Essays in International Macroeconomics

by
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A thesis submitted for the degree of
Doctor of Philosophy
at the
University of Dublin

Department of Economics,
Trinity College Dublin

2007

Declaration

I declare that this dissertation has not been submitted as an exercise for a degree at this or any other University.

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Acknowledgments

I am very grateful to my thesis advisor Philip Lane for his continuous help and encouragement. I thank Patrick Honohan, Michael Klein and Jay Shambaugh for helpful comments. I thank my internal examiner Dudley Cooke and my external examiner Michael Bleaney for their comments and suggestions. I am grateful to the IRCHSS and the HEA-PRTLI grant to the IIIS for financial support.

I gratefully acknowledge the feedback received from the Trinity International Macroeconomics Group, TCD Economics Graduate Seminar, the 20th congress of the European Economic Association in 2005, the 22nd congress of the European Economic Association in 2007, the 19th meeting of the Irish Economic Association in 2005, the 21st meeting of the Irish Economic Association in 2007, the 14th world congress of the International Economic Association in 2005.

I thank my parents, Ara Galstyan and Yelena Shakhbazyan, for giving me the opportunity to pursue higher education. I can not thank enough my wife, Raimonda Elvikyte, for her help and patience during my work on the dissertation. Without her, this work would have been impossible, and I am greatly indebted to her.

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Chapter 1

General Introduction

1.1 Abstract

This dissertation is a collection of three separate essays in the area of international macroeconomics.

How does the history of a variable matter for its current state? Do current account reversals affect the persistence of international capital flows? These questions, relevant in policy circles for the analysis of the trajectory and the timing of adjustment of external imbalances, are the motivators of the second chapter titled "How persistent are international capital flows?". In this chapter we document the dynamic properties of the current account, trade balance and international capital flows. For this purpose, three different approaches are taken: probit, non-parametric estimation and an asymmetric autoregression. The probabilistic approach shows that, in general, deficits and net inflows tend to be more persistent than surpluses and net outflows. This result is robust to either specification of pooled and country-specific probits. Current account reversals have a significant effect on the persistence of capital flows, especially in developing countries. The latter also have more persistent deficits and net inflows than industrial countries. The results of non-parametric estimation are in line with the results obtained from the probit. In the case of asymmetric autoregression, we find that surpluses are more persistent than deficits: although the probability of remaining in surplus is lower, the scale of surpluses tends to show more persistence from the scale of deficits.

The third chapter of the thesis is motivated by the possible effects that country size can have on the magnitude of the classic transfer effect. Thus we study how country size affects the role of the exchange rate in external adjustment. First, the impact of country size on the sensitivity of relative prices to external imbalances is explored in a standard two-country neoclassical model. We find that the magnitude of the effect depends on country size. Second, at the empirical level, a significant effect of external

imbalances on relative prices is found. In particular, a trade surplus is associated with a deteriorating terms of trade and a declining relative price of non-traded goods, feeding into a depreciation of the real exchange rate. Estimation for G3 and non-G3 sub-samples reveals a systematic pattern in the sensitivity of relative prices to external imbalances, with the transfer effect stronger in larger countries.

The fourth chapter of the thesis is inspired by the current debate on the effects that the growth of relative income can have on the terms of trade. The contribution of this chapter is threefold. First, using panel data technique and 6 digit HS1992 import data, we estimate a range of substitution elasticities to construct variety-corrected terms of trade series. The estimated elasticity of substitution between varieties is equal to 9, while the elasticity of substitution at the level of goods is equal to 3. Second, we propose a decomposition strategy of trade flows into extensive and intensive margins. We find that ignoring the extensive margin in the construction of aggregate price indices results in an overestimation of the actual price index by 0.3 percentage points annually. Third, we test how the terms of trade responds to changes in intensive and extensive margins. We find that an increase in the intensive margin of exports is associated with a deterioration of the terms of trade. We also find that an increase in the extensive margin of exports results in a deterioration of the terms of trade, at least in the short run.

The fifth chapter of the thesis offers general conclusions and directions for further research.

1.2 Relevant Literature

1.2.1 How Persistent are International Capital Flows?

The persistence of capital flows has already received academic attention. Sarno and Taylor (1999), using maximum likelihood and Kalman Filtering techniques, study the persistence properties of international capital flows to Latin American and Asian developing countries. Clarida et al. (2007) use threshold autoregression model to estimate the asymmetric adjustment between different states of the current account. Though the estimated coefficients are significant, tests of coefficient equalities are not provided. For instance, autoregressive coefficients for Canada above mean and below mean are 0.927 and 0.930 respectively, while for Japan they are 0.908 and 0.894. The authors report half lives also, with surplus being more persistent for Canada, and deficit being more persistent for Japan. Definitely the measure of half-life depends on the reported autoregressive coefficients, which are very close to each other. The question is, are those coefficients significantly different from each other? Chortareas et al. (2004) test for current account solvency in Latin America using STAR-modified unit root tests. They find support for the sustainability of Latin American debt. Edwards (2004) studies persistence of large current accounts, where persistence is measured with the marginal probability. He finds that large current account surpluses are more persistent than large current account deficits. Reinhart and Rogoff (2003), analyzing panel data on external debt, show that the probability of transition from a bad state into a good state is higher than the transition in the other direction.

Some recent research has concentrated on understanding sharp reductions in current account to GDP ratios (Milesi-Ferretti and Razin, 1998, 2000). Our construction of current reversals follows in logic these authors: (i) a reduction of the current account to GDP ratio by three percentage points, after controlling for temporary fluctuations and moderate current account to GDP ratios; and (ii) a change of the current account to a surplus from previous period's deficit. The authors document that a sudden stop of international capital flows can result in a current account reversal if the country already runs a sizable current account deficit.

To contribute to this literature, we study the persistence of a wider range of international capital flow categories, compared to previous studies, using three different methods: probit, a non-parametric estimator and an asymmetric autoregression. The probabilistic approach shows that, in general, deficits and net inflows tend to be more persistent than surpluses and net outflows. This result is robust to either specification of pooled and country-specific probits. Current account reversals have a significant effect on the persistence of capital flows, especially in developing countries. The latter also have more persistent deficits and net inflows than industrial countries. The results of non-parametric estimation are in line with the results obtained from the probit. In the case of asymmetric autoregression, we find that surpluses are more persistent than deficits: although the probability of remaining in surplus is lower, the scale of surpluses tends to show more persistence from the scale of deficits.

1.2.2 Country Size and the Transfer Effect

Research on the role of the exchange rate in external adjustment has a long established tradition. Following the famous debate between Keynes (1929) and Ohlin (1929) on the effects of German reparations, the transfer problem has become a central issue in international macroeconomics. Two major approaches have been taken: one emphasizing the impact of international payments on the terms of trade (Obstfeld and Rogoff, 1995; Broner et al., 1997), the other highlighting the impact on the relative price of non-traded goods (Lane and Milesi-Ferretti, 2002, 2004).

There is a tremendous amount of literature studying the transfer effect. Samuelson

(1952) challenges the "orthodox" view regarding the implications of transport costs and the deteriorating terms of trade of the transfer paying country. Osbtfeld and Rogoff (1996), building on the Ricardian trade model of Dornbusch et al. (1977), show that a positive home transfer (trade surplus) lowers domestic relative wages and increases the range of domestically produced goods, resulting in a fall of both the real exchange rate and the terms of trade. To emphasize the effect of the terms of trade, Obstfeld and Rogoff (1995) build a small country model endowed with some monopoly power. In this model, a financial transfer to home from the rest of the world decreases domestic labor supply and, consequently, the supply of domestic traded goods, resulting in an increase in the price of domestic relative to foreign traded goods. Lane and Milesi-Ferretti (2004), being more concerned with the possible exogeneity of the terms of trade for many countries, setup a small country model with an exogenous traded and a monopolistically competitive non-traded sector. A transfer to home from the rest of the world decreases labor supply to the non-traded sector, reducing the supply of non-traded goods which is matched by an increase in the relative price of non-traded goods.

At the empirical level, Obstfeld and Rogoff (1995, 1996) estimate cross sectional regressions of the real exchange rate on the net foreign asset position and find a significant positive coefficient. Broner et al. (1997) study the terms of trade as the main link between relative prices and external imbalances and find a cointegrating relation between the real exchange rate, net foreign asset position and the relative price of non-traded goods. In contrast, Lane and Milesi-Ferretti (2004) study the relative price of non-traded goods as the link between external imbalances and the real exchange rate and find a cointegrating relation between the real exchange rate, net foreign asset position, relative per capita GDPs and the terms of trade. The results also show significant differences in magnitudes of the transfer effect between large and small countries.

We think that the two main strands of the literature that concentrate either on the terms of trade or the relative price of non-traded goods are incomplete because: (i) the data strongly supports the endogeneity of the relative price of non-traded goods to external imbalances; (ii) the terms of trade need not be exogenous even for small countries if they specialize in a niche sector of production. This paper fills the gap by (i) endogenizing both the terms of trade and the relative price of non-traded goods to external imbalances simultaneously; and (ii) studying the relation between external adjustment, relative prices and country size at both theoretical and empirical levels.

In this chapter our theoretical base follows Obstfeld and Rogoff (2006). These authors study global imbalances in a general equilibrium setup with an adjustment in both the terms of trade and the relative price of non-traded goods. In this model, however, the supply side is exogenous to relative prices. Endogenizing the supply side, we find that the magnitude of the transfer effect depends on country size. It is worth noting that Benigno and Thoenissen (2003) paper is qualitatively close to ours since they also endogenize both the terms of trade and the relative price of non-traded goods in their study of the real exchange rate. However, the authors look at the supply side determinants of the real exchange rate and not at the net foreign asset position.

The empirical part of our paper builds on the research by Lane and Milesi-Ferretti (2002, 2004). Guided by the model, we estimate relative price sensitivities to external imbalances for two different samples of industrial countries: G3 and non-G3. We depart from the Lane and Milesi-Ferretti (2002, 2004) approach, though, by allowing for an endogenous determination of the terms of trade. Our empirical results show a significant transfer effect. A reduction of trade deficit is associated with deteriorating terms of trade and a declining relative price of non-traded goods, feeding into a depreciation of the real exchange rate. Sensitivity of relative prices to external imbalances varies systematically between G3 and non-G3 samples: larger countries tend to have a larger sensitivity.

1.2.3 The Terms of Trade and the Margins of Trade Flows

How does the terms of trade respond to an increase in relative income? Since the seminal contribution of Bhagwati (1958) this question has fascinated many influential economists. The classic answer to the question is that an increase in domestic income relative to the main trading partners results in a deterioration of the terms of trade. In 1969 Houthakker and Magee estimated income elasticities of trade flows and found that the income elasticity of imports for the United States was greater than the income elasticity of the United States exports to the rest of the world. The implications were striking. If the United States and the rest of the world were to grow at the same rate, then the United States should have experienced either a consistent deterioration of the terms of trade or ever increasing trade deficit. Neither happened.

The failure of this theory to explain the behavior of the terms of trade of the United States in 1970s led to some new research in the area of international macroeconomics. The most elegant explanation belongs to Krugman (1989). Constructing a simple world economy model with monopolistically competitive firms, increasing returns and endogenous number of goods, Krugman shows that if the income increases as a result of creation of new goods, then, given that trading partners love variety, the terms of trade need not deteriorate.

Since our contribution is empirical, we find it useful to review some empirical papers most relevant to our study. The most outstanding one is the work by Acemoglu and Ventura (2002). The central prediction of the paper is the notion that faster capital accumulation fosters deterioration of the terms of trade. To test this statement, the authors relate the change in the terms of trade to the relative growth rate of nominal income and technology. Since the latter is not observable, the authors propose a two stage procedure in separating the effect of income growth on the terms of trade. In the first stage, the growth rate due to accumulation is isolated using Barro-type convergence regression, where the vector of controls includes steady state determinants of income (human capital, institutional variables, etc.). In the second stage, the terms of trade are regressed on the predicted growth rate from the first stage regression (and the controls of the first stage regression excluding the initial level of income). The regression results show that countries that grow faster than the rest of the world face depreciated terms of trade. Epifani and Gancia (2006) extend the sample size relative to Acemoglu and Ventura (2002) until 2000. Their terms of trade regressions follow essentially the logic of Acemoglu and Ventura, and so does the result.

The second work worth mentioning is Debaere and Lee (2002). These authors relate the terms of trade to the domestically produced export goods relative to the foreign import goods and market potential. The latter captures the strength of demand for a country's product by measuring the size of the neighboring markets. Because of unobserved variety, the authors construct output values net of productivity term. The latter is constructed by assuming that a fixed share of business R&D is spent on product innovation, and running a fixed-effects regression of output on technology, physical and human capital. The relative market potential is derived from a gravity equation of bilateral export pairs. First a gravity equation is estimated, then the predicted values are substituted into the formula for the relative market potential. To account for varieties/qualities, the authors construct two additional variables: relative GDP per capita and relative technologies. The results of the regressions are more or less economically and statistically significant coefficients. Relative output has a negative sign, while the market potential has a positive sign. Both GDP per capita and R&D have a positive sign.

Gagnon (2005) estimates the terms of trade regressions following interpretation of the Acemoglu and Ventura methodology. The main point of this regressions is to show that the growth rate of GDP is not reflected in a deteriorating terms of trade. Then Gagnon puts forward Krugman's argument that growth due to increased varieties need not result in the deterioration of the terms of trade. He builds a model where the varieties are proxied by the share of domestic output in world output. The regression results show that the exporters output ratio is highly significant, implying that fast-growing countries need not experience secular deterioration in their terms of trade.

Main limitations of the papers discussed above are: (i) reliance on the terms of trade data that is ignorant of new or disappearing varieties; (ii) regressions with proxies to margins of trade flows, instead of actual margins. Our value added relative to this existing work is fixing both of the points above. We do this in three steps. First, using panel data technique and 6 digit HS1992 import data, we estimate a range of substitution elasticities to construct a variety-corrected terms of trade series. The estimated elasticity of substitution between varieties is equal to 9, while the elasticity of substitution at the level of goods is equal to 3.

Second, we propose a decomposition strategy of trade flows into extensive and intensive margins. We find that ignoring the extensive margin in the construction of aggregate price indices results in an overestimation of the actual price index by 0.3 percentage points annually.

Third, we test how the terms of trade responds to changes in intensive and extensive margins. We find that an increase in the intensive margin of exports is associated with a deterioration of the terms of trade. We also find that an increase in the extensive margin of exports results in a deterioration of the terms of trade, at least in the short run.

Having presented our main results and most relevant literature for the dissertation, we now turn to more detailed treatment of the issues and results.

Chapter 2

How Persistent are International Capital Flows?

2.1 Introduction

The sustainability and adjustment of current account imbalances have been major issues in recent research. The greatest attention has concerned the trajectory of possible adjustments of the US current account deficit, which, growing steadily since 1991, has reached a remarkable 6.5 percent of GDP in 2006. A situation such that a variable (the current account in this case) is steadily in a deficit or in a surplus may be labeled a persistent deficit or surplus.

How does the history of a variable matter for its current state? Do current account reversals affect the persistence of international capital flows? These questions, relevant in policy circles for the analysis of the trajectory and the timing of adjustment of external imbalances, are the motivators of the current study.

The persistence of capital flows has already received academic attention. Sarno and Taylor (1999), using maximum likelihood and Kalman Filtering techniques, study the persistence properties of international capital flows to Latin American and Asian developing countries. Clarida et al. (2007) use threshold autoregression model to estimate the asymmetric adjustment between different states of the current account.[1] Chortareas et al. (2004) test for current account solvency in Latin America using STAR-modified unit root tests. Edwards (2004) studies persistence of large current accounts, where

[1]Though the estimated coefficients are significant, tests of coefficient equalities are not provided. For instance, autoregressive coefficients for Canada above mean and below mean are 0.927 and 0.930 respectively, while for Japan they are 0.908 and 0.894. The authors report half lives also, with surplus being more persistent for Canada, and deficit being more persistent for Japan. Definitely the measure of half-life depends on the reported autoregressive coefficients, which are very close to each other. The question is, are those coefficients significantly different from each other?

persistence is measured with the marginal probability. Reinhart and Rogoff (2003), analyzing panel data on external debt, show that the probability of transition from a bad state into a good state is higher than the transition in the other direction.

To contribute to this literature, we study the persistence of a wider range of international capital flow categories using three different methods: probit, a non-parametric estimator and an asymmetric autoregression. We find that deficits and net inflows tend to be more persistent than surpluses and net outflows. For instance, the probability of transition from a current account deficit into a deficit next period is 0.88, while the probability of transition from a current surplus into a surplus in the next period is 0.77. We find that FDI are more persistent than portfolio investments and the other investments category in either state. The probability of remaining in a deficit state is 0.88 for FDI, 0.74 for portfolio investments and 0.73 for the other investments category, while the probability of remaining in a surplus state is 0.75 for FDI, 0.72 for portfolio investments and 0.68 for the other investments category. Non-parametric approach yields results qualitatively consistent with probit. In the case of autoregression, in the total sample, only equity securities have a larger persistence of inflows (the autoregressive coefficient is 0.8 in the case of deficits, and 0.5 in the case of surpluses). In the sample of industrial countries portfolio investment with its subcomponents have a higher persistence of inflows (the autoregressive coefficient for equity securities is 0.8 in the case of deficits, and 0.3 in the case of surpluses; the coefficient for debt securities is 1.3 in the case of deficits, and 0.8 in the case of surpluses). In the case of developing countries, FDI have a higher persistence of inflows, with the autoregressive coefficient being equal to 0.3 in the case of deficits.

Some recent research has concentrated on understanding sharp reductions in current account to GDP ratios (Milesi-Ferretti and Razin, 1998, 2000). They document that a sudden stop of international capital flows can result in a current account reversal if the country already runs a sizable current account deficit. The next question that this paper studies is exactly the opposite of Milesi-Ferretti and Razin (1998). Namely, do the dynamic properties of international capital flows change when a country experiences a current account reversal? We use two different measures of current account reversals: (i) a reduction of the current account to GDP ratio by three percentage points, after controlling for temporary fluctuations and moderate current account to GDP ratios; and (ii) a change of the current account to a surplus from previous period's deficit.[2] We find that the current account reversals have a significant effect in the sample of developing countries. The latter have lower persistence of deficit and net inflows than industrial countries, given the current account reversal has occurred (except FDI category).

The paper is organized as follows. Section 2 discusses econometric specifications,

[2]See Section 2.3 for more details.

describes the data and modifies the non-parametric measure of persistence developed by Dias and Marques (2005). Section 3 presents the main empirical findings. The last section concludes.

2.2 Data and Econometric Specifications

Different measures of persistence have been considered in the literature. Among widely used ones are "sum of autoregressive coefficients", "spectrum of zero frequency", "largest autoregressive root" and "half life".[3] The most prominent of these is the "half life" which, having such an attractive feature as a measure of persistence in units of time, has been used extensively.[4] Dias and Marques (2005), studying the persistence of inflation, suggest a non-parametric measure, based on mean reversion. Another measure of persistence, widely spread in labor economics, is the probability of state dependence. State dependence arises when the probability of experiencing an event is a function of experiencing an event in the past. As a consequence of an event (e.g. positive FDI flows) the preferences, prices or possibly constraints are affected, which in turn affects the future probability of experiencing the same event.

2.2.1 Probit

The first approach we choose is a probabilistic one, specified by the following binary probit model:

$$p(x_{i,t} = 1|\cdot) = \Phi(\alpha + \beta x_{i,t-1}) \tag{2.1}$$

where x_t is the variable of interest and Φ stands for the normal cumulative distribution. We measure the persistence by the conditional probability $p(x_{i,t} = j|x_{i,t-1} = j)$ for $j = 0, 1$.

Regarding equation (2.1), we use a pooled estimator since the fixed effects estimator is biased. For comparison, individual country-by-country estimation of parameters is also done.

2.2.2 Non-parametric approach

Dias and Marques (2005) have suggested a non-parametric estimator, which is robust to the model specification (number of lags). Their approach is based on mean reversion and does not allow the positive and negative state distinction. In this section, we modify their approach to incorporate the latter as well.

[3]See Dias and Marques (2005) for discussions and relevant references on relative behavior of different measures of persistence.

[4]For examples see Imbs et al. (2005) and Clarida et al. (2007).

Assume variable x_t crosses its mean n times out of total number of available T observations. So, $T - n$ times the series has not been crossing the mean. For the purpose of this paper we will assume the steady state mean value of the variable to be equal to zero. Define by T_p the time spent in the positive, and by T_n the time spent in the negative states. Then we can decompose the number of times not crossing the mean into the positive and negative state counterparts by writing it as a weighted average of relative time in either states of the series:

$$T - n = \frac{T_p}{T}(T - n) + \frac{T_n}{T}(T - n) = \frac{T_p}{T}(T_n \text{ [illegible] } \frac{T_n}{T}(T - n) \qquad (2.2)$$

Because absolute $T - n$ has little interpretation, the relative to total T is a better measure of persistence.[5] Thus we have:

$$1 - \frac{n}{T} = \frac{T_p}{T}(1 - \frac{n}{T}) + (1 - \frac{T_p}{T})(1 - \frac{n}{T}) = \gamma_{positive} + \gamma_{negative} \qquad (2.3)$$

Note that the left hand side is the measure of persistence suggested by Dias and Marques (2005). The right hand side is just the weighted average of this measure, where the weights are relative time in the positive and negative states of the series. In our paper, this allows the analysis of persistence of net inflows and outflows.

To study the properties of the estimator, assume the variable z takes value 1 if the series is in a positive state and 0 otherwise, while variable y is defined the other way around. Then the weights are averages of series z and y. In a similar manner we can generate a variable m which takes value 1 if the mean is crossed and 0 otherwise. Thus n/T also represents the average of the variable m. Since the sample mean converges in probability to the expectation of the variable, the consistency of the estimator follows directly. The restrictive side of this estimator is its applicability to time series, and our ignorance of its asymptotic distribution.

