications on relative wages of eliminating current account imbalances in a multilateral Ricardian model of trade. They find that the wage of the debtor country falls relative to the surplus country. For a given elasticity of substitution among goods, the drop in relative wages is larger in the short run, when the extensive margin of trade is shut down. Contrary to Dekle, Eaton, and Kortum (2008), this paper explores the sensitivity of exchange rate movements to the elasticity of substitution among goods. This paper shows that the classical result of a negative relationship between the elasticity of substitution and the magnitude of the exchange rate adjustment may be overturned in a model of transfer with firm heterogeneity.

Finally, the introduction of firm heterogeneity in an otherwise standard model of global rebalancing maps the insights from the trade literature to understanding the impact of transfers on exchange rates. In this respect, this paper is related to Ghironi and Melitz (2005), as it contributes to bridging the gap between international macroeconomics and trade theory. Ghironi and Melitz (2005) provide an endogenous microfounded explanation for the Harrod-Balassa-Samuelson effect in a similar model, where the firm-level decision to export determines the within-sectoral *nontradedness* of goods. This paper differs from Ghironi and Melitz (2005) in its objective and in its modeling, as it allows for nontradable goods along with the endogenous *nontraded* goods.

The remainder of the paper is organized as follows. Section I introduces a two-country model of current account imbalances with a tradable and a nontradable sectors and firm heterogeneity. Section II investigates analytically the implications of a real current account adjustment at the symmetrical equilibrium in a simplified model that neglects nontradable goods. Section III provides a quantitative assessment of the impact of a transfer that eliminates the U.S. current account deficit in the complete model with nontradable and tradable goods. Section IV concludes.

I. A Model of Global Imbalances with Firm Heterogeneity

This section introduces a standard two-country general equilibrium model with a tradable and a nontradable sectors. In both sectors, firms are heterogeneous in terms of productivity and the structure of trade flows is determined by the sales of heterogeneous exporting firms as in Chaney (2008).

The world economy consists of two countries: Home and Foreign. The size L_H (L_F) of the Home (Foreign) country is denoted in terms of labor units. In each country domestic labor units are assumed to be the domestic numéraire. All prices in the Home (Foreign) country are therefore measured in terms of Home (Foreign) units of labor. This means that unit wages in both countries are $w = w^* = 1$. As a consequence of the choice of the numéraire, the exchange rate ε is defined as units of Home labor per unit of

Foreign labor. An upward (downward) change in ε therefore refers to a depreciation (appreciation) of Home labor.

Households

Each representative household supplies h units of labor inelastically at the nominal wage $w=1$. The household maximizes utility from consumption

$$C_H = \left[k^{\frac{1}{\theta}} C_{H,T}^{\frac{\theta-1}{\theta}} + (1-k)^{\frac{1}{\theta}} C_{H,N}^{\frac{\theta-1}{\theta}}\right]^{\frac{\theta}{\theta-1}}, \tag{1}$$

where $C_{H,T}$ denotes the consumption of tradable goods, $C_{H,N}$ the consumption of nontradable goods, $0<k<1$ measures the share of tradable goods in total consumption, and $\theta \geq 1$ is the (constant) elasticity of substitution between tradable and nontradable goods. The consumer price index for the Home country is then:

$$P = \left[kP_T^{1-\theta} + (1-k)P_N^{1-\theta}\right]^{\frac{1}{1-\theta}}. \tag{2}$$

The basket of goods $C_{H,T}$ is defined over a continuum of tradable goods $\omega \in \Omega_H$:

$$C_{H,T} = \left[\int\limits_{\omega \in \Omega_H} c(\omega)^{\frac{\sigma-1}{\sigma}} d\omega\right]^{\frac{\sigma}{\sigma-1}},$$

where $\sigma > 1$ is the elasticity of substitution across goods. Let $p(\omega)$ denote the home currency price of a good $\omega \in \Omega_H$. The Home price index for tradable goods is then:

$$P_T = \left[\int\limits_{\omega \in \Omega_H} p(\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$$

and the demand for each individual tradable good is $c(\omega) = [p(\omega)/P_T]^{-\sigma} C_{H,T}$. The basket of tradable goods $C_{H,T}$ is therefore a function of total expenditure in the Home country:

$$C_{H,T} = k\left(\frac{P_T}{P}\right)^{-\theta} C_H. \tag{3}$$

In a similar fashion, the basket of goods $C_{H,N}$ is defined over a continuum of nontradable goods $\upsilon \in \Upsilon_H$:

$$C_{H,N} = \left[\int\limits_{\upsilon \in \Upsilon_H} c(\upsilon)^{\frac{\sigma-1}{\sigma}} d\upsilon\right]^{\frac{\sigma}{\sigma-1}},$$

where $\sigma > 1$ is the elasticity of substitution across goods. Let $p(\upsilon)$ denote the home currency price of a good $\upsilon \in \Upsilon_H$. The Home price index for nontradable goods is then:

$$P_N = \left[\int_{\upsilon \in \Upsilon_H} p(\upsilon)^{1-\sigma} d\upsilon \right]^{\frac{1}{1-\sigma}}$$

and the demand for each individual nontradable good is $c(\upsilon) = [p(\upsilon)/P_N]^{-\sigma} C_{H,N}$. Finally, the basket of nontradable goods $C_{H,N}$ is also a function of total expenditure:

$$C_{H,N} = (1-k)\left(\frac{P_N}{P}\right)^{-\theta} C_H. \tag{4}$$

In the Foreign country, the representative household supplies h units of labor inelastically at the nominal wage $w^* = 1$, maximizes a similar utility function, with the same parameters and the same expression for the consumption baskets of tradable ($C_{F,T}$) and nontradable goods ($C_{F,N}$):

$$C_F = \left[k^{\frac{1}{\theta}} C_{F,T}^{\frac{\theta-1}{\theta}} + (1-k)^{\frac{1}{\theta}} C_{F,N}^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}, \tag{5}$$

$$P^* = \left[k P_T^{*1-\theta} + (1-k) P_N^{*1-\theta} \right]^{\frac{1}{1-\theta}} \tag{6}$$

that implies:

$$C_{F,T} = k\left(\frac{P_T^*}{P^*}\right)^{-\theta} C_F, \tag{7}$$

$$C_{F,N} = (1-k)\left(\frac{P_N^*}{P^*}\right)^{-\theta} C_F. \tag{8}$$

Firms

In both countries, there is a continuum of firms in each sector. In the tradable good sector, each firm produces one different variety $\omega \in \Omega$. In the nontradable good sector, each firm produces one variety $\upsilon \in \Upsilon$. Labor is the only factor of production. Firms are heterogeneous as they produce goods with different productivities. A firm with a productivity level x is able to produce x units of good using one unit of labor.