2.2.3 Autoregression

The half life is an alternative measure for persistence, and measures the time necessary for the effect of a given shock to be halved. Thus persistence measured by this and the previous two methods is quite a different concept. For our purposes we use the asymmetric autoregression specified as

$$x_{i,t} = a_i + \begin{Bmatrix} b_1 x_{i,t-1} \text{if } x_{i,t-1} \geq \gamma \\ b_2 x_{i,t-1} \text{if } x_{i,t-1} < \gamma \end{Bmatrix} + u_{i,t} \qquad (2.4)$$

[5]If $n_1 = n_2 = 5$ for two different series, while $T_1 > T_2$, then it would be reasonable to claim higher persistence of the first series.

where $\gamma = 0$.[6] This specification means that, depending on the country's state within a particular category, its "speed of convergence", implicitly defined by the magnitude of autoregressive coefficient, is different. Equation (2.4) can be estimated using a dummy variable with the following econometric specification:

$$x_{i,t} = \alpha_i + \beta x_{i,t-1} + \delta D x_{i,t-1} + u_{i,t} \tag{2.5}$$

where D is a dummy variable, which takes value zero if $x_{i,t-1} < 0$, and one if $x_{i,t-1} \geq 0$. β measures the speed of convergence, and if δ is significant, and the hypothesis that $\beta + \delta$ equals to β is rejected, then the adjustment is asymmetric.

Equation (2.5) is a case of a dynamic panel model. These models have been studied by Anderson and Hsiao (1981) and Arellano and Bond (1991) among others. Estimation of a dynamic panel equation proceeds in two steps. First, the equation is differenced to remove the individual effect. Then the estimation is implemented under the assumption of sequential moment conditions and strictly exogenous instruments. Given the sequential moments condition holds, the differenced error term will be uncorrelated with $x_{i,t-2}$ and $Dx_{i,t-2}$ (or the corresponding differences).[7]

Anderson and Hsiao (1981) suggest instrumenting the endogenous variable in the first stage, then, using the fitted values of the endogenous variable, estimate the equation of interest. As opposed to the previous estimator, Arellano and Bond (1991) suggest the entire set of instruments in a generalized method of moments estimation by exploiting additional moment restrictions, and thus gaining efficiency compared to Anderson and Hsiao (1981). We choose the Anderson-Hsiao type estimator, based on the simulations by Judson and Owen (1996). Using Monte-Carlo simulations, they show that from a list of compatible fixed effects estimators, for the time span and cross-sectional units used in this study, Anderson-Hsiao estimator is the least biased (though it is the least efficient also (has relatively large standard errors)).

Another possible estimator is the least square dummy variable corrected estimator (Kiviet, 1995), developed for a balanced panel. It has been shown that with AR(1) panel representation the least squares dummy variable estimator is biased of order T^{-1}. Since the two stage least squares tend to have large standard errors "[o]ften we must choose between a possibly inconsistent estimator that has relatively small standard errors (OLS) and a consistent estimator that is so imprecise, that nothing interesting can be concluded (2SLS)" (Wooldridge, 2002:104). For this reason we report results

[6] Another method is the Threshold Autoregression, in which the threshold would not be imposed, as is done in our case, but estimated. The reason why threshold autoregression is not considered here, is due to the panel nature of the data. Although this is an active are of research, there is no fully satisfactory answer to the problem of TAR in a panel setting.

[7] Arellano and Bond (1991) have shown that lagged levels as instruments are more efficient than their differences. For this reason we choose the lagged levels as instruments.

from the ordinary least squares fixed effects estimation as well.

2.2.4 Data description

The data used in this paper are annual and cover the period 1970-2005. Data on capital flows, current account and trade balance are obtained from International Financial Statistics database by the IMF. GDP in current US dollars is taken from the World Development Indicators database by the World Bank. The sample of countries includes 19 industrial and 33 developing countries, which are listed in Appendix A of the current chapter.

2.3 Results

2.3.1 Probit

Main specification

The first econometric specification considered is the pooled probit. Table 2.1 shows the combined estimates for positive and negative flows. Almost all coefficients are statistically significant. The column "Lag" has only positive coefficients in the total sample as well as sub-samples of industrial and developing countries. All of the lagged variables are statistically significant at the conventional levels of significance. Since the coefficients in probit specifications are hard to interpret, it is common to construct marginal probabilities. Instead we will construct the levels of probabilities since we think that the levels of transition probabilities are a better measure of persistence than the marginal probabilities. But first we check whether the transition probabilities from deficit to deficit and surplus to surplus states are significantly different from each other. This would signal existence of asymmetric adjustment. A formal way to do that would be deriving asymptotic distribution of conditional probabilities, and then testing the hypothesis of equality. We choose an approach that is relatively simpler to implement.

Since both slopes and the corresponding standard errors are equal by construction between the two probits (positive and negative flows) in Table 2.1, the source of asymmetry can be found in the intercept.[8] All intercepts are statistically significant at 10 percent. So, by constructing 90 percent confidence intervals and looking for the intersection regions, we can judge whether the coefficients and thus the transitional probabilities are equal.[9]

[8]The same data with different definitions has been used: in one case surpluses and net outflows take value one and deficits and net inflows - zero, in the other case - the other way around. These two problems are mathematically equivalent.

[9]A formal way for testing for intercept equality from two different estimation would be deriving the asymptotic distribution of the difference between coefficients, and then using some test, say Wald. The

From Table 2.2 we can see the presence of asymmetry in the process of adjustment. In the total sample, only the trade balance has a relatively large overlap of confidence intervals of negative and positive intercepts. Portfolio investments and debt securities also have an overlap, but it is relatively smaller. The confidence intervals of negative and positive intercepts do not overlap in all other categories. Thus the probabilities of transition for the latter group can be asymmetric. In the sample of industrial countries, all of the categories, except other investments and reserve assets, have overlapping confidence intervals. The overlap is minor for the current account balance, trade balance, FDI and debt securities. In the sample of developing countries only portfolio investments and other investments have a major overlap of confidence intervals. There is a minor overlap in the case of the trade balance. All other categories seem to have asymmetric transition probabilities.

So far the confidence intervals indicated asymmetry in the transition probabilities. To judge the size of this asymmetry we must construct the transition probability matrix. These are presented in Figure 2.1. In the total sample, the current account balance, the trade balance, FDI, portfolio investments and other investments have a larger persistence of deficits than surpluses. The probability of remaining in a deficit state is 0.88 for the current account, compared to the 0.77 probability of remaining in the surplus state. The probability of remaining in a deficit state is 0.84 for the trade balance, compared to the 0.84 probability of remaining in the surplus state. This was expected as there was a major overlap of the confidence intervals. The probability of remaining in a deficit state for FDI is 0.88, compared to the 0.75 probability of remaining in the surplus state. For portfolio investments the probability of remaining in a deficit state is 0.74, compared to the 0.72 probability of remaining in the surplus state. Though there is a slight difference in persistence, the overlap of confidence intervals of negative and positive intercepts for this category suggests possible symmetry in the persistence of flows. This is true for the category of the debt securities as well, though the persistence of outflows is greater than the persistence of inflows. For other investments the probability of remaining in a deficit state is 0.73, compared to the 0.68 probability of remaining in the surplus state.

In the sample of industrial countries the current account deficit has a persistence of 0.87, while the surplus has a persistence of 0.81. The inflow of portfolio investments has a persistence of 0.76, compared to the 0.70 persistence of outflows. The inflow of debt securities has a persistence of 0.77, as opposed to the 0.69 persistence of outflows. The inflow of other investments has a persistence of 0.69, as opposed to the 0.57 persistence of outflows. All other categories have a greater persistence of outflows, although the confidence interval test suggest possible symmetry in all of the cases.

computation of the asymptotic variance is quite complicated. For this reason we approach the problem using confidence intervals.

In the sample of developing countries the current account deficit has a persistence of 0.88, while the surplus has a persistence of 0.72. The trade deficit is more persistent than the trade surplus, with persistence probabilities of 0.86 and 0.82. Note that the trade balance has marginally overlapping confidence intervals. The inflow of other investments has a persistence of 0.76, as opposed to the 0.74 persistence of outflows. In this case there is a major overlap of confidence intervals, signalling symmetry in persistence. All other categories have a greater persistence of outflows, though the confidence interval test suggests possible symmetry in all of the cases.

In general, the evidence is for higher persistence of deficits and net inflows than surpluses and net outflows, meaning that countries in the negative state are more likely to stay in that state than countries in the positive state. This can be seen more easily by looking at the probabilities of transition from one state into the opposite one: $p(x_t > 0|x_{t-1} < 0) < p(x_t < 0|x_{t-1} > 0)$. Once a country is in the negative state, it is harder to move to the positive state, than would be otherwise. This conclusion was also achieved by the analysis of Reinhart and Rogoff (2003) for external debt.

Although pooled probit estimation provides a good description of asymmetric adjustment of international balance sheet components, the results can be biased due to false state dependence. In the case of pooled probit, the estimator, *ceteris paribus*, is consistent, as opposed to the properties of fixed-effects probit.[10] Yet, possible individual heterogeneity can bias the results significantly, particularly if the unobserved heterogeneity is correlated with the disturbance term. In this case ignoring the former will result in false state dependence (Heckman, 1981).

To overcome this problems, country-specific probits are used. But this approach in turn has problems. For some countries, data length is too short and for that particular period the variable of interest may carry the same sign. In this case, probit estimation is impossible. For this reason some countries are dropped out of the estimation.[11] Averaged transition probabilities are computed and the transition probability matrix based on these results is presented in Table 2.3.

As can be seen from this table, the average of transition probabilities supports the results of pooled estimation for both full sample, and breakdown into industrial and developing countries sub-samples. In the samples of all countries, the current account, FDI, portfolio investments and other investments have a higher persistence of deficits and net inflows than surpluses and net outflows. In the case of industrial countries, the current account, portfolio investments, debt securities and other investments categories have a higher persistence of surpluses and net outflows. In the sample of developing countries, the current account balance, FDI and other investments categories have a

[10]Bias can be reduced by using, for example, a modified maximum likelihood estimator (Carro, 2006).
[11]The list of dropped countries is available on request from the author.

higher persistence of surpluses and net outflows. For the rest of the categories the situation is reversed. It is worth noting, that the magnitude of standard deviations suggest a failure to reject the null hypothesis of symmetry in all of the cases.

Comparing the results of current account persistence to Edwards (2004), we can see some differences. His direct interests are episodes of large surpluses and deficits. Running fixed-effects probits, Edwards (2004) finds that the point estimates of marginal probabilities are larger for large surpluses than for large deficits. Based on this finding, the conclusion is that countries running large surpluses tend to stay in the surplus state longer than countries running large deficits. A possible explanation could be current account reversals. While the results are interesting, they are sensitive to the definition of persistence. A plausible definition of persistence given in the introduction states that it is the probability of experiencing an event conditional on the fact that the same event happened in the past. Using this definition of persistence, our estimations so far suggest that deficits are more persistent than surpluses.

Current account reversals

In this subsection, the study of current account persistence is dropped in order to investigate the effects of current account reversals on the persistence of different categories of international capital flows. Tables 2.4 and 2.5 show the results from estimation with a current account reversal dummy as an additional explanatory variable. Two definitions of current account reversal are used. In Table 2.4 a current account reversal is defined in a strong sense: if a country changes its current account to a surplus from the previous period's deficit, then the country experiences a current account reversal. The introduction of the new explanatory variable has not affected the statistical significance of the lagged dependent variable. In fact, it has some explanatory power for the state of the trade balance, portfolio investments, other investments and reserve assets. The positive coefficient on $\text{CA}^{\text{rvs}}_{\text{positive}}$ and negative coefficient on $\text{CA}^{\text{rvs}}_{\text{negative}}$ suggest that the current account reversal contributes positively to the probability of net outflows and negatively to the probability of net inflows. For instance, the negative sign on $\text{CA}^{\text{rvs}}_{\text{negative}}$ indicates a decreasing probability of being in the negative state after the reversal, if the country was in that state initially.

A further decomposition into different sub-samples slightly changes the picture. In the sample of industrial countries the current account reversal is statistically significant in explaining the state of the trade balance and equity securities. For all other categories the current account reversal variable is statistically insignificant.

In the sample of developing countries the current account reversal is statistically significant in explaining the states of the trade balance, portfolio investments and other investments. For all other categories the current account reversal variable is statistically insignificant.

In Table 2.5, the definition of reversal is similar in construction to Milesi-Ferretti and Razin (1998). Three conditions need to be satisfied for a country to experience a current account reversal: (i) a reduction of current account deficit to GDP ratio by 3 percentage points; (ii) right after the reversal current account deficit to GDP ratio should be below 10 percent; and (iii) for two years after the reversal occurred, the current account to GDP ratio should be larger than it was a year before the reversal. The first condition states that the current account deficit should decrease by three percentage points relative to GDP. The second condition is necessary for considering sizable reductions of current account deficit.[12] The third condition removes temporary changes of the current account due to consumption smoothing.

In these specifications, all intercepts and coefficients on lags of the variables are statistically significant. The lag again has only positive coefficients, implying increasing probability conditioned on the past value. The situation with current account reversal coefficient is slightly different than in the case of definition I. In the sample of all countries the current account reversal is statistically significant in explaining states of the trade balance, portfolio investments, debt securities and other investments. In the sample of industrial countries the current account reversal is not significant for any category, implying that the current account reversals do not affect the persistence of international capital flows. In the sample of developing countries, the current account reversal explains states of the trade balance, portfolio investments, debt securities and other investments.

We have also computed the transition probabilities conditioned on the current account reversal. These are presented in Figures 2.2 and 2.3. Both definitions of current account reversal give similar results for persistence. When a country has not encountered a current account reversal, the probability of remaining in a surplus state is smaller than the probability of remaining in a deficit state, implying a higher persistence of deficits and net inflows. The situation changes when a current account reversal has occurred. For instance, the probability of remaining in a surplus state for trade balance jumps for various country samples and stays above the probability of remaining in a deficit state. This also holds for portfolio investments, debt securities and other investments. When the opposite is true, the probabilities are so close, that the null hypothesis of symmetry is hard to reject.

Summarizing this section, in general, deficits and net inflows seem to be more persistent than surpluses and net outflows. The result is robust to either specification of

[12] A reduction of current account deficit from 10 to 7 percent of GDP is relatively more important than a reduction of current account from 25 to 22 percent of GDP.

pooled and individual probits. FDI is more persistent than portfolio investments in either state. In turn, the latter is more persistent than other investments category in either state. The persistence of the current account is larger than the persistence of the trade balance, although the probabilities are quite close. This result can be linked to the high persistence of investment income. The current account reversals have a significant effect in the sample of developing countries. The latter have lower persistence of deficit and net inflows than industrial countries, given the current account reversal has occurred (except FDI category).

2.3.2 Non-parametric approach

This subsection presents results from the non-parametric estimation, which, being a more intuitive measure of persistence, is robust to the model specification as well.

Equation (2.3) has been estimated for our sub-samples and the results are summarized in Table 2.6. In the sample of all countries, the current account, trade balance, FDI, portfolio investments and other investments have a higher probability of remaining in the deficit state, than remaining in the surplus state. In the sample of industrial countries, the current account, portfolio investments debt securities and other investments have a higher probability of remaining in the deficit state, than remaining in the surplus state. In the sample of developing countries the current account, trade balance, FDI and other investments have a higher probability of remaining in the deficit state, than remaining in the surplus state.

Looking at the composite measure of persistence $\gamma = \gamma_{positive} + \gamma_{negative}$, we see that FDI is more persistent than portfolio investments. The latter is more persistent that the other investments category. So, the adjustment is not only asymmetric between deficits and surpluses, but also different components of balance sheet adjust differently. These results are consistent with the probit specification, supporting the idea that deficits and net inflows are more persistent than surpluses and net outflows. Note that persistence coefficients, that are very close to each other, have also been very close in the probit case. This symmetry between the two approaches signals a consistency of the probit estimates.

The current account is more persistent than the trade balance in either state both in the total sample as well as in sub-samples. This result is also consistent with the results from the probit specification. The current account, trade balance deficits and net FDI inflows are more persistent in the developing than industrial countries.

In summary, the results of this subsection are qualitatively the same as the results from probit estimations: deficits and net inflows seem to be more persistent than surpluses and net outflows.

2.3.3 Autoregressive approach

In the previous subsections we measured the probability of being in a given state conditional on being in the same state in the previous period. The half life is an alternative measure for persistence, and measures the time necessary for the effect of a given shock to be halved. Thus persistence measured by this method has a different meaning than the one measured by either probit or non-parametric methods.

To implement the estimation, we transform our variables into their ratios to GDP. Before proceeding further, we test for the presence of the unit root in our data. Two panel unit root tests have been used: ADF and Philips-Perron. Summary results, presented in Table 2.7, suggest that a unit root is rejected for all variables in our sample.

Equation (2.5) has been estimated for net flows using both two stage least squares and fixed effects approaches. The results are reported in Tables 2.8 and 2.9. In the case of fixed effects, the lag and the interaction dummy are significant for almost all variables in all sub-samples. Whenever both the lag and the interaction dummy are significant, and the equality of computed negative and positive state coefficients is rejected, the results differ from the results of previous subsection. For instance, in the total sample, only equity securities have a larger persistence of inflows (the autoregressive coefficient is 0.8 in the case of deficits, and 0.5 in the case of surpluses). In the sample of industrial countries portfolio investment with its subcomponents have a higher persistence of inflows (the autoregressive coefficient for equity securities is 0.8 in the case of deficits, and 0.3 in the case of surpluses; the coefficient for debt securities is 1.3 in the case of deficits, and 0.8 in the case of surpluses). In the case of developing countries, FDI have a higher persistence of inflows, with the autoregressive coefficient being equal to 0.3 in the case of deficits.

In the case of two stage least squares the lag and interaction dummy are significant in most of the cases. Whenever both lag and interaction dummy are significant, and the equality of computed negative and positive state coefficients is rejected, the equity securities category has a higher persistence of inflows than outflows (the autoregressive coefficient for equity securities is 0.7 in the case of deficits, and -0.6 in the case of surpluses in the total sample and in the sample of industrial countries, while 0.4 and -0.4 in the sample of developing countries). In all the other cases the opposite is true. We find less support for asymmetric autoregression for the current account in this section when the results are compared to Clarida et al. (2007). These authors, using threshold autoregression, find that from seven industrial countries, four have higher persistence of deficits than surpluses (persistence is measured by half life).[13]

[13] We think that the difference between our approach and Clarida et al. (2007) is driven by estimated

Tables 2.10 to 2.13 present results from both of the regressions above with an additional explanatory variable: the current account reversal dummy for both of its definitions. The reversal dummy is always significant in the trade balance regressions and hardly significant in the other cases. Inclusion of the reversal dummy has not significantly affected the coefficients from the previous estimation. In case of the first definition of the current account reversal, results from the fixed effects regression suggest portfolio equities have higher persistence of net inflows in the total sample, with surplus and deficit coefficients being 0.8 and 0.5 respectively. In the sample of industrial countries portfolio investments with its subcomponents have a higher persistence of net inflows: the autoregressive coefficient for equity securities is 0.8 in the case of deficits, and 0.3 in the case of surpluses; the coefficient for debt securities is 1.3 in the case of deficits, and 0.8 in the case of surpluses. Results from the two stage regression suggest portfolio equities have a higher persistence of net inflows in the total sample, with the autoregressive coefficient being equal to 0.7 in the case of deficits, and -0.6 in the case of surpluses. In the sample of industrial countries equity securities have a higher persistence of inflows with the autoregressive coefficient being equal to 0.8 in the case of deficits, and -0.7 in the case of surpluses. In the developing countries sample FDI have a higher persistence of inflows, with the autoregressive coefficient being equal to 0.4 in the case of deficits, and 0.2 in the case of surpluses. Thus we find that the scale of surpluses tends to show more persistence than the scale of deficits

2.3.4 Discussion

In the case of probit, deficits and net inflows are more persistent than surpluses and net outflows. The result is robust to either specification of pooled and individual probits. FDI is more persistent than portfolio investments in either state. In turn, the latter is more persistent than other investments category in either state. The persistence of the current account is larger than the persistence of the trade balance, though the probabilities are quite close. The current account reversals have a significant effect in the sample of developing countries. The latter have lower persistence of deficits and net inflows than industrial countries, given the current account reversal has occurred (except FDI category).

In the case of the non-parametric estimator, the results strongly support the results from probit estimations: deficits and net inflows are more persistent than surpluses and net outflows. FDI is more persistent than portfolio investments. The latter is more persistent that the other investments category. The current account is more persistent than the trade balance in either state. The current account, trade balance deficits and

versus imposed threshold tradeoff.

net FDI inflows are more persistent in the developing than industrial countries.

In the case of asymmetric autoregression, we obtain a different set of results: the equity securities is the only category with higher persistence of inflows than outflows. In all the other cases the we find that surpluses are more persistent.

The definition of persistence as probability of transition from one state into the other is very close in logic to the definition of persistence based on a mean reversion. For this reason the results from these two approaches are in line with each other. The logic underlying the measure of persistence using the speed of convergence, is a different concept. There is a major difference in the data as well: with probabilistic and mean reversion approaches we use binary data, while with the autoregression we use ratios of flow variables to GDP. For this reason the results between probabilistic and mean reversion approaches are not directly comparable to the results of asymmetric autoregression.

2.4 Conclusions

The existing literature on the persistence of capital flows has concentrated on either the estimates of half life, or constructions of marginal probabilities. To contribute to this literature, we study a wider range of capital flows using three possible approaches to understanding the persistence and the dynamics of the current account and main components of international capital flows.

The probabilistic approach shows, that, in general, deficits and net inflows are more persistent than surpluses and net outflows. This result is robust to either specification of pooled and individual probits. FDI are more persistent than portfolio investments in either state. The latter is more persistent than other investments category in either state. The persistence of the current account is larger than the persistence of the trade balance. Developing countries tend to have a higher persistence of deficits and net inflows than industrial countries. Current account reversals have a significant effect on transition probabilities, particularly in developing countries.

We developed further the non-parametric estimator, proposed by Dias and Marques (2005). The estimation results strongly support the results from probit estimations. The current account, trade balance, FDI, portfolio investments and other investments have a higher probability of remaining in the deficit state, than remaining in the surplus state. FDI is more persistent than the portfolio investments category, while the current account is more persistent than the trade balance in either the deficit or surplus state.

In the case of asymmetric autoregression, we find that surpluses are more persistent than deficits: although the probability of remaining in a surplus state is lower, the scale of surpluses tends to show more persistence than the scale of deficits.

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Table 2.1: Pooled probit of a dummy variable on its lag

A: All countries	$C_{positive}$	$C_{negative}$	Lag	R^2	Obs.
Current account balance	-1.15	-0.72	1.88	0.32	1587
	(0.05)***	(0.06)***	(0.08)***		
Trade balance	-0.99	-0.98	1.96	0.36	1587
	(0.05)***	(0.05)***	(0.08)***		
FDI	-1.20	-0.68	1.87	0.32	1528
	(0.05)***	(0.06)***	(0.08)***		
Portfolio investments	-0.64	-0.58	1.22	0.16	1553
	(0.05)***	(0.05)***	(0.07)***		
Equity securities	-0.56	-0.88	1.44	0.21	1477
	(0.06)***	(0.05)***	(0.07)***		
Debt securities	-0.57	-0.65	1.22	0.16	1514
	(0.05)***	(0.05)***	(0.07)***		
Other investments	-0.62	-0.46	1.08	0.13	1587
	(0.05)***	(0.05)***	(0.07)***		
Reserve assets	0.18	-0.51	0.33	0.01	1587
	(0.05)***	(0.04)***	(0.07)***		
B: Industrial countries					
Current account balance	-1.14	-0.89	2.03	0.38	613
	(0.08)***	(0.09)***	(0.12)***		
Trade balance	-0.79	-1.05	1.84	0.32	613
	(0.09)***	(0.08)***	(0.12)***		
FDI	-0.73	-0.96	1.68	0.28	605
	(0.08)***	(0.08)***	(0.12)***		
Portfolio investments	-0.70	-0.53	1.23	0.16	613
	(0.07)***	(0.08)***	(0.11)***		
Equity securities	-0.53	-0.71	1.24	0.16	603
	(0.08)***	(0.07)***	(0.11)***		
Debt securities	-0.73	-0.49	1.23	0.16	611
	(0.07)***	(0.08)***	(0.11)***		
Other investments	-0.51	-0.19	0.69	0.05	613
	(0.07)***	(0.08)**	(0.11)***		
Reserve assets	0.05	-0.33	0.28	0.01	613
	(0.08)	(0.07)***	(0.10)***		
C: Developing countries					
Current account balance	-1.16	-0.58	1.75	0.28	974
	(0.06)***	(0.08)***	(0.10)***		
Trade balance	-1.08	-0.91	2.00	0.37	974
	(0.07)***	(0.07)***	(0.10)***		
FDI	-1.44	-0.16	1.60	0.22	923
	(0.07)***	(0.11)	(0.12)***		
Portfolio investments	-0.59	-0.61	1.20	0.15	940
	(0.06)***	(0.06)***	(0.09)***		
Equity securities	-0.59	-1.00	1.59	0.25	874
	(0.08)***	(0.06)***	(0.10)***		
Debt securities	-0.43	-0.73	1.16	0.14	903
	(0.07)***	(0.06)***	(0.09)***		
Other investments	-0.71	-0.63	1.34	0.19	974
	(0.06)***	(0.06)***	(0.09)***		
Reserve assets	0.29	-0.61	0.33	0.01	974
	(0.07)***	(0.05)***	(0.09)***		

Note: Results from pooled probit estimation. Column $C_{positive}$ indicates value of intercept of probit estimation with assigned value of one to positive flows and zero to negative flows. Column $C_{negative}$ indicates value of intercept of probit estimation with assigned value of one to negative flows and zero to positive flows.
***,**,* significant at 1,5 and 10 percent respectively.

Table 2.2: Testing asymmetry: confidence intervals

A: All countries	$\theta^{lower}_{positive}$	$\theta^{upper}_{positive}$	$\theta^{lower}_{negative}$	$\theta^{upper}_{negative}$
Current account balance	-1.24	-1.07	-0.82	-0.62
Trade balance	-1.07	-0.90	-1.06	-0.90
FDI	-1.28	-1.12	-0.77	-0.58
Portfolio investments	-0.72	-0.56	-0.67	-0.50
Equity securities	-0.66	-0.46	-0.97	-0.80
Debt securities	-0.65	-0.49	-0.73	-0.57
Other investments	-0.71	-0.54	-0.54	-0.38
Reserve assets	0.10	0.26	-0.58	-0.44
B: Industrial countries				
Current account balance	-1.27	-1.01	-1.04	-0.74
Trade balance	-0.94	-0.64	-1.18	-0.92
FDI	-0.86	-0.60	-1.09	-0.83
Portfolio investments	-0.82	-0.59	-0.66	-0.40
Equity securities	-0.66	-0.40	-0.82	-0.59
Debt securities	-0.85	-0.62	-0.63	-0.36
Other investments	-0.62	-0.39	-0.32	-0.06
Reserve assets	-0.08	0.18	-0.45	-0.22
C: Developing countries				
Current account balance	-1.26	-1.06	-0.72	-0.45
Trade balance	-1.20	-0.97	-1.03	-0.80
FDI	-1.56	-1.33	-0.34	0.02
Portfolio investments	-0.69	-0.49	-0.71	-0.52
Equity securities	-0.72	-0.46	-1.10	-0.90
Debt securities	-0.55	-0.32	-0.83	-0.63
Other investments	-0.81	-0.61	-0.73	-0.53
Reserve assets	0.17	0.40	-0.70	-0.53

Note: $\theta^{lower}_{positive}$ and $\theta^{upper}_{positive}$ indicate lower and upper bounds of 90 percent confidence interval of intercept for positive flows, while $\theta^{lower}_{negative}$ and $\theta^{upper}_{negative}$ indicate lower and upper bounds of 90 percent confidence interval of intercept for negative flows. The interval was computed by $w \pm z_{\frac{\alpha}{2}} s.e.$, where w is the intercept and $s.e.$ is the standard error of the intercept.

Table 2.3: Country estimates

A: All countries	$P(X_t > 0 \mid X_{t-1} > 0)$	$P(X_t < 0 \mid X_{t-1} > 0)$	$P(X_t < 0) \mid X_{t-1} < 0)$	$P(X_t > 0) \mid X_{t-1} < 0)$	Obs.
Current account balance	0.67	0.33	0.81	0.19	43
	(0.20)	(0.20)	(0.14)	(0.14)	
Trade balance	0.77	0.23	0.68	0.32	41
	(0.19)	(0.19)	(0.20)	(0.20)	
FDI	0.64	0.36	0.70	0.30	27
	(0.19)	(0.19)	(0.20)	(0.20)	
Portfolio investments	0.67	0.33	0.68	0.32	46
	(0.18)	(0.18)	(0.19)	(0.19)	
Equity securities	0.75	0.25	0.67	0.33	45
	(0.17)	(0.17)	(0.17)	(0.17)	
Debt securities	0.68	0.32	0.66	0.34	47
	(0.19)	(0.19)	(0.19)	(0.19)	
Other investments	0.64	0.36	0.70	0.30	50
	(0.19)	(0.19)	(0.14)	(0.14)	
Reserve assets	0.67	0.33	0.41	0.59	49
	(0.11)	(0.11)	(0.14)	(0.14)	
B: Industrial countries					
Current account balance	0.70	0.30	0.82	0.18	17
	(0.21)	(0.21)	(0.13)	(0.13)	
Trade balance	0.79	0.21	0.62	0.38	16
	(0.20)	(0.20)	(0.17)	(0.17)	
FDI	0.76	0.24	0.65	0.35	14
	(0.13)	(0.13)	(0.23)	(0.23)	
Portfolio investments	0.61	0.39	0.69	0.31	16
	(0.20)	(0.20)	(0.16)	(0.16)	
Equity securities	0.68	0.32	0.68	0.32	17
	(0.18)	(0.18)	(0.17)	(0.17)	
Debt securities	0.62	0.38	0.71	0.29	17
	(0.18)	(0.18)	(0.17)	(0.17)	
Other investments	0.55	0.45	0.68	0.32	19
	(0.16)	(0.16)	(0.12)	(0.12)	
Reserve assets	0.62	0.38	0.45	0.55	19
	(0.10)	(0.10)	(0.17)	(0.17)	
C: Developing countries					
Current account balance	0.64	0.36	0.80	0.20	26
	(0.20)	(0.20)	(0.15)	(0.15)	
Trade balance	0.76	0.24	0.72	0.28	25
	(0.19)	(0.19)	(0.21)	(0.21)	
FDI	0.51	0.49	0.76	0.24	13
	(0.16)	(0.16)	(0.15)	(0.15)	
Portfolio investments	0.70	0.30	0.67	0.33	30
	(0.16)	(0.16)	(0.20)	(0.20)	
Equity securities	0.80	0.20	0.66	0.34	28
	(0.15)	(0.15)	(0.17)	(0.17)	
Debt securities	0.71	0.29	0.64	0.36	30
	(0.18)	(0.18)	(0.20)	(0.20)	
Other investments	0.69	0.31	0.71	0.29	31
	(0.18)	(0.18)	(0.15)	(0.15)	
Reserve assets	0.69	0.31	0.39	0.61	30
	(0.12)	(0.12)	(0.12)	(0.12)	

Note: Probit specification (dummy variable on its lag) is estimated for each country separately. Then the probabilities are computed using $\Phi(\alpha + \beta X_{t-1})$ normal distribution. Columns 2 to 5 indicate arithmetic averages of the group with standard deviation in parenthesis. The last column indicates the number of countries in each group.

Table 2.4: Pooled probit conditioned on the current account reversal (definition I)

A: All countries	$C_{positive}$	$C_{negative}$	Lag	CA^{rvs}_{pos}	CA^{rvs}_{neg}	R^2	Obs.
Trade balance	-1.19	-0.92	2.11	1.68	-1.68	0.41	1580
	(0.06)***	(0.06)***	(0.08)***	(0.17)***	(0.17)***		
FDI	-1.22	-0.67	1.89	0.17	-0.17	0.33	1521
	(0.05)***	(0.06)***	(0.08)***	(0.14)	(0.14)		
Portfolio investments	-0.66	-0.57	1.23	0.21	-0.21	0.16	1546
	(0.05)***	(0.05)***	(0.07)***	(0.12)*	(0.12)*		
Equity securities	-0.56	-0.88	1.45	0.01	-0.01	0.21	1470
	(0.06)***	(0.05)***	(0.07)***	(0.13)	(0.13)		
Debt securities	-0.59	-0.63	1.22	0.19	-0.19	0.16	1507
	(0.05)***	(0.05)***	(0.07)***	(0.12)	(0.12)		
Other investments	-0.68	-0.42	1.10	0.63	-0.63	0.14	1580
	(0.05)***	(0.05)***	(0.07)***	(0.12)***	(0.12)***		
Reserve assets	0.15	-0.49	0.34	0.24	-0.24	0.01	1580
	(0.05)***	(0.04)***	(0.07)***	(0.12)**	(0.12)**		
B: Industrial countries							
Trade balance	-0.93	-1.01	1.94	1.29	-1.29	0.35	613
	(0.10)***	(0.08)***	(0.13)***	(0.28)***	(0.28)***		
FDI	-0.75	-0.94	1.69	0.30	-0.30	0.28	605
	(0.09)***	(0.08)***	(0.12)***	(0.22)	(0.22)		
Portfolio investments	-0.71	-0.53	1.23	0.03	-0.03	0.16	613
	(0.08)***	(0.08)***	(0.11)***	(0.21)	(0.21)		
Equity securities	-0.50	-0.73	1.23	-0.36	0.36	0.16	603
	(0.08)***	(0.08)***	(0.11)***	(0.22)*	(0.22)*		
Debt securities	-0.74	-0.49	1.23	0.10	-0.10	0.16	611
	(0.08)***	(0.08)***	(0.11)***	(0.20)	(0.20)		
Other investments	-0.52	-0.17	0.69	0.22	-0.22	0.05	613
	(0.07)***	(0.08)**	(0.11)***	(0.20)	(0.20)		
Reserve assets	0.04	-0.31	0.28	0.24	-0.24	0.01	613
	(0.08)	(0.07)***	(0.1)***	(0.20)	(0.20)		
C: Developing countries							
Trade balance	-1.34	-0.84	2.18	1.89	-1.89	0.44	967
	(0.08)***	(0.08)***	(0.11)***	(0.21)***	(0.21)***		
FDI	-1.47	-0.15	1.62	0.15	-0.15	0.23	916
	(0.07)***	(0.11)	(0.13)***	(0.19)	(0.19)		
Portfolio investments	-0.62	-0.59	1.21	0.32	-0.32	0.16	933
	(0.06)***	(0.06)***	(0.09)***	(0.16)**	(0.16)**		
Equity securities	-0.61	-0.99	1.59	0.23	-0.23	0.25	867
	(0.08)***	(0.07)***	(0.1)***	(0.18)	(0.18)		
Debt securities	-0.46	-0.70	1.16	0.24	-0.24	0.14	896
	(0.07)***	(0.06)***	(0.09)***	(0.16)	(0.16)		
Other investments	-0.81	-0.57	1.39	0.94	-0.94	0.21	967
	(0.06)***	(0.07)***	(0.09)***	(0.16)***	(0.16)***		
Reserve assets	0.25	-0.60	0.34	0.22	-0.22	0.01	967
	(0.08)***	(0.05)***	(0.09)***	(0.15)	(0.15)		

Note: Columns 5 and 6 indicate the coefficient on the current account reversal dummy (takes value one if reversal occurred) for positive and negative flows respectively. Current account reversal is defined as a condition when the sign of the current account changes from negative to positive in one year.

***,**,* significant at 1,5 and 10 percent respectively.

Table 2.5: Pooled probit conditioned on the current account reversal (definition II)

A: All countries	$C_{positive}$	$C_{negative}$	Lag	CA^{rvs}_{pos}	CA^{rvs}_{neg}	R^2	Obs.
Trade balance	-1.16	-0.93	2.10	1.12	-1.12	0.38	1474
	(0.06)***	(0.06)***	(0.08)***	(0.14)***	(0.14)***		
FDI	-1.21	-0.68	1.89	-0.05	0.05	0.33	1416
	(0.05)***	(0.07)***	(0.08)***	(0.15)	(0.15)		
Portfolio investments	-0.69	-0.58	1.27	0.27	-0.27	0.17	1443
	(0.05)***	(0.05)***	(0.07)***	(0.13)**	(0.13)**		
Equity securities	-0.58	-0.87	1.45	0.20	-0.20	0.21	1370
	(0.06)***	(0.05)***	(0.08)***	(0.14)	(0.14)		
Debt securities	-0.61	-0.63	1.24	0.22	-0.22	0.16	1411
	(0.05)***	(0.05)***	(0.07)***	(0.13)*	(0.13)*		
Other investments	-0.71	-0.43	1.13	0.50	-0.50	0.14	1474
	(0.05)***	(0.05)***	(0.07)***	(0.12)***	(0.12)***		
Reserve assets	0.19	-0.47	0.28	0.12	-0.12	0.01	1474
	(0.06)***	(0.04)***	(0.07)***	(0.12)	(0.12)		
B: Industrial countries							
Trade balance	-0.77	-1.04	1.81	0.25	-0.25	0.31	575
	(0.09)***	(0.08)***	(0.13)***	(0.29)	(0.29)		
FDI	-0.77	-0.95	1.72	-0.05	0.05	0.29	567
	(0.09)***	(0.09)***	(0.12)***	(0.30)	(0.30)		
Portfolio investments	-0.73	-0.55	1.28	-0.32	0.32	0.17	575
	(0.08)***	(0.08)***	(0.11)***	(0.31)	(0.31)		
Equity securities	-0.54	-0.69	1.23	0.11	-0.11	0.16	565
	(0.08)***	(0.08)***	(0.11)***	(0.29)	(0.29)		
Debt securities	-0.73	-0.51	1.24	-0.31	0.31	0.16	573
	(0.08)***	(0.08)***	(0.11)***	(0.31)	(0.31)		
Other investments	-0.55	-0.20	0.75	0.25	-0.25	0.06	575
	(0.07)***	(0.08)**	(0.11)***	(0.26)	(0.26)		
Reserve assets	0.11	-0.31	0.20	0.15	-0.15	0.00	575
	(0.08)	(0.07)***	0.11)*	(0.26)	(0.26)		
C: Developing countries							
Trade balance	-1.44	-0.84	2.27	1.51	-1.51	0.43	899
	(0.09)***	(0.08)***	(0.12)***	(0.16)***	(0.16)***		
FDI	-1.48	-0.15	1.63	0.15	-0.15	0.23	849
	(0.07)***	(0.11)	(0.13)***	(0.18)	(0.18)		
Portfolio investments	-0.66	-0.60	1.26	0.38	-0.38	0.17	868
	(0.07)***	(0.07)***	(0.09)***	(0.15)***	(0.15)***		
Equity securities	-0.62	-1.00	1.62	0.20	-0.20	0.25	805
	(0.08)***	(0.07)***	(0.1)***	(0.17)	(0.17)		
Debt securities	-0.49	-0.70	1.19	0.28	-0.28	0.15	838
	(0.07)***	(0.06)***	(0.09)***	(0.15)*	(0.15)*		
Other investments	-0.82	-0.58	1.40	0.60	-0.60	0.20	899
	(0.07)***	(0.07)***	(0.09)***	(0.14)***	(0.14)***		
Reserve assets	0.26	-0.57	0.30	0.06	-0.06	0.01	899
	(0.08)***	(0.06)***	(0.09)***	(0.14)	(0.14)		

Note: Columns 5 and 6 indicate the coefficient on the current account reversal dummy (takes value one if reversal occurred) for positive and negative flows respectively. Current account reversal is defined as a condition when (i) reduction of current account deficit as a share of GDP is at least 3 percent, (ii) right after the reversal the current account deficit as a share of GDP is below 10 percent, (iii) for two years after the reversal has occurred the current account deficit as a share of GDP is larger than pre-reversal level.
***,**,* significant at 1,5 and 10 percent respectively.

Table 2.6: Non-parametric estimate of persistence

A: All countries	$\gamma_{positive}$	$\gamma_{negative}$	γ
Current account balance	0.27	0.55	0.82
	(0.23)	(0.24)	(0.08)
Trade balance	0.39	0.43	0.82
	(0.26)	(0.28)	(0.09)
FDI	0.23	0.58	0.81
	(0.25)	(0.31)	(0.12)
Portfolio investments	0.35	0.37	0.72
	(0.17)	(0.17)	(0.12)
Equity securities	0.49	0.28	0.77
	(0.22)	(0.16)	(0.13)
Debt securities	0.38	0.33	0.72
	(0.19)	(0.17)	(0.11)
Other investments	0.31	0.39	0.70
	(0.15)	(0.15)	(0.12)
Reserve assets	0.40	0.20	0.60
	(0.14)	(0.06)	(0.11)
B: Industrial countries			
Current account balance	0.36	0.48	0.84
	(0.27)	(0.25)	(0.08)
Trade balance	0.49	0.33	0.82
	(0.26)	(0.26)	(0.10)
FDI	0.44	0.35	0.78
	(0.27)	(0.25)	(0.10)
Portfolio investments	0.32	0.40	0.72
	(0.20)	(0.20)	(0.13)
Equity securities	0.43	0.32	0.74
	(0.22)	(0.15)	(0.15)
Debt securities	0.32	0.41	0.72
	(0.21)	(0.20)	(0.12)
Other investments	0.26	0.37	0.64
	(0.08)	(0.12)	(0.10)
Reserve assets	0.34	0.23	0.58
	(0.08)	(0.06)	(0.09)
C: Developing countries			
Current account balance	0.22	0.59	0.81
	(0.20)	(0.23)	(0.09)
Trade balance	0.33	0.49	0.82
	(0.23)	(0.28)	(0.09)
FDI	0.11	0.72	0.83
	(0.14)	(0.24)	(0.14)
Portfolio investments	0.36	0.35	0.72
	(0.15)	(0.16)	(0.11)
Equity securities	0.53	0.26	0.79
	(0.22)	(0.16)	(0.12)
Debt securities	0.42	0.29	0.71
	(0.18)	(0.15)	(0.11)
Other investments	0.34	0.39	0.73
	(0.17)	(0.17)	(0.12)
Reserve assets	0.44	0.18	0.62
	(0.15)	(0.05)	(0.12)

Note: Standard deviation in parenthesis. $\gamma = \gamma_{positive} + \gamma_{negative}$.

Table 2.7: Unit root tests

A: All countries	*ADF*	*ADF**	*PP*	*PP**
Current account balance	229.3	217.0	223.7	221.7
	(0.00)	(0.00)	(0.00)	(0.00)
Trade balance	180.6	237.7	165.0	159.3
	(0.00)	(0.00)	(0.00)	(0.00)
FDI	399.8	398.8	389.6	593.4
	(0.00)	(0.00)	(0.00)	(0.00)
Portfolio investments	431.5	358.5	520.3	659.9
	(0.00)	(0.00)	(0.00)	(0.00)
Equity securities	307.0	523.5	390.5	650.9
	(0.00)	(0.00)	(0.00)	(0.00)
Debt securities	409.4	389.9	521.2	649.3
	(0.00)	(0.00)	(0.00)	(0.00)
Other investments	444.5	409.5	488.5	475.1
	(0.00)	(0.00)	(0.00)	(0.00)
Reserve assets	790.8	643.5	877.5	1743.1
	(0.00)	(0.00)	(0.00)	(0.00)
B: Industrial countries				
Current account balance	58.1	60.1	47.7	45.1
	(0.02)	(0.01)	(0.13)	(0.20)
Trade balance	62.9	93.7	52.7	54.3
	(0.01)	(0.00)	(0.06)	(0.04)
FDI	216.8	195.2	173.5	387.4
	(0.00)	(0.00)	(0.00)	(0.00)
Portfolio investments	159.2	139.0	201.6	177.2
	(0.00)	(0.00)	(0.00)	(0.00)
Equity securities	111.2	95.8	168.5	175.6
	(0.00)	(0.00)	(0.00)	(0.00)
Debt securities	162.7	160.9	207.0	201.5
	(0.00)	(0.00)	(0.00)	(0.00)
Other investments	202.3	180.0	250.8	256.6
	(0.00)	(0.00)	(0.00)	(0.00)
Reserve assets	334.0	280.0	375.7	746.3
	(0.00)	(0.00)	(0.00)	(0.00)
C: Developing countries				
Current account balance	171.1	156.9	176.1	176.6
	(0.00)	(0.00)	(0.00)	(0.00)
Trade balance	117.7	144.0	112.4	104.9
	(0.00)	(0.00)	(0.00)	(0.00)
FDI	183.0	203.5	216.1	206.0
	(0.00)	(0.00)	(0.00)	(0.00)
Portfolio investments	272.2	219.4	318.7	482.7
	(0.00)	(0.00)	(0.00)	(0.00)
Equity securities	195.8	427.7	222.0	475.3
	(0.00)	(0.00)	(0.00)	(0.00)
Debt securities	246.7	229.0	314.2	447.7
	(0.00)	(0.00)	(0.00)	(0.00)
Other investments	242.2	229.5	237.7	218.5
	(0.00)	(0.00)	(0.00)	(0.00)
Reserve assets	456.8	363.5	501.8	996.8
	(0.00)	(0.00)	(0.00)	(0.00)

Note: P-values are in parenthesis. All regressions include individual intercept. Columns 3 and 5 include trend.