Home (Foreign) firms selling their goods in the domestic market pay a fixed cost of production $F_{H,D}$ ($F_{F,D}$), expressed in Home (Foreign) units of labor. The fixed cost is assumed to be the same in the tradable and nontradable sectors. When firms in the tradable sector export goods, they incur higher costs. Because of the iceberg transport cost $\tau > 1$, for one unit shipped, only a fraction $1/\tau$ arrives at destination, the rest being melt in the transportation. Then, Home (Foreign) exporting firms have to pay a fixed cost of production $F_{H,EXP} \geq F_{H,D}$ ($F_{F,EXP} \geq F_{F,D}$), expressed in Home (Foreign) units of labor.

Prices and Profits

Prices are set by profit maximizing firms as a constant mark-up $\phi = (\sigma/\sigma - 1)$ over marginal costs. All prices are denominated in units of labor of the country where they are produced. Prices of tradable goods are:

$$p_{H,D}(x) = \frac{\phi}{x} \qquad p_{H,EXP}(x) = \frac{\tau\phi}{x} \qquad p^*_{F,D}(x) = \frac{\phi}{x} \qquad p^*_{F,EXP}(x) = \frac{\tau\phi}{x}.$$

The prices of nontradable goods are:

$$p_{H,N}(x) = \frac{\phi}{x} \qquad p^*_{F,N}(x) = \frac{\phi}{x}.$$

Owing to the presence of the fixed cost, firms with low productivity are not able to export. The profits for a Home firm in the nontradable good sector are denoted as $\pi_{H,N}(x)$, whereas the profits for a Home firm in the tradable good sector are denoted as $\pi_{H,T}(x) = \pi_{H,D}(x) + \varepsilon\pi^*_{H,EXP}(x)$,[4] where

$$\pi_{H,D}(x) = \begin{cases} \frac{1}{\sigma}\left[\frac{p_{H,D}(x)}{P_T}\right]^{1-\sigma} P_T C_{H,T} - F_{H,D} & \text{if active} \\ 0 & \text{otherwise} \end{cases}$$

$$\pi^*_{H,EXP}(x) = \begin{cases} \frac{1}{\sigma}\left[\frac{\frac{1}{\varepsilon}p_{H,EXP}(x)}{P^*_T}\right]^{1-\sigma} P^*_T C_{F,T} - \frac{F_{H,EXP}}{\varepsilon} & \text{if firm } x \text{ exports} \\ 0 & \text{otherwise} \end{cases}$$

$$\pi_{H,N}(x) = \begin{cases} \frac{1}{\sigma}\left[\frac{p_{H,N}(x)}{P_N}\right]^{1-\sigma} P_N C_{H,N} - F_{H,D} & \text{if active} \\ 0 & \text{otherwise} \end{cases}$$

Pareto Distribution of Productivity and Zero-Profit Conditions

Firm productivity is Pareto distributed with a scale parameter $\bar{x}$ and a shape parameter $\gamma > \sigma - 1$[5]:

$$G(x) = 1 - \left(\frac{\bar{x}}{x}\right)^{\gamma}.$$

[4] In a similar way, the profits for Foreign firms are $\pi^*_{F,T}(x) = \pi^*_{F,D}(x) + (1/\varepsilon)\pi_{F,EXP}(x)$, and $\pi^*_{F,N}(x)$ where: $\pi^*_{F,D}(x) = (1/\sigma)[(p^*_{F,D}(x))/P^*_T]^{1-\sigma} P^*_T C_{F,T} - F_{F,D}$ if the firm is active on the domestic market, and 0 otherwise; $\pi_{F,EXP}(x) = (1/\sigma)[(\varepsilon p^*_{F,EXP}(x))/P_T]^{1-\sigma} P_T C_{H,T} - \varepsilon F_{F,EXP}$ if the firm exports, and 0 otherwise; $\pi^*_{F,N}(x) = (1/\sigma)[(p^*_{F,N}(x))/P^*_N]^{1-\sigma} P^*_N C_{F,N} - F_{F,D}$ if the firm is active in the nontradable good sector, and 0 otherwise.

[5] This assumption on the shape parameter γ and elasticity σ ensures a finite mean for the sales of the firms.

Because of the Pareto assumption, the distribution of firm size is also Pareto with shape $\psi = (\gamma/\sigma - 1)$. The assumption of Pareto distributed productivities is made for analytical tractability. From an empirical standpoint, Axtell (2001) estimates the power law exponent for the distribution of U.S. firm size and find a value close to 1 (a phenomenon known as Zipf's law). Levchenko, di Giovanni, and Rancière (2010) estimate the power law exponent for the distribution of French firm size in the context of international trade with heterogeneous firms as in Melitz (2003). They also find a value for ψ close to 1 (around 1.05).

In both the Home and the Foreign country, a firm produces in the domestic market and exports if and only if this is profitable. In the Home country, firms producing tradable goods are active on the domestic market if their level of productivity x is above the threshold $\bar{x}_{H,D}$, and export if their level of productivity x is above the threshold $\bar{x}_{H,EXP}$. Then, firms producing nontradable goods are active on the domestic market if their level of productivity x is above the threshold $\bar{x}_{H,N}$. These productivity thresholds are given by the following zero-profit conditions:

$$\pi_{H,D}(x) = \frac{1}{\sigma}\left[\frac{p_{H,D}(\bar{x}_{H,D})}{P_T}\right]^{1-\sigma} P_T C_{H,T} - F_{H,D} = 0, \tag{9}$$

$$\pi^*_{H,EXP}(x) = \frac{1}{\sigma}\left[\frac{\frac{1}{\varepsilon}p_{H,EXP}(\bar{x}_{H,EXP})}{P^*_T}\right]^{1-\sigma} P^*_T C_{F,T} - \frac{F_{H,EXP}}{\varepsilon} = 0, \tag{10}$$

$$\pi_{H,N}(x) = \frac{1}{\sigma}\left[\frac{p_{H,N}(\bar{x}_{H,N})}{P_N}\right]^{1-\sigma} P_N C_{H,N} - F_{H,D} = 0. \tag{11}$$

In the Foreign country, similar zero-profit conditions yield the thresholds on productivity $\bar{x}_{F,D}$, $\bar{x}_{F,EXP}$, $\bar{x}_{F,N}$ respectively for the domestic market, the export and the nontradable sector.