Table 2.8: Autoregression: fixed effects estimation of persistence

A: All countries	Lag	D_s	R^2	Prob.	Obs.
Current account balance	0.11	0.81	0.28	0.00	1580
	(0.03)***	(0.08)***			
Trade balance	0.60	0.20	0.70	0.00	1580
	(0.03)***	(0.05)***			
FDI	0.28	0.42	0.32	0.00	1521
	(0.03)***	(0.07)***			
Portfolio investments	0.59	-0.07	0.34	0.26	1546
	(0.04)***	(0.06)			
Equity securities	0.80	-0.32	0.57	0.00	1470
	(0.02)***	(0.05)***			
Debt securities	0.73	-0.06	0.46	0.29	1507
	(0.04)***	(0.06)			
Other investments	0.18	0.60	0.12	0.00	1580
	(0.03)***	(0.08)***			
Reserve assets	-0.11	0.29	0.09	0.00	1580
	(0.06)*	(0.08)***			
B: Industrial countries					
Current account balance	0.72	0.20	0.78	0.00	613
	(0.04)***	(0.07)***			
Trade balance	0.74	0.17	0.83	0.01	613
	(0.05)***	(0.07)**			
FDI	0.21	0.68	0.33	0.00	605
	(0.07)***	(0.10)***			
Portfolio investments	1.24	-0.87	0.54	0.00	613
	(0.06)***	(0.09)***			
Equity securities	0.82	-0.46	0.61	0.00	603
	(0.03)***	(0.08)***			
Debt securities	1.29	-0.55	0.68	0.00	611
	(0.06)***	(0.07)***			
Other investments	0.27	0.40	0.20	0.00	613
	(0.07)***	(0.12)***			
Reserve assets	-0.01	0.04	0.00	0.76	613
	(0.10)	(0.13)			
C: Developing countries					
Current account balance	0.09	0.82	0.26	0.00	967
	(0.04)**	(0.11)***			
Trade balance	0.58	0.20	0.68	0.00	967
	(0.04)***	(0.06)***			
FDI	0.34	-0.14	0.28	0.19	916
	(0.04)***	(0.11)			
Portfolio investments	-0.16	0.77	0.37	0.00	933
	(0.06)***	(0.07)***			
Equity securities	0.20	0.43	0.46	0.00	867
	(0.07)***	(0.08)***			
Debt securities	-0.19	0.72	0.28	0.00	896
	(0.06)***	(0.08)***			
Other investments	0.18	0.61	0.12	0.00	967
	(0.04)***	(0.10)***			
Reserve assets	-0.13	0.32	0.09	0.00	967
	(0.07)*	(0.10)***			

Note: The third column indicates the coefficient on the lagged interaction of the dummy variable with the flow data. Dummy variable takes a value of 1 if the flow is positive. Prob. indicates Wald probability of rejecting $H_0 : Lag = Lag + D_s$.
***,**,* significant at 1,5 and 10 percent respectively.

Table 2.9: Autoregression: two stage least squares estimation of persistence

A: All countries	Lag	D_s	Prob.	Obs.
Current account balance	0.10	1.46	0.00	1527
	(0.05)**	(0.43)***		
Trade balance	0.49	0.47	0.03	1527
	(0.13)***	(0.22)**		
FDI	0.31	-0.10	0.62	1461
	(0.09)***	(0.20)		
Portfolio investments	-0.33	0.81	0.00	1484
	(0.11)***	(0.21)***		
Equity securities	0.72	-1.34	0.00	1398
	(0.19)***	(0.30)***		
Debt securities	-0.65	1.50	0.00	1441
	(0.14)***	(0.25)***		
Other investments	0.20	0.83	0.00	1527
	(0.05)***	(0.20)***		
Reserve assets	-0.24	0.58	0.00	1527
	(0.11)**	(0.17)***		
B: Industrial countries				
Current account balance	0.88	0.44	0.83	594
	(0.30)***	(2.08)		
Trade balance	0.88	0.40	0.69	594
	(0.28)***	(0.99)		
FDI	0.21	0.11	0.73	585
	(0.17)	(0.33)		
Portfolio investments	-8.20	11.40	0.28	594
	(8.21)	(10.6)		
Equity securities	0.75	-1.43	0.00	583
	(0.29)***	(0.42)***		
Debt securities	8.33	-7.82	0.26	591
	(6.37)	(6.93)		
Other investments	0.28	-0.68	0.02	594
	(0.14)**	(0.30)**		
Reserve assets	-0.05	0.17	0.45	594
	(0.16)	(0.23)		
C: Developing countries				
Current account balance	0.09	1.49	0.00	933
	(0.06)	(0.53)***		
Trade balance	0.45	0.51	0.05	933
	(0.15)***	(0.26)**		
FDI	0.37	-0.21	0.37	876
	(0.11)***	(0.24)		
Portfolio investments	-0.02	0.19	0.44	890
	(0.09)	(0.24)		
Equity securities	0.43	-0.77	0.05	815
	(0.16)***	(0.39)**		
Debt securities	-0.07	0.34	0.13	850
	(0.10)	(0.23)		
Other investments	0.20	0.93	0.00	933
	(0.06)***	(0.25)***		
Reserve assets	-0.27	0.67	0.00	933
	(0.14)**	(0.22)***		

Note: The third column indicates the coefficient on the lagged interaction of the dummy variable with the flow data. Dummy variable takes a value of 1 if the flow is positive. Prob. indicates Wald probability of rejecting $H_0 : Lag = Lag + D_s$.
***,**,* significant at 1,5 and 10 percent respectively.

Table 2.10: Autoregression: fixed effects estimation of persistence, definition I

A: All countries	Lag	D_s	CA_{rvs}	R^2	Prob.	Obs.
Trade balance	0.57	0.26	0.04	0.72	0.00	1580
	(0.03)***	(0.05)***	(0.00)***			
FDI	0.28	0.42	0.00	0.32	0.00	1521
	(0.03)***	(0.07)***	(0.00)			
Portfolio investments	0.59	-0.07	0.00	0.34	0.26	1546
	(0.04)***	(0.06)	(0.00)			
Equity securities	0.80	-0.32	0.00	0.57	0.00	1470
	(0.02)***	(0.05)***	(0.00)			
Debt securities	0.73	-0.06	0.00	0.46	0.29	1507
	(0.04)***	(0.06)	(0.00)			
Other investments	0.18	0.60	0.03	0.13	0.00	1580
	(0.03)***	(0.08)***	(0.01)***			
Reserve assets	-0.10	0.29	0.01	0.10	0.00	1580
	(0.06)*	(0.08)***	(0.00)***			
B: Industrial countries						
Trade balance	0.71	0.23	0.02	0.84	0.00	613
	(0.04)***	(0.07)***	(0.00)***			
FDI	0.21	0.68	0.00	0.33	0.00	605
	(0.07)***	(0.10)***	(0.00)			
Portfolio investments	1.24	-0.87	0.01	0.54	0.00	613
	(0.06)***	(0.09)***	(0.01)			
Equity securities	0.82	-0.47	-0.01	0.61	0.00	603
	(0.03)***	(0.08)***	(0.00)			
Debt securities	1.29	-0.55	0.01	0.68	0.00	611
	(0.06)***	(0.07)***	(0.01)			
Other investments	0.27	0.41	0.01	0.20	0.00	613
	(0.07)***	(0.12)***	(0.01)			
Reserve assets	-0.03	0.07	0.01	0.02	0.61	613
	(0.10)	(0.13)	(0.00)***			
C: Developing countries						
Trade balance	0.56	0.26	0.06	0.71	0.00	967
	(0.04)***	(0.06)***	(0.01)***			
FDI	0.34	-0.14	0.00	0.28	0.19	916
	(0.04)***	(0.11)	(0.00)			
Portfolio investments	-0.16	0.77	0.00	0.37	0.00	933
	(0.06)***	(0.07)***	(0.00)			
Equity securities	0.20	0.44	0.00	0.46	0.00	867
	(0.07)***	(0.08)***	(0.00)			
Debt securities	-0.19	0.72	0.00	0.28	0.00	896
	(0.06)***	(0.08)***	(0.00)			
Other investments	0.18	0.62	0.04	0.12	0.00	967
	(0.04)***	(0.10)***	(0.02)***			
Reserve assets	-0.11	0.32	0.01	0.10	0.00	967
	(0.07)	(0.10)***	(0.00)***			

Note: The third column indicates the coefficient on the lagged interaction of the dummy variable with the flow data. Dummy variable takes a value of 1 if the flow is positive. Prob. indicates Wald probability of rejecting $H_0 : Lag = Lag + D_s$.
***,**,* significant at 1,5 and 10 percent respectively.

Table 2.11: Autoregression: two stage least squares estimation of persistence, definition I

A: All countries	Lag	D_s	CA_{rvs}	Prob.	Obs.
Trade balance	0.45	0.52	0.04	0.02	1527
	(0.12)***	(0.22)**	(0.00)***		
FDI	0.31	-0.10	0.00	0.62	1461
	(0.09)***	(0.20)	(0.00)		
Portfolio investments	-0.33	0.81	0.00	0.00	1484
	(0.11)***	(0.21)***	(0.00)		
Equity securities	0.73	-1.34	0.00	0.00	1398
	(0.19)***	(0.30)***	(0.00)		
Debt securities	-0.65	1.50	0.00	0.00	1441
	(0.14)***	(0.25)***	(0.00)		
Other investments	0.19	0.83	0.02	0.00	1527
	(0.05)***	(0.19)***	(0.01)**		
Reserve assets	-0.22	0.57	0.01	0.00	1527
	(0.11)**	(0.17)***	(0.00)***		
B: Industrial countries					
Trade balance	0.83	0.40	0.02	0.67	594
	(0.26)***	(0.94)	(0.01)***		
FDI	0.21	0.11	0.00	0.74	585
	(0.17)	(0.33)	(0.00)		
Portfolio investments	-8.40	11.68	-0.02	0.30	594
	(8.63)	(11.1)	(0.03)		
Equity securities	0.75	-1.45	0.00	0.00	583
	(0.29)***	(0.43)***	(0.00)		
Debt securities	8.40	-7.88	0.01	0.26	591
	(6.44)	(7.00)	(0.02)		
Other investments	0.28	-0.68	0.00	0.02	594
	(0.14)**	(0.30)**	(0.00)		
Reserve assets	-0.11	0.25	0.01	0.28	594
	(0.16)	(0.23)	(0.00)***		
C: Developing countries					
Trade balance	0.40	0.56	0.05	0.02	933
	(0.14)***	(0.25)**	(0.01)***		
FDI	0.37	-0.22	0.00	0.37	876
	(0.11)***	(0.24)	(0.00)		
Portfolio investments	-0.02	0.19	0.00	0.43	890
	(0.10)	(0.25)	(0.00)		
Equity securities	0.44	-0.78	0.00	0.05	815
	(0.16)***	(0.39)**	(0.00)		
Debt securities	-0.07	0.35	0.00	0.13	850
	(0.10)	(0.23)	(0.00)		
Other investments	0.19	0.93	0.04	0.00	933
	(0.06)***	(0.25)***	(0.01)**		
Reserve assets	-0.24	0.63	0.02	0.00	933
	(0.14)*	(0.22)***	(0.00)***		

Note: The third column indicates the coefficient on the lagged interaction of the dummy variable with the flow data. Dummy variable takes a value of 1 if the flow is positive. Prob. indicates Wald probability of rejecting $H_0 : Lag = Lag + D_s$.
***,**,* significant at 1,5 and 10 percent respectively.

Table 2.12: Autoregression: fixed effects estimation of persistence, definition II

A: All countries	Lag	D_s	CA_{rvs}	R^2	Prob.	Obs.
Trade balance	0.66	0.16	0.06	0.72	0.00	1474
	(0.03)***	(0.05)***	(0.00)***			
FDI	0.35	-0.06	0.00	0.33	0.36	1416
	(0.03)***	(0.07)	(0.00)			
Portfolio investments	-0.03	0.65	0.00	0.30	0.00	1443
	(0.05)	(0.06)***	(0.00)			
Equity securities	0.83	-0.36	0.00	0.60	0.00	1370
	(0.02)***	(0.05)***	(0.00)			
Debt securities	-0.06	0.89	0.00	0.48	0.00	1411
	(0.05)	(0.06)***	(0.00)			
Other investments	0.18	0.61	0.03	0.11	0.00	1474
	(0.03)***	(0.08)***	(0.01)***			
Reserve assets	-0.11	0.26	0.00	0.08	0.00	1474
	(0.06)*	(0.08)***	(0.00)			
B: Industrial countries						
Trade balance	0.87	0.07	0.04	0.85	0.33	575
	(0.05)***	(0.07)	(0.00)***			
FDI	0.34	0.03	0.00	0.29	0.75	567
	(0.06)***	(0.09)	(0.00)			
Portfolio investments	0.36	0.34	-0.01	0.38	0.00	575
	(0.08)***	(0.11)***	(0.01)			
Equity securities	0.86	-0.65	0.00	0.63	0.00	565
	(0.03)***	(0.09)***	(0.01)			
Debt securities	0.37	0.59	0.00	0.69	0.00	573
	(0.09)***	(0.10)***	(0.01)			
Other investments	0.46	-0.37	0.02	0.14	0.01	575
	(0.07)***	(0.15)**	(0.01)***			
Reserve assets	-0.04	0.04	0.00	0.00	0.75	575
	(0.10)	(0.14)	(0.00)			
C: Developing countries						
Trade balance	0.63	0.17	0.06	0.71	0.01	899
	(0.04)***	(0.06)***	(0.01)***			
FDI	0.36	-0.22	0.00	0.29	0.05	849
	(0.04)***	(0.11)**	(0.00)			
Portfolio investments	-0.17	0.73	0.00	0.28	0.00	868
	(0.06)***	(0.08)***	(0.00)			
Equity securities	0.16	0.64	0.00	0.59	0.00	805
	(0.06)**	(0.07)***	(0.00)			
Debt securities	-0.21	0.72	0.00	0.23	0.00	838
	(0.06)***	(0.08)***	(0.00)			
Other investments	0.18	0.64	0.04	0.12	0.00	899
	(0.04)***	(0.11)***	(0.01)**			
Reserve assets	-0.12	0.30	0.00	0.08	0.00	899
	(0.08)	(0.10)***	(0.00)			

Note: The third column indicates the coefficient on the lagged interaction of the dummy variable with the flow data. Dummy variable takes a value of 1 if the flow is positive. Prob. indicates Wald probability of rejecting $H_0 : Lag = Lag + D_s$.

***,**,* significant at 1,5 and 10 percent respectively.

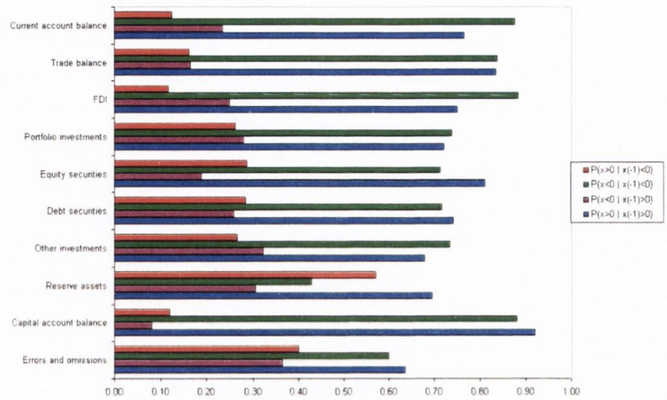
Table 2.13: Autoregression: two stage least squares estimation of persistence, definition II

A: All countries	Lag	D_s	CA_{rvs}	Prob.	Obs.
Trade balance	0.53	0.56	0.06	0.01	1421
	(0.12)***	(0.21)***	(0.01)***		
FDI	0.21	0.14	0.00	0.44	1356
	(0.09)**	(0.18)	(0.00)		
Portfolio investments	-0.03	0.17	0.01	0.45	1383
	(0.08)	(0.23)	(0.00)*		
Equity securities	0.51	-0.92	0.00	0.01	1300
	(0.27)*	(0.38)**	(0.00)		
Debt securities	0.01	-0.16	0.01	0.71	1347
	(0.11)	(0.44)	(0.00)*		
Other investments	0.20	0.90	0.05	0.00	1421
	(0.05)***	(0.20)***	(0.01)***		
Reserve assets	-0.06	0.36	0.01	0.05	1421
	(0.12)	(0.18)*	(0.00)***		
B: Industrial countries					
Trade balance	0.97	0.57	0.05	0.59	556
	(0.28)***	(1.06)	(0.01)***		
FDI	-0.44	1.01	0.00	0.00	547
	(0.14)***	(0.25)***	(0.00)		
Portfolio investments	-0.02	-0.04	-0.01	0.89	556
	(0.16)	(0.31)	(0.01)		
Equity securities	0.57	-1.11	0.00	0.06	546
	(0.45)	(0.59)*	(0.00)		
Debt securities	-0.47	3.03	0.00	0.49	554
	(0.61)	(4.39)	(0.01)		
Other investments	0.10	-0.10	0.02	0.73	556
	(0.14)	(0.28)	(0.01)***		
Reserve assets	-0.06	0.18	0.00	0.47	556
	(0.17)	(0.24)	(0.00)		
C: Developing countries					
Trade balance	0.49	0.60	0.07	0.01	865
	(0.15)***	(0.24)**	(0.01)***		
FDI	0.44	-0.31	0.00	0.21	809
	(0.11)***	(0.25)	(0.00)		
Portfolio investments	-0.05	0.28	0.01	0.37	827
	(0.11)	(0.31)	(0.00)**		
Equity securities	0.18	0.14	0.00	0.79	754
	(0.18)	(0.53)	(0.00)		
Debt securities	-0.04	0.22	0.01	0.41	793
	(0.10)	(0.26)	(0.00)**		
Other investments	0.20	0.97	0.06	0.00	865
	(0.07)***	(0.27)***	(0.01)***		
Reserve assets	-0.06	0.39	0.01	0.10	865
	(0.16)	(0.23)*	(0.00)***		

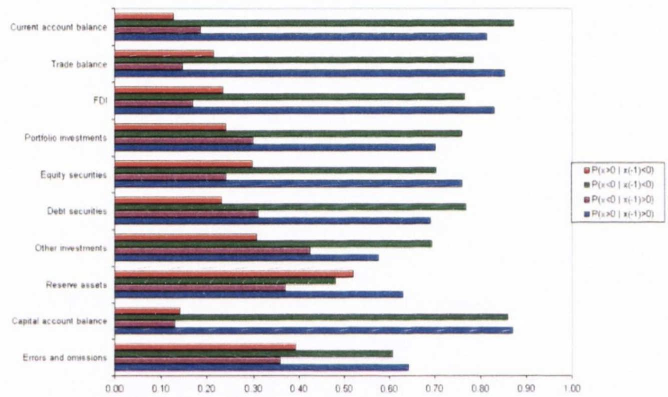
Note: The third column indicates the coefficient on the lagged interaction of the dummy variable with the flow data. Dummy variable takes a value of 1 if the flow is positive. Prob. indicates Wald probability of rejecting $H_0 : Lag = Lag + D_s$.

***,**,* significant at 1,5 and 10 percent respectively.

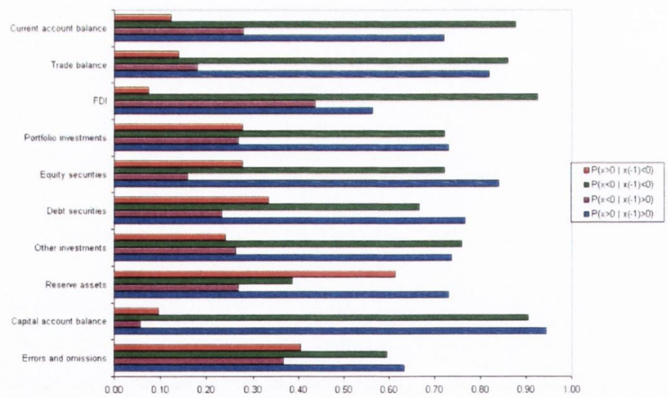
Figure 2.1: Transition probabilities



(a) All countries

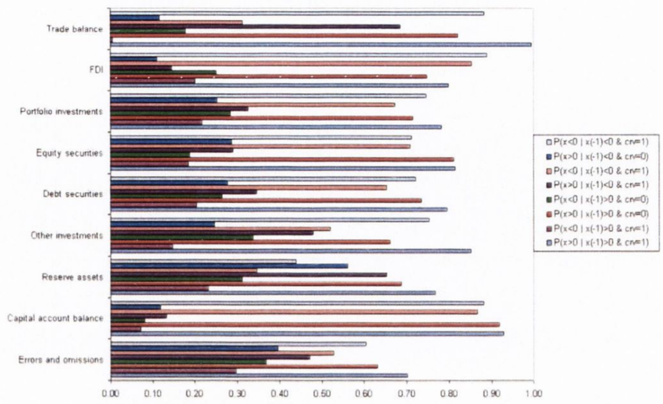


(b) Industrial countries

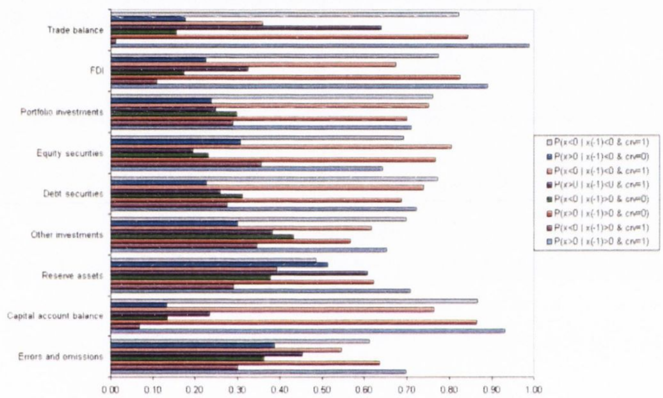


(c) Developing countries

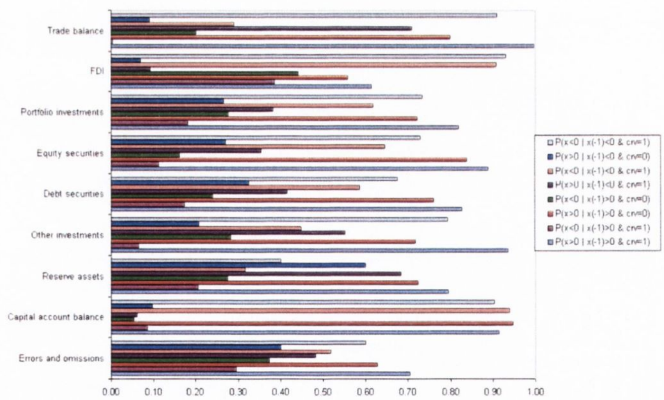
Figure 2.2: Transition probabilities conditional on current account reversal: definition I



(a) All countries

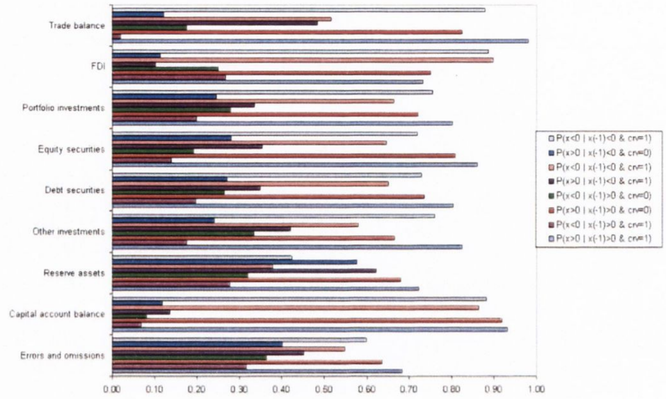


(b) Industrial countries

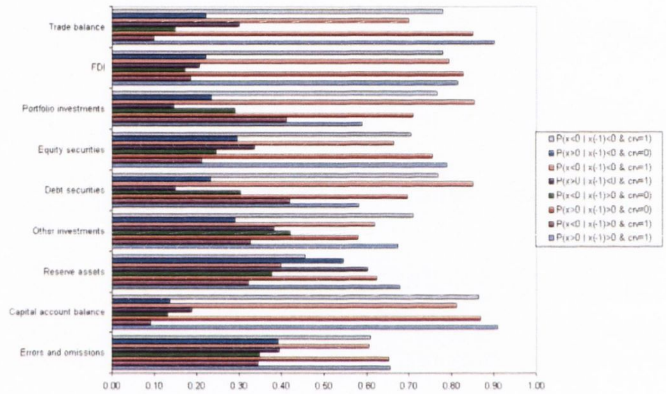


(c) Developing countries

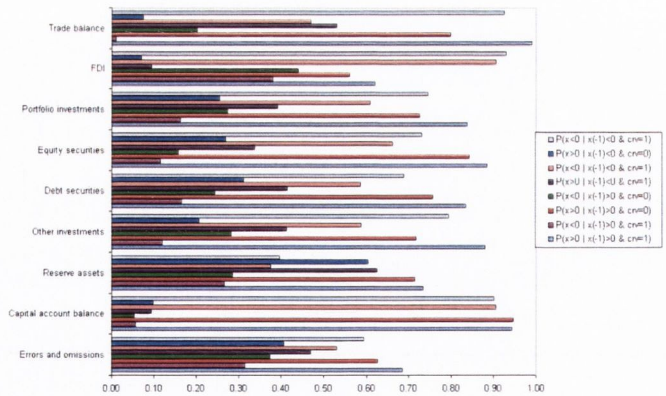
Figure 2.3: Transition probabilities conditional on current account reversal: definition II



(a) All countries



(b) Industrial countries



(c) Developing countries

2.6 Appendix A: Country List

Sample of industrial countries: Australia, Austria, Canada, Finland, France, Germany, Iceland, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, United States

Sample of developing countries: Argentina, Bahrain, Barbados, Brazil, Cameroon, Chile, China, Colombia, Costa Rica, Cte d'Ivoire, Egypt, El Salvador, Gabon, Guatemala, Hungary, Israel, Korea, Kuwait, Malaysia, Mexico, Pakistan, Panama, Peru, Philippines, Senegal, Singapore, South Africa, Sri Lanka, Thailand, Tunisia, Turkey, Uruguay, Venezuela

Chapter 3

Country Size and the Transfer Effect

3.1 Introduction

Research on the role of the exchange rate in external adjustment has a long established tradition. Following the famous debate between Keynes (1929) and Ohlin (1929) on the effects of German reparations, the transfer problem has become a central issue in international macroeconomics. Two major approaches have been taken: one emphasizing the impact of international payments on the terms of trade, the other highlighting the impact on the relative price of non-traded goods.[1]

The motivation for this paper is to investigate whether country size affects the magnitude of the transfer effect.[2] There are several reasons to believe that the transfer effect is different between large and small countries. First, as emphasized by Keynes (1929), the presence of "home bias" is necessary for the transfer effect to exist. Second, the contribution of the relative price of non-traded goods to the real exchange rate has proved to be important in both theoretical and empirical literature on external imbalances.[3] Larger countries tend to have both a larger expenditure share on domestic traded goods and a larger non-traded sector. For these reasons, we may expect the scale of the transfer effect to be sensitive to country size. However, we are unaware of any quantitative study of the transfer effect and its dependence on country size.

There is a tremendous amount of literature studying the transfer effect. Samuelson (1952) challenges the "orthodox" view regarding the implications of transport costs and

[1]For the first approach see Obstfeld and Rogoff (1995), Broner et al. (1997), for the second see Lane and Milesi-Ferretti (2002, 2004).

[2]Since countries come in different sizes, the size of a country may be important in studying a range of issues, including the external adjustment of, say, the USA vs Portugal.

[3]See Obstfeld and Rogoff (2005, 2006), Lane and Milesi-Ferretti (2002, 2004).

the deteriorating terms of trade of the transfer paying country. Osbtfeld and Rogoff (1996), building on the Ricardian trade model of Dornbusch et al. (1977), show that a positive home transfer (trade surplus) lowers domestic relative wages and increases the range of domestically produced goods, resulting in a fall of both the real exchange rate and the terms of trade. To emphasize the effect of the terms of trade, Obstfeld and Rogoff (1995) build a small country model endowed with some monopoly power. In this model, a financial transfer to home from the rest of the world decreases domestic labor supply and, consequently, the supply of domestic traded goods, resulting in an increase in the price of domestic relative to foreign traded goods. Lane and Milesi-Ferretti (2004), being more concerned with the possible exogeneity of the terms of trade for many countries, setup a small country model with an exogenous traded and a monopolistically competitive non-traded sector. A transfer to home from the rest of the world decreases labor supply to the non-traded sector, reducing the supply of non-traded goods which is matched by an increase in the relative price of non-traded goods.

At the empirical level, Obstfeld and Rogoff (1995, 1996) estimate cross sectional regressions of the real exchange rate on the net foreign asset position and find a significant positive coefficient. Broner et al. (1997) study the terms of trade as the main link between relative prices and external imbalances and find a cointegrating relation between the real exchange rate, net foreign asset position and the relative price of non-traded goods. In contrast, Lane and Milesi-Ferretti (2004) study the relative price of non-traded goods as the link between external imbalances and the real exchange rate and find a cointegrating relation between the real exchange rate, net foreign asset position, relative per capita GDPs and the terms of trade. The results also show significant differences in magnitudes of the transfer effect between large and small countries.

We think that these two main strands of the literature are incomplete. First, the data strongly supports the endogeneity of the relative price of non-traded goods to external imbalances.[4] Second, the terms of trade need not be exogenous even for small countries if they specialize in a niche sector of production. This paper fills the gap by (i) endogenizing both the terms of trade and the relative price of non-traded goods to external imbalances simultaneously; and (ii) studying the relation between external adjustment, relative prices and country size at both theoretical and empirical levels.

Our theoretical base follows Obstfeld and Rogoff (2006).[5] These authors study

[4] Lane and Milesi-Ferretti (2002, 2004) find a strong long-run relationship between the trade balance, net foreign asset position and the relative price of non-traded goods.

[5] Benigno and Thoenissen (2003) paper is qualitatively close to ours since they also endogenize both the terms of trade and the relative price of non-traded goods in their study of the real exchange rate. However, the authors look at the supply side determinants of the real exchange rate and not at the net foreign asset position.

global imbalances in a general equilibrium setup with an adjustment in both the terms of trade and the relative price of non-traded goods. In this model, however, the supply side is exogenous to relative prices. In contrast, we model a general equilibrium with intrinsically differentiated traded goods and allow for an endogenous determination of the terms of trade and the relative price of non-traded goods, feeding into the production decisions. The production side of the economy exhibits constant returns to scale. However, a fixed factor of production is inter-sectorally immobile, which creates a dependence of the relative price of non-traded goods on external imbalances. These assumptions, combined with a decreasing marginal utility of consumption from the rest of the world and a larger size of non-traded sector for larger economies, generate a positive relation between the country size and the absolute value of the sensitivity of relative prices to external imbalances. For instance, a 1 percentage point reduction in the trade deficit to GDP ratio requires a 3.6 percentage point depreciation of the real exchange rate for a small country with 1 percent population size relative to the world. In contrast, a 1 percentage point reduction in the trade deficit to GDP ratio requires a 6.1 percentage point depreciation of the real exchange rate for a large country with 35 percent population size relative to the world.[6]

The empirical part of our paper builds on the research by Lane and Milesi-Ferretti (2002, 2004). Guided by the model, we estimate relative price sensitivities to external imbalances for two different samples of industrial countries: G3 and non-G3. We depart from the Lane and Milesi-Ferretti (2002, 2004) approach, though, by allowing for an endogenous determination of the terms of trade. Our empirical results show a significant transfer effect. A reduction of trade deficit is associated with deteriorating terms of trade and a declining relative price of non-traded goods, feeding into a depreciation of the real exchange rate. Sensitivity of relative prices to external imbalances varies systematically between G3 and non-G3 samples: larger countries tend to have a larger sensitivity. For instance, in a sample of non-G3 industrial countries the estimated transfer coefficient is 1.3, as opposed to the estimated transfer coefficient of 7.7 in the G3 sample.

The rest of the paper is organized as follows. Section 2 describes the theoretical framework; section 3 the empirical approach; section 4 the results; and section 5 conclusions.

[6]In a sample of 17 industrial countries, Norway, Finland, Denmark, Austria, Sweden, Belgium and Portugal have a 1 percent population share relative to the aggregate, while the USA has a share of 35 percent.

3.2 Theoretical Framework

We consider a two-country, two-sector world economy. Size differences are introduced via population, with n and $1-n$ agents living in the domestic and foreign countries respectively. Being more concerned with the long-run, uncertainty is ignored. Nominal prices are completely flexible, and labor is free to move between sectors but not internationally.

3.2.1 Consumer's problem

Home agent j maximizes the objective function

$$U(j) = \sum_{s=t}^{\infty} \beta^{s-t} \left(\frac{C_s^{1-\sigma}(j)}{1-\sigma} - \frac{L_s^2(j)}{2} \right) \tag{3.1}$$

where $\sigma > 0$ is the inverse of the elasticity of intertemporal substitution, $\beta \in (0,1)$ is the discount factor and $L_t(j)$ is work effort. Aggregate consumption $C_t(j)$ depends on both traded $C_{T,t}(j)$ and non-traded $C_{N,t}(j)$ goods

$$C_t(j) = \left(\gamma^{\frac{1}{\theta}} C_{T,t}^{\frac{\theta-1}{\theta}}(j) + (1-\gamma)^{\frac{1}{\theta}} C_{N,t}^{\frac{\theta-1}{\theta}}(j) \right)^{\frac{\theta}{\theta-1}} \tag{3.2}$$

where $\theta > 0$ denotes the elasticity of substitution between traded and non-traded goods. Consumption of traded goods is a constant elasticity of substitution index of domestic $C_{TH,t}(j)$ and foreign $C_{TF,t}(j)$ traded goods

$$C_{T,t}(j) = \left(\alpha^{\frac{1}{\eta}} C_{TH,t}^{\frac{\eta-1}{\eta}}(j) + (1-\alpha)^{\frac{1}{\eta}} C_{TF,t}^{\frac{\eta-1}{\eta}}(j) \right)^{\frac{\eta}{\eta-1}} \tag{3.3}$$

where $\eta > 0$ captures the elasticity of substitution between domestic and foreign traded goods, while $\alpha > 1/2$ represents the "home bias" in consumption of traded goods. The assumption of "home bias" in preferences, commonly employed in theoretical research (Warnock, 2003; Obstfeld and Rogoff, 2005, 2006), is an explicit way of modeling frictions in goods market. Under this assumption, purchasing power parity fails, even if the law of one price holds for traded goods. The sub-utility of foreign agent j' has similar functional forms. Preferences are asymmetric, for a foreign consumer attaches weights γ^* and $\alpha^* > 1/2$ to the foreign traded good.

To capture country-size effects on the pattern of consumption, the weight, in our calibration, are implicitly related to country size. The relation, pictured in Figure 3.2, is linear and increasing in country size for both "home bias" and the weight of non-traded goods in aggregate consumption. These assumptions ensure a larger size of the non-traded sector for larger countries.[7]

The domestic consumer price index, measured in home currency units, is

$$P_t = \left(\gamma P_{T,t}^{1-\theta} + (1-\gamma) P_{N,t}^{1-\theta}\right)^{\frac{1}{1-\theta}} \tag{3.4}$$

where $P_{N,t}$ is the domestic price of non-traded goods and $P_{T,t}$ is the price index of traded goods. The latter is determined by the local currency prices of domestic $P_{TH,t}$ and foreign $P_{TF,t}$ traded goods

$$P_{T,t} = \left(\alpha P_{TH,t}^{1-\eta} + (1-\alpha)\left(\varepsilon_t P_{TF,t}^*\right)^{1-\eta}\right)^{\frac{1}{1-\eta}} \tag{3.5}$$

where ε_t is the nominal exchange rate.[8]

Agents in each country invest in an internationally traded bond B_t that pays interest i_t in domestic currency units, earn labor income $W_t L_t(j)$ and receive dividends $Q_t(j)$ from profits of own country firms. Correspondingly, the flow budget constraint of a domestic agent is

$$B_{t+1}(j) = (1+i_t) B_t(j) + W_t L_t(j) + Q_t(j) - P_t C_t(j) \tag{3.6}$$

Intertemporal optimality equalizes the marginal utility of consumption in the current period with the discounted marginal utility of consumption of the next period

$$C_t^{-\sigma}(j) = \beta \frac{1+i_t}{P_{t+1}/P_t} C_{t+1}^{-\sigma}(j) \tag{3.7}$$

The intratemporal optimality condition states that, at the margin, the ratio between marginal utilities of effort and consumption should equal the real wage

$$\frac{L_t(j)}{C_t^{-\sigma}(j)} = \frac{W_t}{P_t} \tag{3.8}$$

Similar conditions hold for foreign agents.

[7]We choose a linear functional form for its simplicity, while the relation to country size is rationalized by Lane and Milesi-Ferretti (2002).

[8]The presence of the nominal exchange rate is redundant for primary results of the model since it can be rewritten without the nominal exchange rate by assuming that all the transactions are conducted in one global currency. However, indirectly the model's predictions can be used for the policy choice of exchange rate regime. For instance, the real exchange rate adjustment via changes in nominal exchange rate might be more desirable than via large swings in domestic price levels. Thus, countries that have a relatively powerful transfer effect, might be better off by having a relatively flexible exchange rate regime. For this reason we have assumed different currencies in our model economy.

3.2.2 Firm's problem

In each country, there are two representative firms: one producing traded goods, the other non-traded goods.[9] Traded goods are produced by a technology given by

$$Y_{TH,t} = \phi_{T,t} L_{TH,t}^{\psi} \tag{3.9}$$

where $Y_{TH,t}$ represents output, $L_{TH,t}$ labor used in production and $\phi_{T,t}$ is an exogenous productivity shifter in the sector.

Denoting output, labor used in production and the productivity shifter in the non-traded goods sector by $Y_{N,t}$, $L_{TN,t}$ and $\phi_{NT,t}$, we impose the following production function

$$Y_{N,t} = \phi_{N,t} L_{N,t}^{\chi} \tag{3.10}$$

This type of production function is one possible way to make the relative price of non-traded goods to respond to changes in the net foreign asset position. Of course, these relations could be generalized to a standard Cobb-Douglas function by explicitly incorporating some fixed factor into the production, which, in our framework, is implicitly normalized to one.

Firms in both sectors hire labor until the marginal cost of production equals the marginal product of labor. In the traded goods sector this condition is given by

$$\psi \phi_{T,t} L_{TH,t}^{\psi-1} = \frac{W_t}{P_{TH,t}} \tag{3.11}$$

while in the non-traded goods sector by

$$\chi \phi_{N,t} L_{N,t}^{\chi-1} = \frac{W_t}{P_{N,t}} \tag{3.12}$$

Nominal wages W_t between the sectors are equalized due to inter-sectoral labor mobility.

3.2.3 Equilibrium

To characterize the equilibrium, we define the aggregate variables by $X_t = nX_t(j)$ in domestic and $X_t^* = (1-n)\, X_t^*(j')$ in foreign countries. Using equation (3.8), average labor supply in the domestic economy is given by

$$\bar{L}_t = \frac{W_t}{P_t} \bar{C}_t^{-\sigma} \tag{3.13}$$

[9] An interesting extension of the model would be to deal with endogenous number of goods. Melitz and Ottaviano (2005), for example, in a static model show that, when the price elasticity of demand depends on the number of firms, larger countries export a wider range of goods and have higher average productivity.

where $\bar{L}_t$ is average labor supply and $\bar{C}_t$ is average consumption.

The aggregate labor supply in the domestic economy directly depends on the country's size

$$L_t = \frac{W_t}{P_t} n^{1+\sigma} C_t^{-\sigma} \tag{3.14}$$

Note that, in an equilibrium with a zero net foreign asset position, work effort in domestic relative to foreign economy is a convex function of relative country size.

The market clearing condition in the home produced traded goods market is

$$Y_{TH,t} = \gamma\alpha \left(\frac{P_{TH,t}}{P_{T,t}}\right)^{-\eta} \left(\frac{P_{T,t}}{P_t}\right)^{-\theta} C_t + \gamma^* (1-\alpha^*) \left(\frac{P_{TH,t}}{\varepsilon_t P^*_{T,t}}\right)^{-\eta} \left(\frac{P^*_{T,t}}{P^*_t}\right)^{-\theta} C^*_t \tag{3.15}$$

while the market clearing condition in the home produced non-traded goods market is

$$Y_{N,t} = (1-\gamma) \left(\frac{P_{N,t}}{P_t}\right)^{-\theta} C_t \tag{3.16}$$

Using aggregate profits, the resource constraint of home country can be written in the following form

$$B_{t+1} = (1+i_t) B_t + P_{TH,t} Y_{TH,t} + P_{N,t} Y_{N,t} - P_t C_t \tag{3.17}$$

By construction, the consumer price based real exchange rate $e_t = P_t/(\varepsilon_t P^*_t)$, which in nested form is given by

$$e_t = \left(\frac{\gamma^* \left(\alpha^* \tau_t^{\eta-1} + (1-\alpha^*)\right)^{\frac{1-\theta}{1-\eta}} + (1-\gamma^*) \tau_t^{\theta-1} {\lambda_t^*}^{1-\theta}}{\gamma \left(\alpha + (1-\alpha) \tau_t^{\eta-1}\right)^{\frac{1-\theta}{1-\eta}} + (1-\gamma) \lambda_t^{1-\theta}} \right)^{\frac{1}{\theta-1}} \tag{3.18}$$

depends on the terms of trade $\tau_t = P_{TH,t}/(\varepsilon_t P^*_{TF,t})$, as well as domestic $\lambda_t = P_{N,t}/P_{TH,t}$ and foreign $\lambda^*_t = P^*_{N,t}/P^*_{TF,t}$ prices of non-traded relative to traded goods. Our primary interest is the sensitivity of these relative prices to external imbalances.

Denoting steady state variables with tilde, the intertemporal solvency condition in a steady state is given by

$$\frac{\tilde{B}_t}{\tilde{P}_{TH,t}\tilde{Y}_{TH,t} + \tilde{P}_{N,t}\tilde{Y}_{N,t}} = -\frac{\beta}{1-\beta} \frac{\tilde{TB}_t}{\tilde{P}_{TH,t}\tilde{Y}_{TH,t} + \tilde{P}_{N,t}\tilde{Y}_{N,t}} = -\frac{\beta}{1-\beta} \tilde{tby}_t \tag{3.19}$$

where TB_t is the trade balance, tby_t is the ratio of trade balance to GDP. Needless to say, similar equations hold in the foreign country.

Equations (3.9)-(3.12), (3.14)-(3.16), (3.19) with their foreign counterparts and equation (3.18), combined with the definitions of relative prices, form the steady state system. The equilibrium in goods, labor and asset markets jointly determines the relative prices, wages, consumption and output in both domestic and foreign economies.

3.2.4 Calibration and the relative price sensitivity

Our benchmark parametrization for the elasticity of substitution between traded and non-traded goods is 0.5, although we report the sensitivities for a relatively large elasticity of 2.[10] Note that the larger the elasticity, the smaller the sensitivity of relative prices to external imbalances. The elasticity of substitution between domestic and foreign traded goods is set to 2.5, which is the value assumed by Faruqee et al. (2005) and is used in the IMF's Global Economic Model.

For the inverse of the intertemporal elasticity of substitution in consumption, a value of 2 is appropriate (Devereux et al., 2006). The share of labor in the traded and non-traded goods sectors is assumed to be 0.8.[11] The full table describing the calibration is provided in Appendix C of the current chapter.