$$\pi^*_{F,D}(x) = \frac{1}{\sigma}\left[\frac{p^*_{F,D}(x)}{P^*_T}\right]^{1-\sigma} P^*_T C_{F,T} - F_{F,D} = 0, \tag{12}$$

$$\pi_{F,EXP}(x) = \frac{1}{\sigma}\left[\frac{\varepsilon p^*_{F,EXP}(x)}{P_T}\right]^{1-\sigma} P_T C_{H,T} - \varepsilon F_{F,EXP} = 0, \tag{13}$$

$$\pi^*_{F,N}(x) = \frac{1}{\sigma}\left[\frac{p^*_{F,N}(x)}{P^*_N}\right]^{1-\sigma} P^*_N C_{F,N} - F_{F,D} = 0. \tag{14}$$

Aggregate Budget Constraint and Equilibrium

As in Chaney (2008), the total mass of potential entrants in each country is assumed to be proportional to the size of the country, so that larger countries have more potential entrant firms. The price indices for tradable goods and nontradable goods in the Home and Foreign country can be then written as follows:

$$P_T = \left[L_H \int_{\bar{x}_{H,D}}^{\infty} p_{H,D}(x)^{1-\sigma} dG(x) + L_F \int_{\bar{x}_{F,EXP}}^{\infty} \left[\varepsilon p^*_{F,EXP}(x) \right]^{1-\sigma} dG(x) \right]^{\frac{1}{1-\sigma}}, \tag{15}$$

$$P_N = \left[L_H \int_{\bar{x}_{H,N}}^{\infty} p_{H,N}(x)^{1-\sigma} dG(x) \right]^{\frac{1}{1-\sigma}}, \tag{16}$$

$$P^*_T = \left[L_F \int_{\bar{x}_{F,D}}^{\infty} p^*_{F,D}(x)^{1-\sigma} dG(x) + L_H \int_{\bar{x}_{H,EXP}}^{\infty} \left[\frac{p_{H,EXP}(x)}{\varepsilon} \right]^{1-\sigma} dG(x) \right]^{\frac{1}{1-\sigma}}, \tag{17}$$

$$P^*_N = \left[L_F \int_{\bar{x}_{F,N}}^{\infty} p^*_{F,N}(x)^{1-\sigma} dG(x) \right]^{\frac{1}{1-\sigma}}. \tag{18}$$

The final conditions to close the model are given by the aggregate budget constraint, labor market clearing conditions, and the balance of payments. In the following, assume that the Home country is running a current account deficit. As in Obstfeld and Rogoff (2005), this paper analyzes the real adjustment of current account imbalances driven by an increase in Foreign aggregate demand and a decrease in Home aggregate demand. To adjust global imbalance, Home households must thus transfer a positive amount of resources T to Foreign households.

The aggregate budget constraint for the Home country is $PC_H = L_H(1 + (\Pi/L)) - T$. The left-hand side of the aggregate budget constraint represents the value of Home aggregate consumption, whereas the right-hand side is Home aggregate income (labor income plus the share in global profits) minus the transfer of resources. The global profits Π, the sum of profits of Home and Foreign firms, can be shown to be a constant equal to $((\sigma - 1)/(\gamma\sigma - \sigma + 1))L$. One can then write the aggregate budget constraint as[6]:

$$PC_H = L_H \left(\frac{\gamma\sigma}{\gamma\sigma - \sigma + 1} \right) - T. \tag{19}$$

[6]A similar equation holds true for the Foreign country: $P^* C_F = L_F(\gamma\sigma/\gamma\sigma - \sigma + 1) + T/\varepsilon$.

The aggregate budget constraint (19) corresponds to the balance of payments identity:

$$L_H \int_{\bar{x}_{H,EXP}}^{\infty} \sigma\left[\varepsilon\pi^*_{H,EXP}(x) + F_{H,EXP}\right] dG(x)$$

$$- L_F \int_{\bar{x}_{F,EXP}}^{\infty} \sigma\left[\pi_{F,EXP}(x) + \varepsilon F_{F,EXP}\right] dG(x) - T = 0. \quad (20)$$

In the end, Equations (9)-(14), and the balanced current account in Equation (20) jointly determine the productivity thresholds $\bar{x}_{H,D}$, $\bar{x}_{H,N}$, $\bar{x}_{H,EXP}$, $\bar{x}_{F,D}$, $\bar{x}_{F,N}$, $\bar{x}_{F,EXP}$ and the exchange rate ε as functions of the exogenous variable (the transfer T), and parameters (the size of countries L_H and L_F, the transport cost τ, and the fixed costs $F_{H,D}$, $F_{H,EXP}$, $F_{F,D}$, and $F_{F,EXP}$).

II. Real Adjustment of Current Account Imbalances

In this section, I investigate analytically the impact of the current account adjustment on the aggregate flows of exports and imports, the exchange rate, and the productivity thresholds of Home and Foreign firms. For sake of tractability, analytical results are derived for $k=1$, that is in a framework where the nontradable sector is shut down. In Section III, I analyze the more general case with $k \neq 1$.

The aggregate expenditure in the Home country is $P_{H,T}C_{H,T} = [L_H(\gamma\sigma/(\gamma\sigma - \sigma + 1)) - T] \equiv Y_H$. In the Foreign country the aggregate expenditure is $P^*_{F,T}C_{F,T} = [L_F(\gamma\sigma/(\gamma\sigma - \sigma + 1)) + T/\varepsilon] \equiv Y_F$. The model is solved at the symmetrical equilibrium, where $L_H = L_F$, $F_{H,D} = F_{F,D}$, $F_{H,EXP} = F_{F,EXP}$, $T = 0$ and $\varepsilon = 1$. First, the adjustment of the current account position is decomposed into the intensive and the extensive margins of trade. The equilibrium depreciation of the exchange rate associated with the adjustment of the current account is then computed.