Since our system is highly non-linear, we rely on numerical techniques and proceed in three steps. First, Newton's homotopy is employed to solve the system for the case of symmetric countries around a benchmark steady state with a zero net foreign asset position. Then, using the symmetric equilibrium solution as a point of departure, we utilize the Newton-Raphson procedure and find solutions for the other $n \in (0,1)$ by continuously updating the starting guesses with the solutions from the previous steps.[12] Finally, we take a log-linear approximation of the system around the benchmark and, using equation (3.19), derive the following equation

$$\ln \tilde{q}_t = \alpha_{q0} + \alpha_{q1} \tilde{tby}_t + \alpha_{q2} \ln \tilde{\phi}_{T,t} + \alpha_{q3} \ln \tilde{\phi}_{N,t} + \alpha_{q4} \ln \tilde{\phi}^*_{T,t} + \alpha_{q5} \ln \tilde{\phi}^*_{N,t} \tag{3.20}$$

where $\tilde{q}_t \in (\tilde{e}_t, \tilde{\tau}_t, \tilde{\lambda}_t)$, $\tilde{e}_t$ is the real exchange rate, $\tilde{\tau}_t$ the terms of trade, $\tilde{\lambda}_t$ the price of non-traded relative to traded goods, $\tilde{tby}_t$ the ratio of trade balance to GDP, $\tilde{\phi}_{T,t}$ the productivity in domestic traded sector, $\tilde{\phi}_{NT,t}$ the productivity in domestic non-traded sector, $\tilde{\phi}^*_{T,t}$ the productivity in foreign traded sector, $\tilde{\phi}^*_{NT,t}$ the productivity in foreign non-traded sector in a steady state at time t. The coefficients α_{q1} represent the sensitivity of relative prices to external imbalances.

[10] The former is assumed by Faruqee et al. (2005), and is used in the IMF's Global Economic Model. The latter is used by Obstfeld and Rogoff (2006) for comparative purposes to a smaller parametrization of elasticities.

[11] Devereux et al. (2006) calibrate the labor share in traded and non-traded sectors to 0.3 and 0.7, with capital considered explicitly. Since the capital is missing in our model, and the fixed factor is implicitly normalized to one, we increase the share of labor to ensure the output is not produced with too little work effort. The equality of weights simplifies the numerical solution.

[12] See Judd (1998) for description of these methods.

Figure 3.3 shows how country size affects the sensitivity of aggregate labor supply to the net foreign asset position to GDP ratio in the domestic economy. The negative sign states that a wealth transfer from the rest of the world to domestic consumers reduces the work effort. This transfer, reducing equilibrium amount of labor, also induces an inter-sectoral reallocation of work effort. Figures 3.4 and 3.5 show the impact of country size on the sensitivities of domestic labor in traded and non-traded sectors to the net foreign asset position to GDP ratio. A negative sensitivity in the traded goods sector indicates that a transfer of financial wealth to the domestic economy from the rest of the world reduces the level of work effort in traded goods sector. The magnitude of this decrease is quite pronounced for the elasticity of substitution between traded and non-traded goods equal to 0.5. In contrast, the transfer can have either a positive or negative impact on the level of work effort in the non-traded sector. For a relatively large elasticity of substitution between traded and non-traded goods, a transfer of financial wealth to home decreases work effort in the non-traded goods sector. While when the elasticity of substitution is relatively low, the wealth transfer increases work effort. The magnitude of the sensitivity is almost invariant to country size.

Figure 3.6 plots the impact of country size on the sensitivity of the foreign marginal utility of importable consumption to the domestic net foreign position to GDP ratio. The sensitivity is positive and increasing in country size. A negative net position of the domestic economy implies a trade surplus via the intertemporal solvency condition. The absorption of the domestic trade surplus by the rest of the world is matched by a declining marginal utility of foreign consumers. Since larger countries can run larger surpluses in absolute terms, the associated decline of the marginal utility is larger. Thus, for the rest of the world to absorb domestic trade surplus, the relative price has to decline. The decline is larger, the larger the trade surplus.

Figure 3.7 shows how country size affects the relation between the sensitivity of the terms of trade to external imbalances. Since larger countries generally have larger imbalances in absolute terms, then, given the decreasing marginal utility of consumption of the rest of the world, the associated deterioration of the terms of trade is larger for larger countries.[13] For example, when the elasticity of substitution between traded and non-traded goods is 0.5 and the elasticity of substitution between domestic and foreign traded goods is 2.5, a 1 percentage point reduction in the trade deficit to GDP ratio requires a 3.5 percentage point decline of export prices relative to import prices for a small country with 1 percent population size relative to the world. In contrast, a 1 percentage point reduction in the trade deficit to GDP ratio requires a 5.2 percentage point decline of the terms of trade for a large country with 35 percent population size

[13] Observe how the sensitivity of the terms of trade tracks the sensitivity of foreign marginal utility of imports.

relative to the world. Though the difference between the sensitivities is not massive, it is still noticeable.

Figure 3.8 plots the impact of country size on the sensitivity of the relative price of non-traded goods to external imbalances. Since external adjustment partially manifests itself via changes in the relative price of non-traded goods, then, for a given relative productivity differential, running trade surpluses is associated with switching consumption from traded to non-traded goods. This consumption switching is achieved through the decline of the relative price of non-traded goods. The larger the trade surplus and the size of the non-traded sector, the larger the corresponding fall in the relative price of non-traded goods. For instance, when the elasticity of substitution between traded and non-traded goods is 0.5 and the elasticity of substitution between domestic and foreign traded goods is 2.5, a 1 percentage point reduction in the trade deficit to GDP ratio requires a 0.5 percentage point decline of the relative price of non-traded goods for a small country with 1 percent population size relative to the world. In contrast, a 1 percentage point reduction in the trade deficit to GDP ratio requires a 0.9 percentage point decline in the relative price of non-traded goods for a large country with 35 percent population size relative to the world.

The deteriorating terms of trade and the declining relative price of non-traded goods translate into the depreciation of the real exchange rate. The relation between the sensitivity of the real exchange rate to external imbalances and country size is plotted in Figure 3.9. With 0.5 elasticity of substitution between traded and non-traded goods and 2.5 elasticity of substitution between domestic and foreign traded goods, a 1 percentage point reduction in the trade deficit to GDP ratio requires a 3.6 percentage point depreciation of the real exchange rate for a small country with 1 percent population size relative to the world. In contrast, a 1 percentage point reduction in the trade deficit to GDP ratio requires a 6.1 percentage point depreciation of the real exchange rate for a large country with 35 percent population size relative to the world.

Note, that when we set the elasticity of substitution between traded and non-traded goods to 2, the magnitude of the sensitivities generated by the model decreases. Table 3.1 reports the modeled sensitivities in more details. We skip the interpretations of how productivity affects the relative prices, since these have been widely studied already.[14] In particular, Benigno and Thoenisson (2003) paper is qualitatively close to ours. The authors build a two country dynamic stochastic general equilibrium model of the real exchange rate where both the relative price of non-traded goods and the terms of trade are endogenous. The model has a rich structure for studying relative price responses to productivity shocks, but the model does not allow the relative price of non-traded

[14]See Balassa (1964), Samuelson (1964), Obstfeld and Rogoff (1996), Benigno and Thoenisson (2003), Corsetti et al. (2006a, b).

goods to respond to external imbalances - a situation at odds with the data. Guided by these theoretical results, we turn to the empirical assessment of how country size affects the magnitude of transfer effect.

3.3 Empirical Setup

In this section we empirically study how country size affects the relation between the trade balance and relative prices.

3.3.1 Data description

The sample, dictated by data availability, includes 17 industrial countries for the period from 1980 to 2003. We use the OECD STAN structural analysis database to construct sectoral price deflators and labor productivities in manufacturing and services to proxy corresponding variables in the traded and non-traded sectors. Data on the trade balance, GDP per capita, GDP (all in 2000 USD) and the real effective exchange rate are taken from World Development Indicators. We construct the terms of trade based on OECD export/import deflators.

The sample is split into G3 and non-G3 groups, proxying large and small countries respectively.[15] Aside from the main countries being defined in G3 and non-G3 groups, twelve additional countries, labeled "other category", are used to construct the series for the rest of the world. These data are set up with the normalized weights estimated by Bayoumi et al. (2005). Figure 3.1 presents the relative importance of each of the groups for main countries. The importance of the "other" group is particularly evident for the United States with an un-adjusted trade share of 31 percent. To construct labor productivity for the rest of the world, we use UN data on sectoral value added and UNIDO (combined with AMECO) data on employment in manufacturing.

3.3.2 Empirical approach

Although the model generates the dependence of the relative prices on the levels of productivities in traded and non-traded sectors, we choose to follow the established tradition and use relative productivities instead. We define *relative sectoral productivity* as the log productivity differential between non-traded and traded goods sectors within a country; *traded productivity differential* as the log of cross country difference in productivities of traded sectors; *relative sectoral productivity differential* as the difference

[15] The G3 are Germany, Japan, United States. The non-G3 sample includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Italy, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom. Appendix A of the current chapter lists all of the countries.

between the inverted relative sectoral productivities.[16] We relate the real exchange rate to the trade balance, the relative sectoral productivity differential (capturing the Balassa-Samuelson effect), and the traded productivity differential. The same variables explain the terms of trade (but with different coefficients).

$$\ln q_t = \mu_{q0} + \mu_{q1} tby_t + \mu_{q2} \left[\ln(\phi_{T,t}/\phi_{N,t}) - \ln(\phi^*_{T,t}/\phi^*_{N,t})\right] + \mu_{q3} \ln(\phi_{T,t}/\phi^*_{T,t}) \quad (3.21)$$

where $q_t \in (e_t, \tau_t)$, e_t is the real exchange rate, τ_t the terms of trade, tby_t the ratio of trade balance to GDP, $\phi_{T,t}$ the productivity in domestic traded sector, $\phi_{NT,t}$ the productivity in domestic non-traded sector, $\phi^*_{T,t}$ the productivity in foreign traded sector, $\phi^*_{NT,t}$ the productivity in foreign non-traded sector.

The relative price of non-traded goods is determined by the trade balance, relative sectoral productivity, and the traded productivity differential

$$\ln \lambda_t = \mu_{\lambda 0} + \mu_{\lambda 1} tby_t + \mu_{\lambda 2} \ln(\phi_{N,t}/\phi_{T,t}) + \mu_{\lambda 3} \ln(\phi_{T,t}/\phi^*_{T,t}) \quad (3.22)$$

where λ_t is the price of non-traded relative to traded goods, tby_t the ratio of trade balance to GDP, $\phi_{T,t}$ the productivity in domestic traded sector, $\phi_{NT,t}$ the productivity in domestic non-traded sector, $\phi^*_{T,t}$ the productivity in foreign traded sector, $\phi^*_{NT,t}$ the productivity in foreign non-traded sector. We expect $\left|\partial\mu_{q1}\right| / \partial n > 0$ for $q \in (e, \tau, \lambda)$.

We proxy the relative productivity differential with GDP per capita relative to the rest of the world; relative sectoral productivity with labor productivity in services relative to manufacturing; traded productivity differential with labor productivity in manufacturing relative to the rest of the world.

Fisher type panel unit root tests, conducted in Table 3.2, point to the non-stationarity of the series, as the tests are unable to reject the unit root in the data. It is well known that a regression with non-stationary series is misleading unless the residuals from this regression are stationary. Having established non-stationarity, we proceed by employing the commonly-used panel dynamic ordinary least squares method (DOLS) and checking for co-integration by applying residual based tests.[17]

The general specification for DOLS(-1,1) is

$$y_{it} = \alpha_i + \theta_t + \boldsymbol{\beta}'\mathbf{x}_{it} + \sum_{j=-1}^{j=1} \Delta\mathbf{x}_{it-j} + \epsilon_{it} \quad (3.23)$$

where y_{it} is the log of real effective exchange rate, the log of terms of trade or the log

[16] Appendix B of the current chapter explains the definitions of variables used in the empirical work.

[17] DOLS was proposed by Stock and Watson (1993). Mark and Sul (2003) study the properties of the estimator in the panel context.

services prices relative to manufacturing.[18] Since our measure of relative prices is an index, it is relevant to include cross-section fixed effects α_i. θ_t represent time fixed effects and captures global shocks, $\mathbf{x}_{it}$ is a vector of control variables. In all of the cases the regressions are run for two samples: G3 and non-G3. Our main interest is the significance and relative magnitude of the coefficient on the trade balance to GDP ratio.

3.4 Results

3.4.1 Terms of trade

Table 3.3 reports results for the terms of trade regressions. In columns (1), (2), (5) and (6) we report the results for the specifications consistent with our model. In columns (3), (4), (7) and (8) we extend the empirical model and include two additional regressors: an export diversification index and an import diversification index.

The trade balance is significant in specifications (1), (5) and (6). Once the traded productivity differential is included, a trade surplus is associated with a deterioration of the terms of trade. In the specification without time fixed effects, a 1 percentage point improvement in the trade surplus to GDP ratio is associated with a 4.7 percentage point deterioration of the terms of trade for large countries. In the sample of small countries, a 1 percentage point improvement in the trade surplus to GDP ratio is associated with a 1.6 percentage point deterioration only. The magnitude of the coefficient between large and small countries differs by a factor of three, compared to the factor of two predicted by the model.

The coefficient of the relative manufacturing productivity differential has a negative sign and is almost always significant. In the case of no time fixed effects, this coefficient is equal to -1.1 and -0.2 in G3 and non-G3 samples respectively. The sensitivity of the terms of trade to the traded productivity differential is about six times larger in large countries.[19]

Although not in the model, we acknowledge that the pattern of production has important effects for the determinants of the terms of trade. Krugman (1989) has shown that if the productivity increase transforms into a new range of goods (extensive margin), the terms of trade need not fall. Love for variety is the main force making the rest of the world absorb the excess supply. This, in turn, can potentially affect

[18] The choice of one lead and lag is dictated by the sample length. Given a relatively short sample length, estimations for each country separately provide poor results. Even though these estimations still support the main prediction of the model, pooling the data increases the accuracy of estimates.

[19] Comparison with the model is slightly complicated. There are many possible combinations to generate relative productivity from productivity levels, with, correspondingly, many possible coefficients. This complicates the comparison between modeled and empirical sensitivities of relative prices.

the sensitivity of the terms of trade to external imbalances. Debaere and Lee (2003) have conducted an extensive empirical study of the terms of trade and the extensive margin and found that fast growing countries can avoid adverse terms of trade effects via expanding the range of traded goods.

Accordingly, we extend the empirical model and include two additional variables: an export diversification index and an import diversification index.[20] The results are reported in columns (3), (4), (7) and (8) of Table 3.3. The trade balance is significant for G3 in a specification with no time fixed effects with a coefficient of -3.8. In a sample of non-G3 countries, the trade balance is always significant. The sensitivity of the terms of trade is -1.1 when there are no time fixed effects. The magnitudes of sensitivities between G3 and non-G3 samples vary with a factor of almost four. Although the productivity differential is no longer significant, export and import diversification indices are significant in two and three cases respectively. Increased variety in the domestic traded sector increases demand from the rest of world due to love of variety, which in turn improves the terms of trade. The reverse argument holds true for the import diversification index. In this specification, multicollinearity between diversification indices and the productivity differential is possible. Nevertheless, the transfer coefficient is still greater for large countries.

In Table 3.3 the "cointegration" row reports Fisher's Chi-square test for the null of non-stationarity of the residuals from the regressions. The test rejects the non-stationarity of the residuals, providing evidence of a long-run relation between the terms of trade, trade balance and relative productivities (and diversification of exports/imports).

3.4.2 Relative price of non-traded goods

In this subsection, we estimate the dependence of the relative price of non-traded goods on the trade balance after controlling for relative sectoral productivity and productivity differentials. Although our model is characterized with endogenous terms of trade, and the reduced form equations already include the determinants of the latter, we report some regression results with the terms of trade as an additional control as well. The results are reported in Table 3.4.[21] The trade balance is significant in all cases. After controlling for the relative sectoral productivity and traded productivity differential, a trade surplus is associated with a decline in the relative price of non-

[20] The diversification index is constructed by summing the absolute deviations of commodity shares from world shares over all commodities.

[21] An individual time trend is included in the list of regressors to induce stationarity of the residuals. The incorporation of an individual time trend is justifiable however, because the relative price of services shows a secular time trend over the sample period. It should be noted that the conclusions regarding the relative magnitudes of the coefficients are not affected in a specification without the time trend.

traded goods. When time fixed effects are not considered in columns (1) and (5), the sensitivity of the relative price of non-traded goods to the trade balance is -1.6 in the G3 sample. However, this sensitivity is -0.4 in the non-G3 sample. A 1 percentage point change in the trade balance to GDP ratio has almost a four times larger effect on the relative price of non-traded goods in large countries compared to the factor of almost two predicted by the model.

The coefficient on relative sectoral productivity is significant in all of the cases and has the expected sign. Higher productivity in the non-traded goods sector drives down the marginal cost of production, resulting in a lower relative price of non-traded goods. However, the productivity differential in manufacturing is never statistically significant.

The "cointegration" row in Table 3.4 indicates that Fisher's Chi Square test rejects the non-stationarity of the residuals, providing evidence of a long-run relation between the relative price of non-traded goods, trade balance, relative productivity differential and traded productivity differential.

3.4.3 Real exchange rate

Table 3.5 reports results for the real exchange rate regressions. The trade balance is significant in almost all specifications. After controlling for the relative sectoral productivity differential and traded productivity differential, a trade surplus is associated with a depreciated real exchange rate. In the specification without time fixed effects, a 1 percentage point increase in the trade balance to GDP ratio is associated with a real depreciation of 7.7 percentage points for large countries as opposed to a 1.2 percentage point depreciation in small countries. The magnitude of the coefficient between large and small countries differs by a factor of six, compared to a factor of two predicted by the model. When global shocks are taken into account in specifications (2) and (6), the factor increases up to eight. The sensitivity of the real exchange rate to the trade balance becomes -8.7 and -1.1 respectively.[22]

The coefficient on the GDP per capita differential, capturing the Balassa-Samuelson effect, is significant in almost all cases. In the specifications without the terms of trade, the coefficient on the log GDP per capita differential is positive, statistically significant, and equal to 1.4 and 0.4 for G3 and non-G3 groups respectively.

The coefficient of the relative manufacturing productivity differential has a negative sign and is significant only for the G3 category. A productivity increase in the domestic traded goods sector drives down the marginal cost of production of traded goods resulting in an increase in the supply of traded goods. This increased supply is matched

[22]Lane and Milesi-Ferretti (2002) also find a negative coefficient on the trade balance in the full as well as sub-samples of developing and industrial countries. The coefficients in the sub-sample of industrial and developing countries, when the time effects are not considered, are correspondingly -5.6 and -0.4.

with a depreciation of the real exchange rate.[23]

We also report results from regressions with the terms of trade as an additional control. In this case, the terms of trade are assumed to be exogenous, a pattern inconsistent with our model. When the time effects are excluded, the trade balance is insignificant only in the G3 sample. When the time effects are included in the specification, the magnitudes of trade balance coefficients between G3 and non-G3 differ by a factor of seven.

The row "cointegration" in Table 3.5 reports the results of the co-integration test. Fisher's Chi-square test rejects the non-stationarity of the residuals in three out of four cases, providing evidence of a long-run relationship between the real exchange rate, trade balance and relative productivities.

Overall, the regressions results show that larger countries have a greater sensitivity of relative prices to the trade balance.

It is worth mentioning that a larger elasticity between traded and non-traded goods in the model more closely matches empirical sensitivities of the non-G3 sample. In contrast, sensitivities generated with a lower elasticity more closely match empirical sensitivities of the G3 sample. Thus, incorporating size dependent elasticities could improve predictions of the model for both large and small countries and bring them closer to the data.

3.5 Conclusions

In this paper we set up a simple two-country model with endogenous terms of trade and relative price of non-traded goods to study the relation between the real exchange rate, relative price of non-traded to traded goods, terms of trade, external imbalances and country size. The model predicts a positive relation between the absolute value of the sensitivity of relative prices to external imbalance and country size. In particular, trade surpluses are associated with deteriorating terms of trade and a declining relative price of non-traded goods, feeding into a depreciation of the real exchange rate.

At the empirical level, after controlling for relative productivity, we find a significant effect of external imbalances on relative prices. Estimation for G3 and non-G3 sub-samples reveals a systematic pattern in the sensitivity of relative prices to external imbalances, with the sensitivity being stronger in larger countries. These results, relevant to the speed and the smoothness of external adjustment, are important to both theoretical and policy issues dealing with relative prices and global imbalances.

Since empirical difference between sensitivities of large and small countries are larger

[23]See Corsetti et al. (2006a) for a theoretical discussion of a positive supply shock resulting in an appreciation of the real exchange rate.

than the differences in sensitivities generated by the model, a study of other mechanisms by which country size may affect the magnitude of the transfer effect could be necessary.

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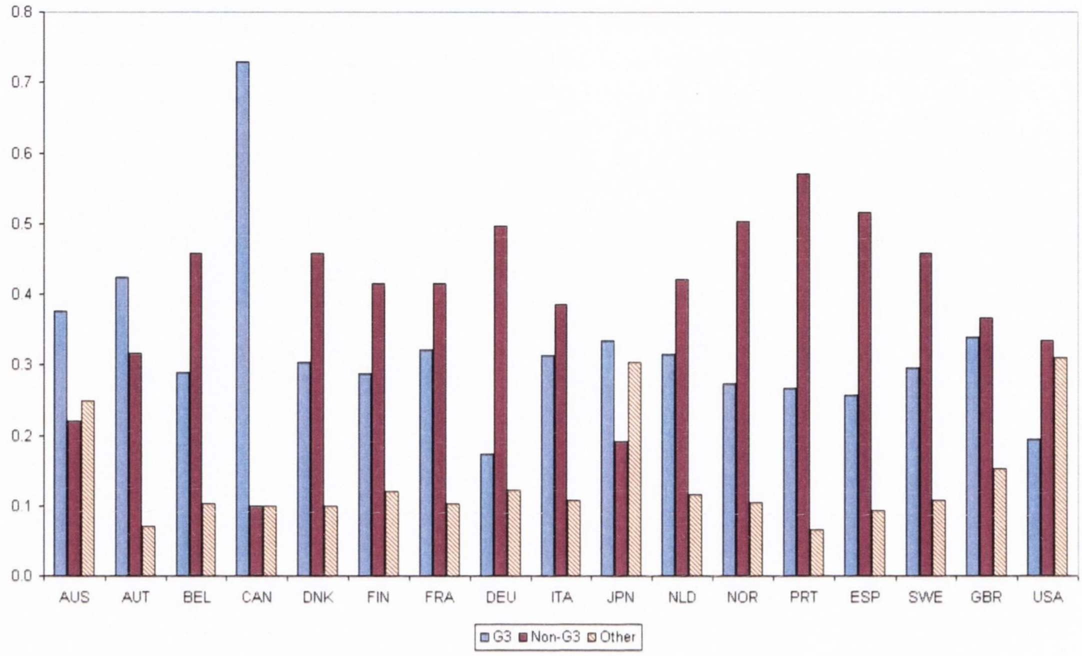
Figure 3.1: Trade weights



Note: Author's calculations based on Bayoumi et al (2005). G3 and non-G3 refer to industrial countries.

Figure 3.2: Assumptions of the model

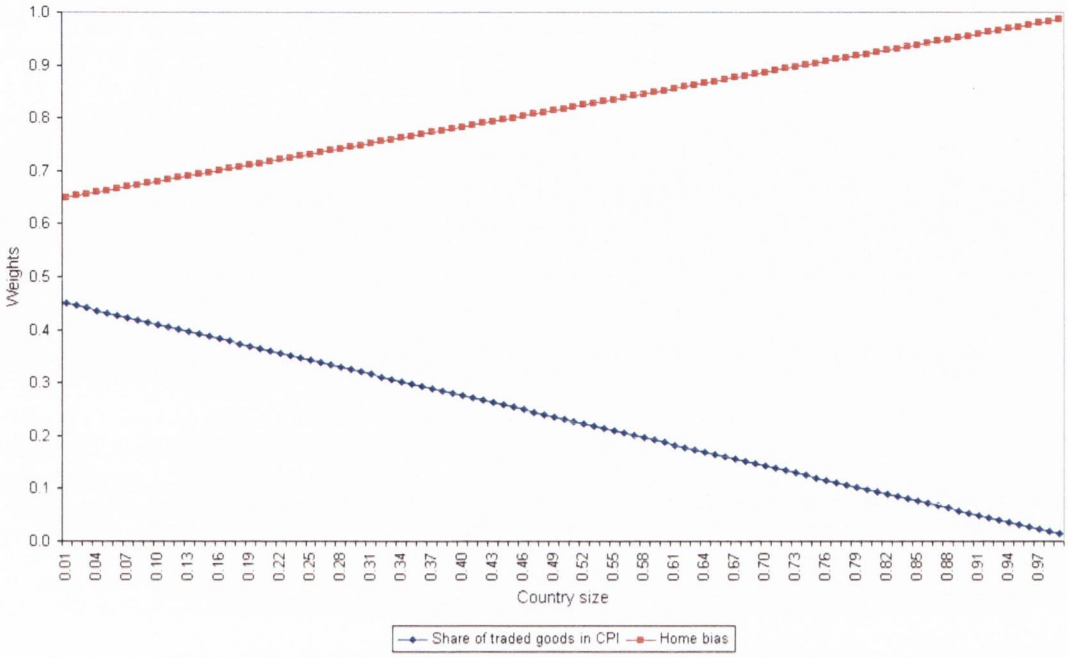
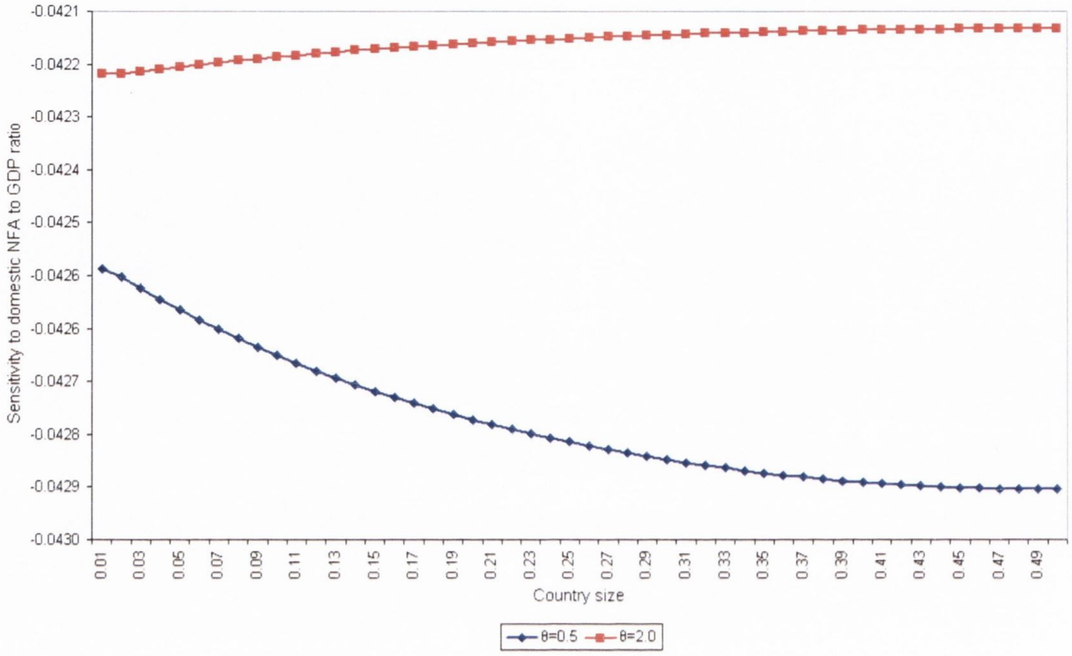
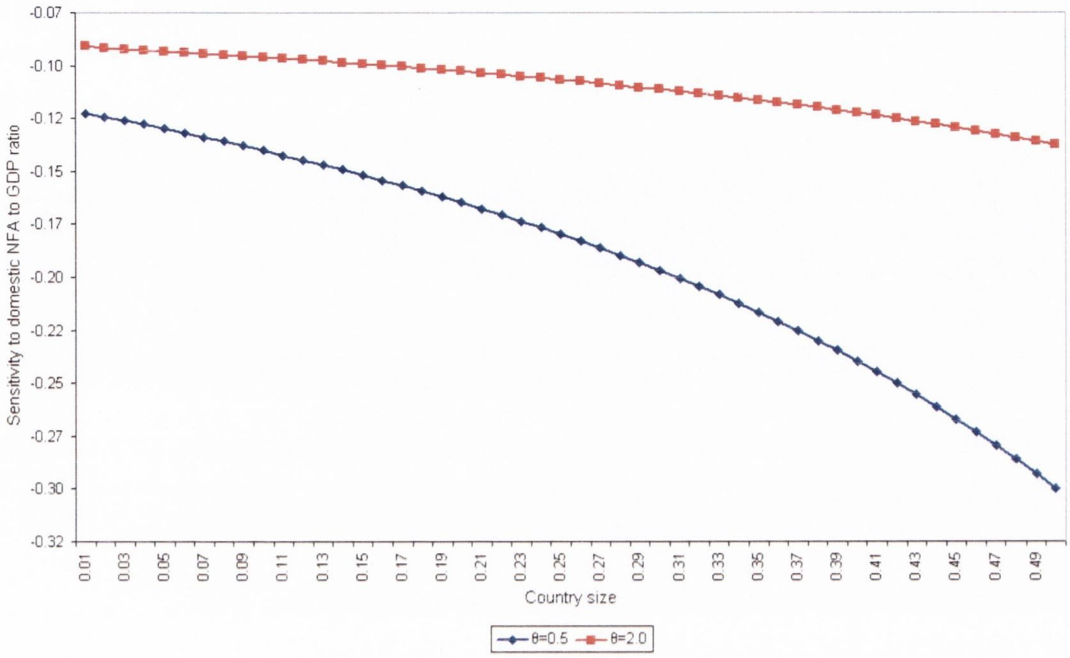


Figure 3.3: Sensitivity of labor supply in domestic economy



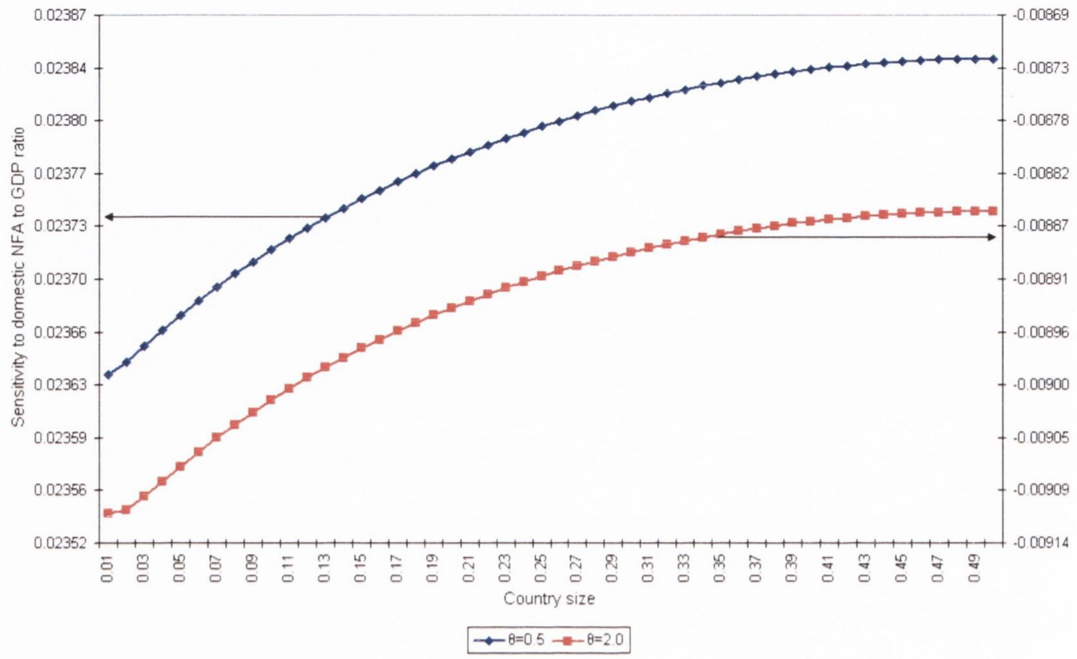
Note: θ is the elasticity of substitution between non-traded and traded goods.

Figure 3.4: Sensitivity of labor supply in domestic traded goods sector



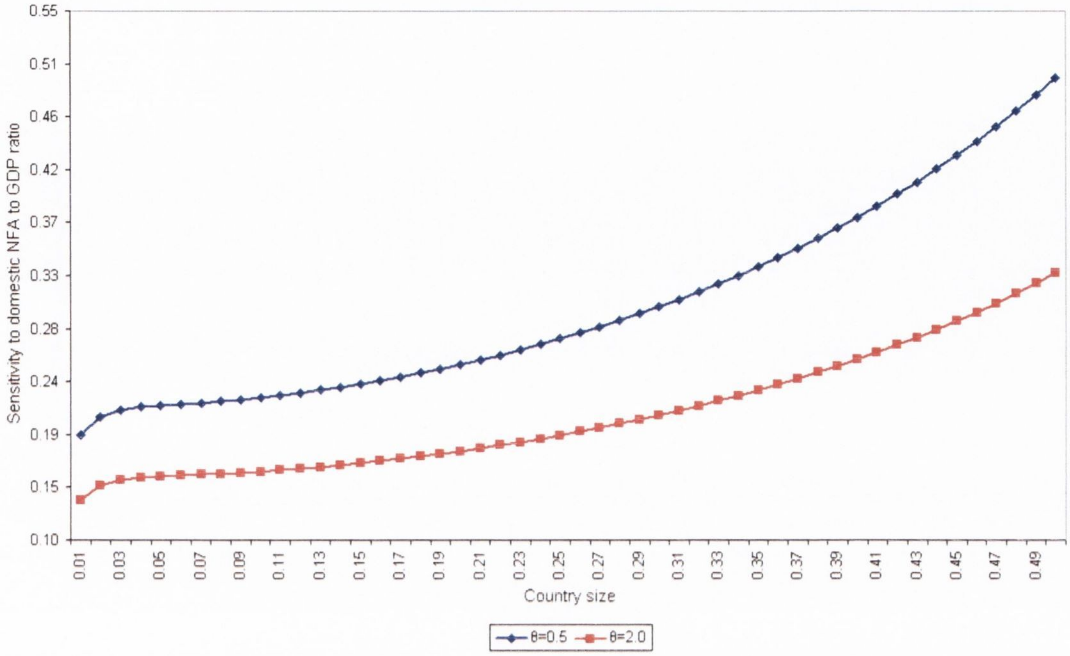
Note: θ is the elasticity of substitution between non-traded and traded goods.

Figure 3.5: Sensitivity of labor supply in domestic non-traded goods sector



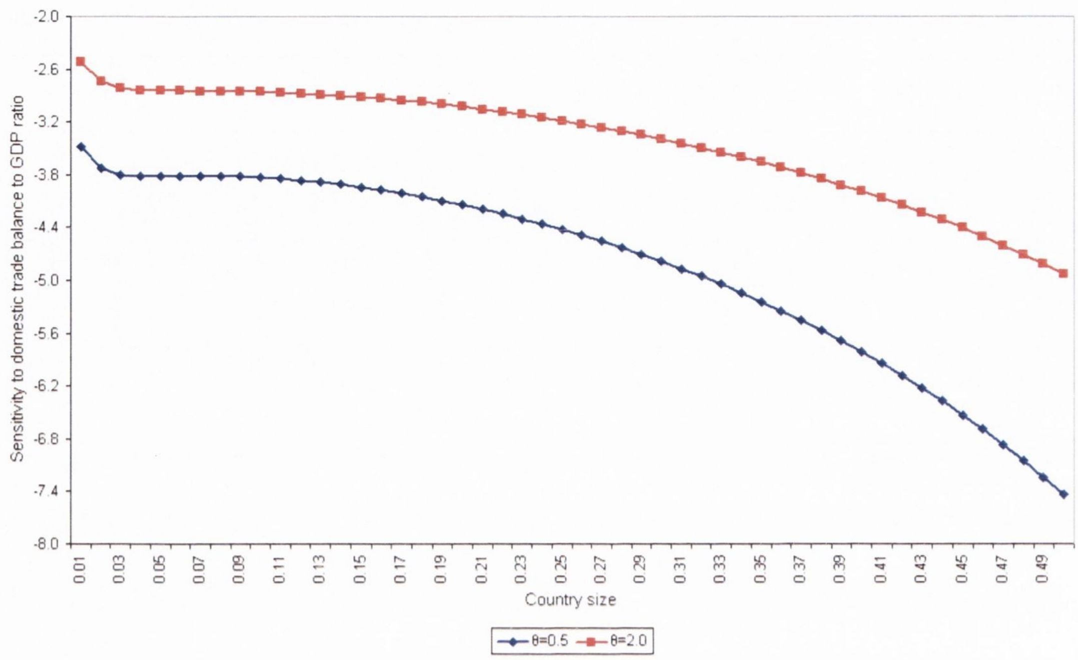
Note: θ is the elasticity of substitution between non-traded and traded goods. Arrows indicate corresponding axes.

Figure 3.6: Sensitivity of foreign marginal utility of importable consumption



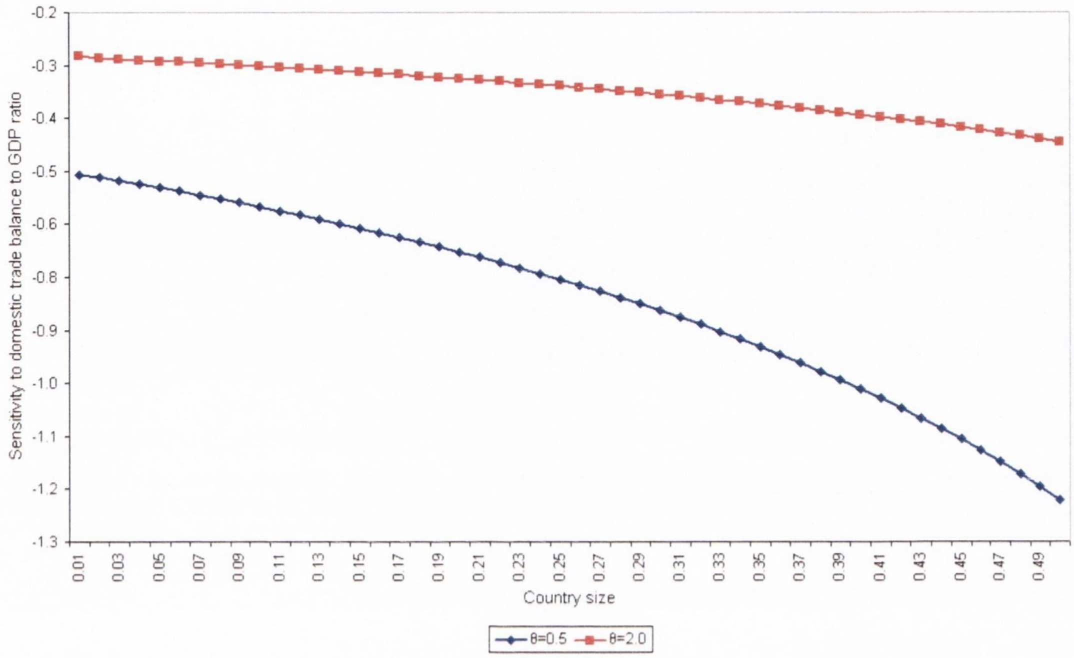
Note: θ is the elasticity of substitution between non-traded and traded goods.

Figure 3.7: Sensitivity of the terms of trade, $\ln(P_{TH}/\varepsilon P^*_{TF})$



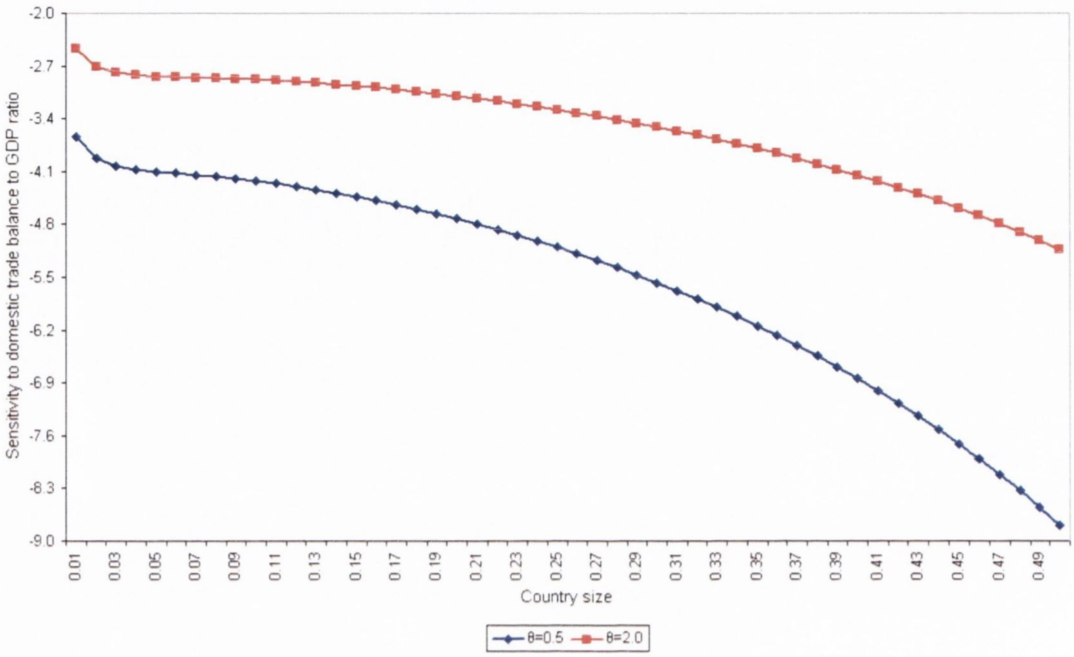
Note: θ is the elasticity of substitution between non-traded and traded goods.

Figure 3.8: Sensitivity of relative non-traded prices, $\ln(P_N/P_{TH})$



Note: θ is the elasticity of substitution between non-traded and traded goods.

Figure 3.9: Sensitivity of the real exchange rate, $\ln(P/\varepsilon P^*)$



Note: θ is the elasticity of substitution between non-traded and traded goods.

Table 3.1: Modeled sensitivities

	(1)	(2)	(3)	(4)
Country size, n	**0.01**	**0.03**	**0.20**	**0.35**
Part A: $\theta = 0.5$				
Terms of trade				
Trade balance	-3.49	-3.80	-4.14	-5.24
Productivity in domestic traded goods sector	-0.17	-0.17	-0.18	-0.18
Productivity in domestic non-traded goods sector	-0.02	-0.02	-0.03	-0.03
Productivity in foreign traded goods sector	0.15	0.16	0.17	0.17
Productivity in foreign non-traded goods sector	0.04	0.04	0.04	0.04
Relative price of non-traded goods				
Trade balance	-0.54	-0.55	-0.70	-0.89
Productivity in domestic traded goods sector	1.11	1.11	1.11	1.11
Productivity in domestic non-traded goods sector	-1.11	-1.11	-1.11	-1.11
Productivity in foreign traded goods sector	0.003	0.003	0.003	0.004
Productivity in foreign non-traded goods sector	0.001	0.001	0.001	0.001
Real exchange rate				
Trade balance	-3.63	-4.03	-4.72	-6.14
Productivity in domestic traded goods sector	0.43	0.44	0.54	0.62
Productivity in domestic non-traded goods sector	-0.61	-0.63	-0.74	-0.83
Productivity in foreign traded goods sector	-0.96	-0.95	-0.87	-0.79
Productivity in foreign non-traded goods sector	1.14	1.14	1.07	0.99
	(5)	(6)	(7)	(8)
Part B: $\theta = 2$				
Terms of trade				
Trade balance	-2.52	-2.81	-3.02	-3.65
Productivity in domestic traded goods sector	-0.34	-0.34	-0.36	-0.38
Productivity in domestic non-traded goods sector	0.15	0.15	0.16	0.18
Productivity in foreign traded goods sector	0.44	0.44	0.42	0.41
Productivity in foreign non-traded goods sector	-0.25	-0.25	-0.23	-0.21
Relative price of non-traded goods				
Trade balance	-0.29	-0.30	-0.34	-0.39
Productivity in domestic traded goods sector	0.85	0.85	0.85	0.85
Productivity in domestic non-traded goods sector	-0.84	-0.84	-0.84	-0.84
Productivity in foreign traded goods sector	-0.02	-0.02	-0.02	-0.01
Productivity in foreign non-traded goods sector	0.01	0.01	0.01	0.01
Real exchange rate				
Trade balance	-2.47	-2.78	-3.09	-3.79
Productivity in domestic traded goods sector	0.18	0.18	0.21	0.24
Productivity in domestic non-traded goods sector	-0.34	-0.35	-0.38	-0.41
Productivity in foreign traded goods sector	-0.42	-0.41	-0.35	-0.31
Productivity in foreign non-traded goods sector	0.59	0.58	0.52	0.48

Note: θ is the elasticity of substitution between non-traded and traded goods. n=0.01 corresponds to the population share of Norway, Finland, Denmark, Austria, Sweden, Belgium, Portugal in a sample of 17 industrial countries; n=0.35 to the population share of USA; n=0.03 to non-G3 average population share; n=0.20 to G3 average population share.