The Intensive and Extensive Margins of Current Account Adjustments

Define the sales of a Home exporting firm as $h(x) = \sigma[\varepsilon\pi^*_{H,EXP}(x) + F_{H,EXP}]$, and the sales of a Foreign exporting firm as $l(x) = \sigma[\pi_{F,EXP}(x) + \varepsilon F_{F,EXP}]$. The aggregate value of Home exports and imports, both expressed in terms of Home currency, are respectively given by

$$EXP_H = L_H \int_{\bar{x}_{H,EXP}}^{\infty} h(x) dG(x),$$

$$IMP_H = L_F \int_{\bar{x}_{F,EXP}}^{\infty} l(x) dG(x).$$

The impact of the transfer of resources on the exchange rate is analyzed by totally differentiating the balanced current account in Equation (20), $(dEXP_H - dIMP_H - dT = 0)$. The differentiation allows to disentangle the intensive and extensive margins of the current account adjustment, as well as the direct impact of the transfer and the indirect adjustment through relative prices:

$$dEXP_H = L_H \left\{ \underbrace{\left[\int_{\bar{x}_{H,EXP}}^{\infty} \frac{\partial h(x)}{\partial T} dG(x) \right]}_{\text{Intensive margin}} dT - \underbrace{\left[G'(\bar{x}_{H,EXP}) \cdot h(\bar{x}_{H,EXP}) \cdot \frac{\partial \bar{x}_{H,EXP}}{\partial T} \right]}_{\text{Extensive margin}} dT \right\}$$

$$+ L_H \left\{ \underbrace{\left[\int_{\bar{x}_{H,EXP}}^{\infty} \frac{\partial h(x)}{\partial \varepsilon} dG(x) \right]}_{\text{Intensive margin}} d\varepsilon - \underbrace{\left[G'(\bar{x}_{H,EXP}) \cdot h(\bar{x}_{H,EXP}) \cdot \frac{\partial \bar{x}_{H,EXP}}{\partial \varepsilon} \right]}_{\text{Extensive margin}} d\varepsilon \right\}$$

$$dIMP_H = L_F \left\{ \underbrace{\left[\int_{\bar{x}_{F,EXP}}^{\infty} \frac{\partial l(x)}{\partial T} dG(x) \right]}_{\text{Intensive margin}} dT - \underbrace{\left[G'(\bar{x}_{F,EXP}) \cdot l(\bar{x}_{F,EXP}) \cdot \frac{\partial \bar{x}_{F,EXP}}{\partial T} \right]}_{\text{Extensive margin}} dT \right\}$$

$$+ L_F \left\{ \underbrace{\left[\int_{\bar{x}_{F,EXP}}^{\infty} \frac{\partial l(x)}{\partial \varepsilon} dG(x) \right]}_{\text{Intensive margin}} d\varepsilon - \underbrace{\left[G'(\bar{x}_{F,EXP}) \cdot l(\bar{x}_{F,EXP}) \cdot \frac{\partial \bar{x}_{F,EXP}}{\partial \varepsilon} \right]}_{\text{Extensive margin}} d\varepsilon \right\}$$

The productivity thresholds $\bar{x}_{H,\,EXP}$ and $\bar{x}_{F,\,EXP}$ evaluated at the symmetrical equilibrium[7] are substituted into the previous expressions to obtain $dEXP_H$ and $dIMP_H$. Then, the total differential of the current account can be written as follows:

$$\underbrace{2B\left(\frac{1}{\psi}\right)}_{\text{intensive}} dT + \underbrace{2BY_H\left[\frac{1}{A}\left(\frac{1}{\psi} - \sigma\right) + \sigma - 1\right]}_{\text{intensive}} d\varepsilon$$

$$+ \underbrace{2B\left(\frac{\psi - 1}{\psi}\right)}_{\text{extensive}} dT + \underbrace{2BY_H\left\{(\psi - 1)\left[\frac{1}{A}\left(\frac{1}{\psi} - \sigma\right) + \sigma\right]\right\}}_{\text{extensive}} d\varepsilon - dT = 0, \qquad (21)$$

[7]See the Appendix for the calculation of the productivity thresholds at the symmetrical equilibrium, when the nontradable sector is shut down.

where $\psi = \gamma/(\sigma - 1)$ is the Pareto shape parameter of the size distribution of firms, B is the openness rate of the Home country (EXP_H/GDP_H) and A is a positive constant.[8]

The intensive and extensive margins of the adjustment are positive, both with respect to a change in the exogenous transfer T and to the endogenous exchange rate ε. This means that both the extensive and the intensive margin of trade increase and contribute to the current account adjustment. In particular, the first term in Equation (21) represents the intensive margin of trade due to the transfer of resources. This term refers to the Ohlin's income effect, according to which the lower demand of Home with respect to Foreign reduces Home imports and increases the sales of existing exporting firms for given relative prices. The second term refers to the intensive margin of trade induced by the change in relative prices. This is the Keynesian terms-of-trade effect. Existing exporting firms increase their sales because the exchange rate depreciates after the transfer, which makes their goods cheaper from the point of view of Foreign households.

The third and fourth terms in Equation (21) mirror the Ohlin's and Keynes' effects but in a new dimension: the extensive margin of trade. The Ohlin's income effect and the Keynesian terms-of-trade effect produce a change in exports and imports that contributes to the adjustment, through the entry of new Home exporting firms in the Foreign market. As in Corsetti, Martin, and Pesenti (2008), the extensive channel of adjustment leads to a lower change in relative prices, so that the required depreciation of the Home currency is lower than in a model with a representative firm where the number of exported goods does not change after the shock. In this paper, by contrast with Corsetti, Martin, and Pesenti (2008), the relative size of the extensive and intensive margins for the current account adjustment depend on the distribution of firm sizes.

For a low Pareto shape parameter of the size distribution of firms ψ,[9] that is when the dispersion firm sizes is high, the intensive margin is greater than the extensive margin. In the polar case $\psi = 1$, the extensive margin of the current account adjustment in Equation (21) is equal to zero both with respect to ε and T. For a given elasticity of substitution among goods σ, ψ is small when the heterogeneity across firms is high. The sales of more productive incumbent firms then represent a large share of aggregate exports, and the sales of less productive new exporting firms contribute less to the current account adjustment. Then, for a given productivity dispersion parameter γ, ψ is small when goods are more substitutable. In this case, aggregate exports are more sensitive to productivity heterogeneity, as the more productive exporting firms charge lower prices and sell more than low productivity firms. When the dispersion of firm sizes is high (ψ small), the

[8] $B = [(\tau^{(1-\sigma)\psi}(\sigma F_{H,EXP})^{1-\psi})/((\sigma F_{H,D})^{1-\psi} + \tau^{(1-\sigma)\psi}(\sigma F_{H,EXP})^{1-\psi})]$ and $A = [(\tau^{(1-\sigma)\psi} \times (\sigma F_{H,EXP})^{1-\psi})/B]$.

[9] Note that $\psi = \gamma/(\sigma - 1) > 1$ as $\gamma > \sigma - 1$ by assumption.

intensive margin is therefore the predominant channel of the current account adjustment.

In the end, these results show that the extensive margin is decreasing in the dispersion of firm sizes. It plays a key role in current account adjustments when firms are less heterogeneous and goods are highly differentiated. In such situation, there is a little productivity gap between exporting and domestic firms. Moreover, since goods are highly differentiated, the market share of firms, even for the less productive, is high. Following a transfer, the aggregate sales of new exporting firms (extensive margin) are larger than those of existing exporters (intensive margin). As a result, the impact of the entry of new exporting firms is sizable with respect to aggregate exports.

The Overall Depreciation of the Exchange Rate

The equilibrium value of $d\varepsilon/dT$, that is the exchange rate depreciation which balances the current account after the transfer of resources, is obtained by adding the two margins of the adjustment with respect to dT and $d\varepsilon$ in Equation (21). This results in:

$$\frac{d\varepsilon}{dT} = \left(\frac{1-2B}{BL}\right)\frac{1}{\psi\sigma C} > 0, \tag{22}$$

where C is a positive constant.[10] Let us define DOM_H as the domestic sales of tradable goods produced by Home firms.[11] Notice that the ratio $(1-2B)/B = (DOM_H - EXP_H)/EXP_H$ is positive as $F_{H,EXP} > F_{H,D}$. The higher is B, that is the openness rate of the country, the lower is the required depreciation.

In Obstfeld and Rogoff (2005), the elasticity of substitution among goods is the key parameter, along with the tradable nontradable elasticity of substitution to quantifying the necessary depreciation of the exchange rate to a current account adjustment. In such standard models a higher elasticity of substitution makes quantities react more to a given change in relative prices, thus implying a lower adjustment of the exchange rate for a given transfer. In Corsetti, Martin, and Pesenti (2008), a higher elasticity of substitution among goods slightly dampens the entry of new exporting firms (extensive margin), but still leads to a lower depreciation of the exchange rate.

One contribution of this paper is to show that this classical emphasis may be incomplete when the entry of heterogeneous firms is allowed. The extensive margin of the current account adjustment is shown to be sensitive to both the elasticity of substitution among goods σ and the productivity dispersion γ. As shown in the previous subsection, the interplay between these two parameters determines the relative size of the intensive and extensive margins, and the magnitude of the exchange rate depreciation.

[10] $C = ((A-1)/A) + (\psi\sigma/\psi\sigma - 1)$.

[11] $DOM_H = L_H \int_{\tilde{x}_{H,D}}^{\infty} d(x)dG(x)$, where $d(x) = \sigma[\pi_{H,D}(x) + F_{H,D}]$.

The impact of a change in the elasticity of substitution on the exchange rate is captured by the derivative of $d\varepsilon/dT$ in Equation (22) with respect to σ. Notice that the derivative is computed for a given ψ, that is by keeping fixed the dispersion of the size of firms, and for given openness rate B and constant A. Formally, the impact of σ on the exchange rate depreciation is given by

$$\frac{\partial\left(\frac{d\varepsilon}{dT}\right)}{\partial\sigma} = \underbrace{-\left(\frac{1-2B}{BL}\right)\frac{1}{\psi\sigma^2 C}}_{(-)} \underbrace{+\left(\frac{1-2B}{BL}\right)\frac{1}{\psi[(\psi\sigma-1)\sigma C]^2}}_{(+)}. \tag{23}$$

The first term in Equation (23) represents the standard result in Obstfeld and Rogoff (2005) and Corsetti, Martin, and Pesenti (2008). In a model without heterogeneous exporting firms, this is the only channel through which the elasticity of substitution affects the magnitude of the required depreciation. When the elasticity among goods is higher, the change in aggregate exports occurs for a smaller change in prices. In this model, the elasticity of substitution determines the aggregate impact of the entry of new exporting firms on the overall current account adjustment. New exporting firms are less productive than existing ones, and this differential in productivity is strengthened by the higher elasticity of substitution. As a result, the aggregate impact of the entry of new exporting firms is smaller. A large part of the adjustment of the current account takes place at the intensive margin, and the depreciation of the exchange rate is higher. This is what is captured by the second term in Equation (23).

III. Quantitative Simulations

In this section, the complete model with both the nontradable and the tradable sectors is calibrated to provide some quantitative elements for an assessment of the relative price changes associated with the adjustment of global current account imbalances. In particular, these quantitative simulations aim at measuring exchange rate movements associated with an international transfer of resources equivalent to the correction of the current U.S. trade imbalance.

In Section II, analytical results show the effect of a transfer to Foreign creditors on the exchange rate and the increase in aggregate exports due to both existing firms (intensive margin) and new exporting firms (extensive margin). The initial conditions were set so that both countries were at the symmetric balanced equilibrium, all firms were producing tradable goods ($k=1$), and the transfer to Foreign households required their external position to move to a surplus of the same size of the transfer itself.

In this section, Home and Foreign countries are asymmetric in terms of their current account position, their size and the fixed costs of production their firms incur. Moreover, both nontradable and tradable goods are produced ($0<k<1$). The transfer of resources is calibrated to restore the balanced equilibrium starting from a situation in which the Home country (United States) runs a current account deficit. The effect of the transfer on exchange rate movements is analyzed over a long enough time span so that firms relocate across the domestic and the export market. In particular, the higher demand from Foreign households leads to a decrease in Home exporting productivity threshold and the entry of new exporting firms into the Foreign market. The simulations explore the response of the economy to the transfer for different levels of elasticity of substitution among goods and productivity dispersion of exporting firms. Results highlight the sensitivity of the extensive margin of the current account adjustment to the size dispersion of firms.

Benchmark Calibration

In the benchmark calibration, the elasticity of substitution among goods σ is set to 3.8 as reported by Bernard and others (2003). They calibrate this value so as to fit U.S. plant and macro trade data. Bernard and others (2003) also report that the standard deviation of log U.S. plant sales is 1.67. As in Ghironi and Melitz (2005), since this standard deviation is equal to $1/(\gamma-\sigma+1)$ in the theoretical model, the Pareto shape parameter of firm productivity distribution γ is set to 3.4. These values of productivity dispersion and elasticity of substitution among goods imply that firm sizes are distributed according to a power law, which is Pareto with shape $\psi=1.21$. Levchenko, di Giovanni, and Rancière (2010) estimate the power law exponent in firm size using French data, and find a slightly lower value, around 1.05.

The effect of a current account adjustment is then studied for alternative values of the elasticity of substitution $\sigma=2$ and $\sigma=3$ as suggested by the international macroeconomics literature. Following Obstfeld and Rogoff (2005), the share of tradable good sector is set to 25 percent of consumption ($k=0.25$), trade costs are set to $\tau=1.3$, and the elasticity of substitution among tradable and nontradable goods is set to $\theta=1$. The size of the world economy is normalized to 100 and the size of the Home and Foreign country is set as $L_H=24$ and $L_F=76$ to roughly approximate the weight of the U.S. economy in world GDP, about 24 percent in 2009.

Home fixed costs of production in the domestic ($F_{H,D}$) and export market ($F_{H,EXP}$) are set such that the ratio of Home exports to Home GDP is 11 percent, corresponding to U.S. values for 2009 (WDI data). Similarly, Foreign fixed costs of production in the domestic ($F_{F,D}$) and export markets ($F_{F,EXP}$) are set such that Foreign exports as a ratio of Foreign GDP are equal to 4.4 percent.[12] Changing the fixed domestic cost $F_{H,D}$ while maintaining the same ratio $F_{H,EXP}/F_{H,D}$ does not affect the Home exports

[12]This value is equal to U.S. imports from the rest of the world in 2009 (about \$1,946 billion) divided by world GDP excluding United States in 2009 (about \$58,141 billion minus \$14,119 billion) according to WDI data.

Table 1. Benchmark Calibration

Parameter	Symbol	Value	Source
Elasticity of substitution among goods	σ	3.8	Ghironi and Melitz (2005)
Elasticity of substitution tradable/nontradable	θ	1	Obstfeld and Rogoff (2005)
Share of tradable good sector	k	0.25	Obstfeld and Rogoff (2005)
Pareto shape parameter	γ	3.4	Ghironi and Melitz (2005)
Transport costs	τ	1.3	Ghironi and Melitz (2005)
Relative size Home country/ Foreign country	L_H/L_F	0.32	$GDP_{U.S.}/GDP_{ROW}$, data WDI 2009
Transfer to GDP ratio	T/GDP_H	−0.027	U.S. ca deficit, data WDI 2009
Home ratio export/domestic fixed costs	$F_{H,EXP}/F_{H,D}$	1.05	Match $EXP_{U.S.}/GDP_{U.S.} = 11\%$, data WDI 2009
Foreign ratio export/domestic fixed costs	$F_{F,EXP}/F_{F,D}$	1.05	Match $IMP_{U.S.}/GDP_{ROW} = 4.4\%$, data WDI 2009

to GDP ratio, and the same holds true for the Foreign country. The fixed domestic costs $F_{H,D}$ and $F_{F,D}$ are therefore set to 1 without loss of generality. For similar reasons, the Pareto scale parameter of productivity distribution $\bar{x}$ is normalized to 1.

At the initial equilibrium, the transfer of resources is $T = -0.027 \cdot GDP_H$, corresponding to the U.S. current account deficit to GDP ratio in 2009. The simulations consider the effects of a transfer $\Delta T = 0.027 \cdot GDP_H$ that eliminates the current account imbalances. The calibration implies that Home aggregate exports increase by 15 percent with respect to the initial equilibrium as an effect of the transfer. Table 1 summarizes the values of the parameters in the benchmark calibration.

Results

Table 2 reports the exchange rate depreciation associated to a transfer equivalent to the U.S. current account deficit, and the share of the extensive and the intensive margin of the adjustment.[13] In the second column, the extensive margin channel is shut down, by assuming that the current account adjustment has no impact on the productivity thresholds. In this case, the response of the economy to the current account adjustment is measured while keeping constant the productivity thresholds at their initial equilibrium level.

Results in Table 2 show that exchange rate movements in response to a current account adjustment are mainly a function of the size dispersion of exporting firms. In standard models where the intensive margin is the only

[13]See the Appendix for the numerical decomposition of the two margins.

Table 2. Current Account Adjustment: Sensitivity to the elasticity of substitution σ.

Parameters				Complete Model			Model Without Extensive Margin		
θ	γ	σ	ψ	ε(%)	Intensive	Extensive	ε(%)	Intensive	Extensive
1	3.4	2	3.40	2.16	0.37	0.63	8.40	1	0
1	3.4	3	1.70	2.92	0.62	0.38	5.23	1	0
1	3.4	3.8	1.21	3.25	0.84	0.16	4.02	1	0
0.5	3.4	2	3.40	2.12	0.37	0.63	8.85	1	0
0.5	3.4	3	1.70	3.02	0.62	0.38	5.54	1	0
0.5	3.4	3.8	1.21	3.46	0.84	0.16	4.31	1	0

channel of adjustment (Obstfeld and Rogoff, 2005), or where the extensive margin is not sensitive to the dispersion of firm productivities (Corsetti, Martin, and Pesenti, 2008), the exchange rate depreciation is orthogonal to the size dispersion of firms.

In the benchmark calibration, with unitary elasticity of substitution θ among tradable and nontradable goods, the exchange rate depreciates by 3.2 percent. Consistent with Corsetti, Martin, and Pesenti (2008), the exchange rate depreciation is lower than the one obtained in a framework without extensive margin adjustments (4 percent). The exchange rate depreciation in the complete model is always lower than what one could obtain in a model without extensive margin of trade. However, the dampening effect of the extensive margin on the exchange rate depreciation decreases as the shape parameter of the size distribution of firms gets closer to 1. The model calibrated to the observed distribution of firm sizes (ψ close to 1) therefore shows that the extensive margin contributes to a small part of the current account adjustment.

Table 2 also reports the sensitivity of the exchange rate depreciation to the elasticity of substitution among goods σ, for given dispersion of firm productivities γ. The sensitivity of the exchange rate is measured by letting σ take different values, but keeping constant the exports to GDP ratio at its pretransfer level. This allows to compare the results for different size dispersion of firms according to different levels of the elasticity of substitution σ. In practice, for a change in σ, the ratios of export fixed costs over the domestic fixed costs ($F_{H,EXP}/F_{H,D}$) and ($F_{F,EXP}/F_{F,D}$) are such that the openness rates of the Home and Foreign country at the initial equilibrium are unchanged.

In standard models of current account adjustments like Obstfeld and Rogoff (2005) and Corsetti, Martin, and Pesenti (2008), the exchange rate depreciation is lower when goods are more substitute. Table 2 reports the results in the model without extensive margin of trade. The increase in the volume of Home net exports occurs for a lower change in relative prices, and a lower exchange rate depreciation is associated with a given level of current account adjustment. In a model without extensive margin adjustments, the transfer has no impact on the structure of the economy. When goods are more substitutable, existing exporting firms (the intensive margin of trade) increase the amount of their sales without much changes in relative prices. In this paper, the exchange rate depreciation is sensitive to the entry of new heterogeneous exporting firms. As shown in the analytical results, when the size dispersion of firms is low (ψ is high), the impact of the extensive margin on the current account adjustment is big and the exchange rate depreciates less. In the calibrated model, the exchange rate depreciates by 2.2 vs. 3.2 percent in the benchmark calibration.[14] However, this dampening effect on the exchange rate depreciation is associated with an implausible low level of firm size dispersion (ψ about three times larger than the one observed in data).

The second part of Table 2 replicates the results for a lower elasticity of substitution among tradable and nontradable goods ($\theta = 0.5$). As suggested by Obstfeld and Rogoff (2005), the level of the intranational elasticity of substitution (between tradable and nontradable goods) has a large impact on exchange rate movements when the share of nontradable goods in the CPI is large (as it is the case in the benchmark). In this paper, the reallocation of demand between the traded and the nontraded sectors also induces a reallocation of firms at the extensive margin. This intranational extensive margin limits movements in prices associated with the current account adjustment, thus dampening the effect emphasized in Obstfeld and Rogoff (2005). The exchange rate depreciation for $\theta = 0.5$ is higher than with a unitary elasticity of substitution, as Home households substitute less the consumption of imported goods with Home nontradable goods. In the meanwhile, the sensitivity of the exchange rate to the international elasticity of substitution σ is unaffected, highlighting the difference between a model with entry of new heterogeneous exporting firms and a model without extensive margin.

Table 3 reports the sensitivity of the exchange rate depreciation to the productivity dispersion γ, for a given elasticity of substitution σ. The sensitivity is measured by letting changes in γ, but keeping constant the exports to GDP ratio at its pretransfer level. This allows to compare the results for different size dispersion of firms due to different levels of productivity dispersion γ. In practice, for a change in γ, the ratio of the export to the domestic fixed costs ($F_{H,EXP}/F_{H,D}$) and ($F_{F,EXP}/F_{F,D}$) are such that the openness rates of the Home and Foreign country at the initial equilibrium are unchanged. Results show that the exchange rate depreciation is lower for a higher level of γ, that is when the productivity

[14]Notice that for an elasticity of substitution of 2, the exchange rate depreciation of the model without extensive margin raises to 8.4 percent. For a larger current account adjustment (deficit equal to 5 percent instead of 2.7 percent of Home GDP), the required depreciation in the model without extensive margin amounts to 15 percent.

Table 3. Current Account Adjustment: Sensitivity to firm productivity dispersion γ

Parameters				Complete Model			Model Without Extensive Margin		
θ	γ	σ	ψ	$\varepsilon(\%)$	Intensive	Extensive	$\varepsilon(\%)$	Intensive	Extensive
1	3.4	3.8	1.21	3.25	0.84	0.16	4.02	1	0
1	4.76	3.8	1.70	2.22	0.62	0.38	3.93	1	0
1	9.52	3.8	3.40	1.05	0.37	0.63	3.88	1	0
0.5	3.4	3.8	1.21	3.46	0.84	0.16	4.31	1	0
0.5	4.76	3.8	1.70	2.28	0.62	0.38	4.13	1	0
0.5	9.52	3.8	3.40	1.05	0.37	0.63	4.10	1	0

of firms is less dispersed. In such a case, the size dispersion of firms is also less dispersed (ψ high) and a large part of the current account adjustment occurs at the extensive margin, leading to a lower exchange rate depreciation.

Not surprisingly, the results for the model without extensive margin in Table 3 show that the exchange rate depreciation is not much affected by the productivity dispersion of firms in the model without extensive margin of trade.[15] This result is closely related to Chaney (2008). In Chaney (2008), the elasticities of the extensive and intensive margins of trade to a change in transport costs are affected in a different way by the elasticity of substitution among goods and the firm productivity dispersion. In particular, Chaney (2008) shows that the elasticity of the intensive margin of trade is not affected by the productivity dispersion γ, whereas the extensive margin of trade is affected by both the productivity dispersion γ and the elasticity of substitution σ. This paper shows that the exchange rate depreciation associated with global rebalancing is not a function of the productivity dispersion of firms when the intensive margin is the unique channel of current account adjustment.

Finally, Table 4 investigates the sensitivity of the results for a higher level of elasticity of substitution. As suggested by Imbs and Mejean (2009), once one allows for heterogeneity in goods substitutability at sector level, the aggregate substitutability can be much higher (around 7) than the classical estimates in the macro literature (around 2).

Notice that for the benchmark size dispersion of firms ($\psi = 1.21$), the exchange rate depreciation is decreasing in the elasticity of substitution among goods (1.4 vs. 3.2 percent). This is another way to show that the standard result in Obstfeld and Rogoff (2005) holds in this model when keeping fixed the size dispersion of firms.

[15]The exchange rate depreciation is slightly affected by the productivity dispersion of firms because of approximation errors.

Table 4. Current Account Adjustment: Sensitivity to firm productivity dispersion γ for σ=7

Parameters				Complete Model			Model Without Extensive Margin		
θ	γ	σ	ψ	ε(%)	Intensive	Extensive	ε(%)	Intensive	Extensive
1	7.26	7	1.21	1.38	0.84	0.16	1.68	1	0
1	10.20	7	1.70	0.94	0.62	0.38	1.65	1	0
0.5	7.26	7	1.21	1.40	0.84	0.16	1.71	1	0
0.5	10.20	7	1.70	0.95	0.62	0.38	1.70	1	0

IV. Conclusion

In this paper, a standard model of international transfer is augmented by the introduction of heterogeneous firms as in Chaney (2008). Recent empirical findings in trade literature have highlighted the quantitative importance of the extensive margin on aggregate trade flows. Hummels and Klenow (2005) find that larger countries trade more and the extensive margin can account for 60 percent of the difference in trade flows. Galstyan and Lane (2008) find that, over a relatively short period of time (2000–2004), around half of U.S. trade growth has occurred at the extensive margin. The sales of new heterogeneous exporting firms therefore may play an important role on the adjustment of global imbalances, and on the size of the secondary burden of a transfer.

The response of the economy to the adjustment of current account imbalances is analyzed in a model where the structure of trade flows is sensitive to the dispersion of firm sizes. The extensive margin of trade may constitute an important channel of current account adjustment when firm sizes get less dispersed, that is when the productivity dispersion of firms is low and goods are more substitutable. In the model calibrated to match the observed distribution of firm sizes, the extensive margin accounts for a small part (16 percent) of the current account adjustment and the exchange rate depreciates by 3.2 percent. As a counterfactual, we show that the dampening effect of the extensive margin on exchange rate movements has sizable magnitude only for implausible low levels of firm size dispersion. When firms are about three times more homogeneous than what is observed in data, the extensive margin accounts for 63 percent of the current account adjustment, and the exchange rate depreciates by 2.2 percent.

These results tend to de-emphasize the quantitative importance of the extensive margin of trade for the adjustment of current account imbalances, and its implications for exchange rate movements. In this respect, these results are thus related to Arkolakis, Costinot, and Rodríguez-Clare (2009), who show that the welfare gains from trade, even for models that include new margins of trade, are not very large.

APPENDIX

A.1. Productivity Thresholds at the Symmetrical Equilibrium

For sake of tractability, the nontradable sector is shut down by taking $k = 1$, so that the aggregate expenditure in the Home country is $P_{H,T}C_{H,T} = [L_H(\gamma\sigma/(\gamma\sigma - \sigma + 1)) - T]\ Y_H$, whereas in the Foreign country it is $P^*_{F,T}C_{F,T} = [L_F(\gamma\sigma/(\gamma\sigma - \sigma + 1)) + (T/\varepsilon)] \equiv Y_F$. Price indices are then $P = P_T$ and $P^* = P^*_T$.

The zero-profit conditions (9), (10), (12), (13) provide the values of productivity thresholds for given price indices:

$$\bar{x}_{H,D} = \frac{\phi}{P}\left(\frac{\sigma F_{H,D}}{Y_H}\right)^{\frac{1}{\sigma-1}}, \tag{A.1}$$

$$\bar{x}_{H,EXP} = \frac{\tau\phi}{\varepsilon P^*}\left(\frac{\sigma F_{H,EXP}}{\varepsilon Y_F}\right)^{\frac{1}{\sigma-1}}, \tag{A.2}$$

$$\bar{x}_{F,D} = \frac{\phi}{P^*}\left(\frac{\sigma F_{F,D}}{Y_F}\right)^{\frac{1}{\sigma-1}}, \tag{A.3}$$

$$\bar{x}_{F,EXP} = \frac{\varepsilon\tau\phi}{P}\left(\frac{\sigma\varepsilon F_{F,EXP}}{Y_H}\right)^{\frac{1}{\sigma-1}}. \tag{A.4}$$

Plugging the productivity thresholds $\bar{x}_{H,D}$ and $\bar{x}_{F,EXP}$ into Equation (15), one can obtain the equilibrium value of the Home price index P. In a similar way, the equilibrium price index $P^*$is obtained by plugging the thresholds $\bar{x}_{F,D}$ and $\bar{x}_{H,EXP}$ into Equation (17):

$$P = \left[\mu L_H\left(\frac{\sigma F_{H,D}}{Y_H}\right)^{\frac{\sigma-\gamma-1}{\sigma-1}} + \mu L_F\left(\frac{\sigma F_{F,EXP}}{Y_H}\right)^{\frac{\sigma-\gamma-1}{\sigma-1}}\tau^{-\gamma}\varepsilon^{\frac{\sigma-\gamma\sigma-1}{\sigma-1}}\right]^{-\frac{1}{\gamma}},$$

$$P^* = \left[\mu L_F\left(\frac{\sigma F_{F,D}}{Y_F}\right)^{\frac{\sigma-\gamma-1}{\sigma-1}} + \mu L_H\left(\frac{\sigma F_{H,EXP}}{Y_F}\right)^{\frac{\sigma-\gamma-1}{\sigma-1}}\tau^{-\gamma}\varepsilon^{\frac{\gamma\sigma-\sigma+1}{\sigma-1}}\right]^{-\frac{1}{\gamma}},$$

where $\mu = \phi^{-\gamma}(\gamma\bar{x}^{\gamma}/\gamma - \sigma + 1)$ is a constant.

Plugging the equilibrium price indices P and P^* into the zero-profit conditions, one can get the productivity thresholds as functions of the exchange rate and fundamentals only.

Solving the model at the symmetrical equilibrium implies $L_H = L_F$, $F_{H,D} = F_{F,D}$, $F_{H,EXP} = F_{F,EXP}$, $T = 0$ and $\varepsilon = 1$. At the symmetrical equilibrium, the price indices are therefore

$$P = P^* = \left\{\mu L_H\left[\left(\frac{\sigma F_{H,D}}{Y_H}\right)^{\frac{\sigma-\gamma-1}{\sigma-1}} + \left(\frac{\sigma F_{F,EXP}}{Y_H}\right)^{\frac{\sigma-\gamma-1}{\sigma-1}}\tau^{-\gamma}\right]\right\}^{-\frac{1}{\gamma}},$$

and the symmetrical equilibrium productivity thresholds are obtained by replacing these price indices into Equations (A.1)–(A.4).

A.2. Numerical Decomposition of the Extensive and the Intensive Margin

Define the vector of the initial equilibrium productivity thresholds $\hat{x} = (\bar{x}_{H,D}, \bar{x}_{H,N}, \bar{x}_{H,EXP}, \bar{x}_{F,D}, \bar{x}_{F,N}, \bar{x}_{F,EXP})$, and the vector of after-transfer equilibrium productivity thresholds $\hat{x}'$. The current account position can be then written as a function of the transfer and the vector of equilibrium productivity thresholds: $CA_H(T, \hat{x})$. The change in the current account position due to the transfer of resources can be therefore decomposed as:

$$\Delta CA_H = \underbrace{[CA_H(0, \hat{x}') - CA_H(0, \hat{x})]}_{\text{Extensive margin}} + \underbrace{[CA_H(0, \hat{x}) - CA_H(-0.027 \cdot GDP_H, \hat{x})]}_{\text{Intensive margin}}$$

and the shares of the extensive and the intensive margin on the overall current account adjustment in Tables 2 and 3 are respectively:

$$\text{extensive} = \frac{[CA_H(0, \hat{x}') - CA_H(0, \hat{x})]}{\Delta CA_H},$$

$$\text{intensive} = \frac{[CA_H(0, \hat{x}) - CA_H(-0.027 \cdot GDP_H, \hat{x})]}{\Delta CA_H}.$$

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