Table 3.2: Panel unit root test

	(1) **G3** **level**	(2) **G3** **difference**	(3) **Non-G3** **level**	(4) **Non-G3** **difference**
ln(rprod_dif)	0.37	45.48	21.98	154.8
	(0.99)	(0.001)	(0.78)	(0.001)
ln(prdmanf_dif)	1.41	32.89	35.61	134.9
	(0.97)	(0.001)	(0.15)	(0.001)
ln(reer)	11.76	31.64	31.77	129.5
	(0.07)	(0.001)	(0.28)	(0.001)
ln(rnp)	1.21	39.65	14.78	135.6
	(0.98)	(0.001)	(0.98)	(0.001)
ln(tot)	9.39	25.53	39.02	178.0
	(0.15)	(0.001)	(0.08)	(0.001)
ln(tot_manf)	6.09	29.86	29.20	141.5
	(0.41)	(0.001)	(0.40)	(0.001)
tby	4.60	24.15	30.23	134.7
	(0.60)	(0.001)	(0.35)	(0.001)
ln(gdppc_dif)	7.82	21.63	33.02	113.0
	(0.25)	(0.001)	(0.24)	(0.001)

Note: ADF Fisher Chi-square. P-values in parenthesis.
The definitions of the variables are as follows: tby is the trade balance to GDP ratio; ln(gdppc_dif) the log of GDP per capita relative to the rest of the world; ln(rprod_dif) the log of labor productivity in services relative to manufacturing; ln(prdmanf_dif) the log of labor productivity in manufacturing relative to the rest of the world; ln(tot) the log of terms of trade based on export/import deflators; ln(tot_manf) the log of terms of trade based on manufacturing prices; ln(rnp) the log of services prices relative to manufacturing prices; ln(reer) the log of real effective exchange rates; di_exp the export diversification index; di_imp the import diversification index.

Table 3.3: Terms of trade regressions

Part A: G3	**(1)**	**(2)**	**(3)**	**(4)**
tby	-4.67	-0.75	-3.77	2.56
	(1.54)***	(1.66)	(1.80)**	(1.84)
ln(prdmanf_dif)	-1.06	-0.56	-0.59	0.65
	(0.12)***	(0.21)**	(0.39)	(0.49)
ln(gdppc_dif)	1.33	1.83	0.85	0.42
	(0.33)***	(0.40)***	(0.42)*	(0.59)
di_exp			0.29	2.77
			(0.54)	(0.99)**
di_imp			-0.61	-1.90
			(0.58)	(0.63)***
Time effect	No	Yes	No	Yes
Observations	63	63	63	63
Countries	3	3	3	3
Adjusted R^2	0.58	0.69	0.56	0.75
Cointegration	11.56	18.92	15.09	40.25
	(0.07)	(0.004)	(0.02)	(0.001)
Part B: Non-G3	**(5)**	**(6)**	**(7)**	**(8)**
tby	-1.62	-1.72	-1.13	-1.86
	(0.36)***	(0.36)***	(0.29)***	(0.27)***
ln(prdmanf_dif)	-0.18	-0.03	-0.04	-0.01
	(0.08)**	(0.07)	(0.07)	(0.06)
ln(gdppc_dif)	-0.07	0.18	-0.01	-0.08
	(0.20)	(0.21)	(0.18)	(0.18)
di_exp			0.11	0.88
			(0.19)	(0.26)***
di_imp			-1.65	-1.20
			(0.26)***	(0.29)***
Time effect	No	Yes	No	Yes
Observations	294	294	294	294
Countries	14	14	14	14
Adjusted R^2	0.55	0.66	0.69	0.74
Cointegration	44.13	47.98	41.37	48.83
	(0.03)	(0.01)	(0.05)	(0.01)

Note: Estimated with DOLS. Standard errors in parenthesis. Cointegration is checked with residual based ADF Fisher Chi-square test, where residuals are obtained from DOLS regressions. P-values in parenthesis.
***,**,* significant at 1, 5 and 10 percent respectively.
The definitions of the variables are as follows: tby is the trade balance to GDP ratio; ln(prdmanf_dif) the log of labor productivity in manufacturing relative to the rest of the world; ln(gdppc_dif) the log of GDP per capita relative to the rest of the world; di_exp the export diversification index; di_imp the import diversification index.

Table 3.4: Relative non-traded price regressions

Part A: G3	**(1)**	**(2)**	**(3)**	**(4)**
tby	-1.63	-2.05	-1.87	-2.00
	(0.56)***	(0.61)***	(0.58)***	(0.62)***
ln(rprod_dif)	-0.26	-0.65	-0.03	-0.37
	(0.13)*	(0.15)***	(0.19)	(0.29)
ln(prdmanf_dif)	0.22	0.08	0.36	0.30
	(0.18)	(0.17)	(0.22)	(0.25)
ln(tot)			-0.11	-0.17
			(0.09)	(0.15)
Time effect	No	Yes	No	Yes
Observations	63	63	63	63
Countries	3	3	3	3
Adjusted R^2	0.99	0.99	0.99	0.99
Cointegration	19.56	17.37	26.11	24.21
	(0.003)	(0.01)	(0.001)	(0.001)
Part B: Non-G3	**(5)**	**(6)**	**(7)**	**(8)**
tby	-0.39	-0.24	-0.59	-0.48
	(0.19)**	(0.19)	(0.23)**	(0.22)**
ln(rprod_dif)	-0.30	-0.50	-0.25	-0.45
	(0.16)*	(0.18)***	(0.16)	(0.19)**
ln(prdmanf_dif)	0.22	0.05	0.26	0.09
	(0.17)	(0.19)	(0.17)	(0.20)
ln(tot)			-0.13	-0.16
			(0.06)**	(0.05)***
Time effect	No	Yes	No	Yes
Observations	294	294	294	294
Countries	14	14	14	14
Adjusted R^2	0.95	0.96	0.95	0.96
Cointegration	64.16	60.38	68.8	60.06
	(0.001)	(0.001)	(0.001)	(0.001)

Note: Estimated with DOLS. Standard errors in parenthesis. Individual time trend is included to induce stationarity of the residuals. Cointegration is checked with residual based ADF Fisher Chi-square test, where residuals are obtained from DOLS regressions. P-values in parenthesis.

***,**,* significant at 1, 5 and 10 percent respectively.

The definitions of the variables are as follows: tby is the trade balance to GDP ratio; ln(rprod_dif) the log of labor productivity in services relative to manufacturing; ln(prdmanf_dif) the log of labor productivity in manufacturing relative to the rest of the world; ln(tot) the log of terms of trade based on export/import deflators.

Table 3.5: Real exchange rate regressions

Part A: G3	(1)	(2)	(3)	(4)
tby	-7.72	-8.69	-2.91	-4.87
	(2.20)***	(3.16)**	(2.94)	(2.53)*
ln(gdppc_dif)	1.40	1.67	0.48	-1.30
	(0.55)**	(0.76)**	(0.59)	(0.47)**
ln(prdmanf_dif)	-0.97	-1.23	-0.09	-0.04
	(0.42)**	(0.47)**	(0.59)	(0.30)
ln(tot)			0.70	1.70
			(0.28)**	(0.20)***
Time effect	No	Yes	No	Yes
Observations	63	63	63	63
Countries	3	3	3	3
Adjusted R^2	0.78	0.69	0.82	0.93
Cointegration	16.96	22.06	14.78	16.29
	(0.01)	(0.001)	(0.02)	(0.01)
Part B: Non-G3	**(5)**	**(6)**	**(7)**	**(8)**
tby	-1.25	-1.06	-0.75	-0.73
	(0.21)***	(0.19)***	(0.28)***	(0.33)**
ln(gdppc_dif)	0.37	0.67	0.41	0.64
	(0.19)*	(0.17)***	(0.19)**	(0.16)***
ln(prdmanf_dif)	0.04	0.11	0.08	0.11
	(0.08)	(0.08)	(0.08)	(0.07)
ln(tot)			0.28	0.18
			(0.08)***	(0.11)*
Time effect	No	Yes	No	Yes
Observations	294	294	294	294
Countries	14	14	14	14
Adjusted R^2	0.65	0.73	0.68	0.75
Cointegration	40.36	45.60	34.02	40.15
	(0.06)	(0.02)	(0.20)	(0.06)

Note: Estimated with DOLS. Standard errors in parenthesis. Cointegration is checked with residual based ADF Fisher Chi-square test, where residuals are obtained from DOLS regressions. P-values in parenthesis.
***,**,* significant at 1, 5 and 10 percent respectively.
The definitions of the variables are as follows: tby is the trade balance to GDP ratio; ln(gdppc_dif) the log of GDP per capita relative to the rest of the world; ln(prdmanf_dif) the log of labor productivity in manufacturing relative to the rest of the world; ln(tot) the log of terms of trade based on export/import deflators.

3.7 Appendix A: Country List

G3: Germany, Japan, United States

Non-G3: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Italy, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom

Other: China, Greece, Hong Kong, Ireland, Israel, Korea, Malaysia, Mexico, New Zealand, Singapore, Thailand, Turkey

3.8 Appendix B: Data Sources and Definitions

tby: The ratio of trade balance to GDP in constant 2000 USD. Trade balance is computed as the difference between exports and imports of goods and services in constant 2000 USD. *Source:* World Bank's World Development Indicators.

ln(gdppc_dif): Log of GDP per capita in constant 2000 USD relative to the rest of the world. Proxies the relative productivity differential (classic Balassa-Samuelson effect). *Source:* World Bank's World Development Indicators.

ln(rprod_dif): Log of labor productivity in services in constant 2000 USD relative to manufacturing in constant 2000 USD. Captures the relative productivity. *Source:* Author's calculation based on the OECD STAN value added in national currency, period average exchange rates from IMF's IFS, and employment from OECD STAN.

ln(prdmanf_dif): Log of labor productivity in manufacturing in constant 2000 USD relative to the rest of the world. Captures traded productivity differential. *Source:* Author's calculation based OECD STAN value added in national currency, period average exchange rates from IMF's IFS, UN data on sectoral value added in constant 1990 USD (re-based to 2000) and UNIDO (supplemented with AMECO) data on employment in manufacturing.

ln(tot): Log of the terms of trade based on export/import deflators. *Source:* Author's calculation based on export/import deflators from OECD Economic Outlook.

ln(tot_manf): Log of the terms of trade based on manufacturing prices. *Source:* Author's calculation based on implicit deflators from OECD STAN and UN data on sectoral value added.

ln(rnp): Log of services relative to manufacturing prices. Captures the log of non-traded relative to traded goods price. *Source:* Author's calculation based on implicit deflators from OECD STAN.

di_exp: Export diversification index. *Source:* UNCTAD.

di_imp: Import diversification index. *Source:* UNCTAD.

3.9 Appendix C: Calibration Table

Parameters and values	Description
$\beta = 0.95$	Discount factor
$\theta = 0.5; 2$	Elasticity of substitution between non-traded and traded goods
$\eta = 2.5$	Elasticity of substitution between home and foreign traded goods
$\sigma = 2$	Inverse of elasticity of substitution in consumption
$\psi = 0.8$	Share of labor in traded sector
$\chi = 0.8$	Share of labor in non-traded sector
$\gamma = 0.45 - \frac{0.44}{99}(100n - 1)$	Share of traded goods in domestic CPI
$\gamma^* = 0.45 - \frac{0.44}{99}(100(1-n) - 1)$	Share of traded goods in foreign CPI
$\alpha = 0.65 + \frac{0.34}{99}(100n - 1)$	Coefficient of domestic "home bias"
$\alpha^* = 0.65 + \frac{0.34}{99}(100(1-n) - 1)$	Coefficient of foreign "home bias"

Chapter 4

The Terms of Trade and the Margins of Trade Flows

4.1 Introduction

How does the terms of trade respond to an increase in relative income? Since the influential contribution of Bhagwati (1958) this question has fascinated many influential economists. The classic answer to the question is that an increase in domestic income relative to the main trading partners results in a deterioration of the terms of trade. In 1969 Houthakker and Magee estimated income elasticities of trade flows and found that the income elasticity of imports for the United States was greater than the income elasticity of the United States exports to the rest of the world. The implications were striking. If the United States and the rest of the world were to grow at the same rate, then the United States should have experienced either a consistent deterioration of the terms of trade or ever increasing trade deficit. Neither happened.

The failure of this theory to explain the behavior of the terms of trade of the United States in 1970s led to some new research in the area of international macroeconomics. The most elegant explanation belongs to Krugman (1989). He argued that if the income increases as a result of creation of new goods, then, given that trading partners love variety, the terms of trade need not deteriorate.

We build on these two approaches and contribute to the debate on the terms of trade empirically. Our contribution is threefold. First, using panel data technique and 6 digit HS1992 import data, we estimate a range of substitution elasticities to construct the terms of trade series corrected for varieties. We estimate the elasticity of substitution between varieties equal to 9, while the elasticity of substitution at the level of goods is estimated equal to 3.

Second, we propose a decomposition strategy of trade flows into extensive and intensive margins. We find that ignoring the extensive margin in the construction of aggregate price indices results in an overestimation of the actual price index by 0.3 percentage points annually.

Third, we test how the terms of trade respond to changes in intensive and extensive margins. We find that an increase in the intensive margin of exports is associated with a deterioration of the terms of trade. We also find that an increase in the extensive margin of exports results in a deterioration of the terms of trade, at least in the short run.

Before proceeding with the explanations of our contributions, we find it useful to review some empirical papers most relevant to our study. The most outstanding one is the work by Acemoglu and Ventura (2002). The central prediction of the paper is the notion that faster capital accumulation fosters deterioration of the terms of trade. To test this statement, the authors relate the change in the terms of trade to the relative growth rate of nominal income and technology. Since the latter is not observable, the authors propose a two stage procedure in separating the effect of income growth on the terms of trade. In the first stage, the growth rate due to accumulation is isolated using Barro-type convergence regression, where the vector of controls includes steady state determinants of income (human capital, institutional variables, etc.). In the second stage, the terms of trade are regressed on the predicted growth rate from the first stage regression (and the controls of the first stage regression excluding the initial level of income). The regression results show that countries that grow faster than the rest of the world face depreciated terms of trade.[1]

The second work worth mentioning is Debaere and Lee (2002). These authors relate the terms of trade to the domestically produced export goods relative to the foreign import goods and market potential. The latter captures the strength of demand for a country's product by measuring the size of the neighboring markets. Because of unobserved variety, the authors construct output values net of productivity term. The latter is constructed by assuming that a fixed share of business R&D is spent on product innovation, and running a fixed-effects regression of output on technology, physical and human capital. The relative market potential is derived from a gravity equation of bilateral export pairs. First a gravity equation is estimated, then the predicted values are substituted into the formula for the relative market potential. To account for varieties/qualities, the authors construct two additional variables: relative GDP per capita and relative technologies. The results of the regressions are more or less economically and statistically significant coefficients. Relative output has a negative

[1] Epifani and Gancia (2006) provide some useful information about the terms of trade movements. They extend the sample size relative to Acemoglu and Ventura (2002) until 2000. The terms of trade regressions follow essentially the logic of Acemoglu and Ventura, and so does the result.

sign, while the market potential has a positive sign. Both GDP per capita and R&D have a positive sign.

Gagnon (2005) estimates the terms of trade regressions following interpretation of the Acemoglu and Ventura methodology. The main point of this regressions is to show that the growth rate of GDP is not reflected in a deteriorating terms of trade. Then Gagnon puts forward Krugman's argument that growth due to increased varieties need not result in the deterioration of the terms of trade. He builds a model where the varieties are proxied by the share of domestic output in world output. The regression results show that the exporters output ratio is highly significant, implying that fast-growing countries need not experience secular deterioration in their terms of trade.

Main limitations of the papers discussed above are: (i) reliance on the terms of trade data that is ignorant of new or disappearing varieties; (ii) regressions with proxies to margins of trade flows, instead of actual margins. Our value added relative to this existing work is fixing both of the points above.

The paper is structured as follows. In section 2 we revisit the theory of the determinants of the terms of trade. In section 3 we present the empirical methodology on the construction of the terms of trade. In section 4 we present the results. In section 5 we offer a discussion of the results. Section 6 concludes.

4.2 Theory

Consider the standard export, $EX(Y^*, \tau)$, and import, $IM(Y, \tau)$, demand functions, where τ is the price of exports in terms of imports, Y and Y^* are domestic and foreign real income respectively.

Assume that the number of exportable varieties produced within a country is positively related to exports (ie. the more varieties are produced, the more the country exports since its trading partners love variety). To take this into account, lets augment export and import demand functions with the number of varieties n and n^*, and write the trade balance as

$$TB = \tau EX(Y^*(n^*, y^*), \tau, n) - IM(Y(n, y), \tau, n^*) \qquad (4.1)$$

In the equation above the real income is expressed as a function of the number of varieties produced, n, and the scale of production of each good, y. Taking log-linear approximation around the balanced trade steady state we get

$$(1 + \xi_\tau - \zeta_\tau)\hat{\tau}_t = (\zeta_y \hat{y}_t - \xi_{y^*}\hat{y}_t^*) + (\zeta_n - \xi_n)\hat{n}_t + (\zeta_{n^*} - \xi_{n^*})\hat{n}_t^* + \phi tby_t \qquad (4.2)$$

where ξ and ζ stand for the elasticities of exports and imports with respect to the superscript, ϕ is inversely proportional to the country size (sum of exports and imports relative to income), and tby is the trade balance scaled by the balanced trade steady state income. All of the elasticities have positive sign except ξ_τ.

Subtracting the same equation at period $t-1$ from equation (4.2) we derive an equation in growth rates:

$$\Delta \ln \tau_t = \frac{\zeta_y}{\chi}\Delta \ln y_t - \frac{\xi_{y^*}}{\chi}\Delta \ln y_t^* + \frac{\zeta_n - \xi_n}{\chi}\Delta \ln n_t + \frac{\zeta_{n^*} - \xi_{n^*}}{\chi}\Delta \ln n_t^* + \frac{\phi}{\chi}\Delta tby_t \quad (4.3)$$

where $\chi = 1 + \xi_\tau - \zeta_\tau$. Note that as long as the Marshall-Lerner condition holds $\chi < 0$. This means that a faster domestic growth in the scale of production, keeping the number of varieties constant, results in a deterioration of the terms of trade, $\zeta_y/\chi < 0$, while an increase in foreign income along the intensive margin improves the domestic terms of trade, since the increased demand for domestic goods shifts the demand curve to the right, increasing the price of domestic exports, $-\xi_{y^*}/\chi > 0$. These are the predictions a model with standard Armington assumptions.

So far we have talked about the intensive margin, even when we discussed an exogenous increase in foreign income. Assume now, that foreign income grows due to increased number of varieties, keeping the scale of production constant.[2] This increased income is matched with an increased demand for domestic exports, $-\xi_{n^*}/\chi > 0$, improving the domestic terms of trade. At the same time the increased number of foreign exportable varieties increases domestic demand for imports, because of domestic consumers' love of variety. The latter tends to increase the price of importables, resulting in a deterioration in the terms of trade, $\zeta_{n^*}/\chi < 0$. Thus, the net effect depends on the relative elasticities, as captured by the last term of equation (4.3).

In a similar manner we can comment on an increased number of domestic varieties, keeping the other variables constant. The latter increases domestic imports as the income raises, resulting in a deterioration in the terms of trade, $\zeta_n/\chi < 0$. On the other hand, the increase in the number of domestic varieties boosts domestic exports due to foreign love of variety. The latter tends to improve the domestic terms of trade, $-\xi_n/\chi > 0$. The composite effect depends on the interaction of these opposite effects.

Note that we have not assumed any structure of production. In a model with standard Armington assumption, the last two terms in equation (4.3) drop out. When the supply side is modeled following Krugman, the first term drops out, and both domestic and foreign varieties have a zero coefficient, thus making the last two terms disappear as well.[3] The last result is the famous prediction of Krugman's model, stating

[2] Increased number of varieties may result in a fall in the scale of production, as consumers will spread their income over a wider range of varieties demanding less of every single variety. The effect on the aggregate income depends on these two effects.

[3] The difference in elasticities in equation (4.3) is equal to zero, since both of the elasticities are equal

that as long as countries accumulate income along the extensive margin, no terms of trade deterioration is necessary.

Finally the last term in equation (4.3) captures the transfer effect.[4] A negative net foreign position is associated with a trade surplus. To achieve the latter, the terms of trade need to deteriorate.[5] The inverse proportionality of the coefficient on the trade balance to output ratio to the country size (sum of exports and imports over GDP), implies that the coefficient on the trade balance is larger for larger countries. The latter means that that a 1 percentage point reduction of imbalances is associated with different magnitudes of adjustment for large and small countries.[6]

Thus, equation (4.3) has in nested form both Krugman and Armington type models. To test this equation we need data on the terms of trade and the margins of trade flows that are internally consistent.

4.3 Empirical Strategy

In this section we propose a decomposition of trade flows into extensive and intensive margins. Our approach is different from previous empirical research on the terms of trade since it provides a consistent decomposition between extensive, intensive margins and prices that are compatible with each other. The closest research to ours is the paper by Hummels and Klenow (2005) that employs similar decomposition strategy and looks at the determinants of the margins of trade flows in a cross-section of countries.

We proceed in following steps. We construct import and export price indices corrected for varieties. To do that, we use the methodology of Feenstra (1994) and Broda and Weinstein (2006) and estimate a range of substitution elasticities in a panel setting. Having trade values and price indices, we construct trade volumes, which in turn are decomposed into extensive and intensive margins. Finally, we run a regression of the corrected terms of trade on the decomposed components of trade flows consistent with equation (4.3). In the regression analysis we use extensive and intensive margins of trade flows as opposed to income since: (i) we do not have income data with underlying distribution of extensive and intensive margins for a large cross-section of countries; and (ii) it is the change in the margins of trade flows that affects the terms of trade. In equation (4.3) all goods and varieties are traded so the extensive margin of income is equivalent to the extensive margin of exports.[7]

to unity in Krugman's model.

[4]See Galstyan (2007), Lane and Milesi-Ferretti (2002, 2004).

[5]See Galstyan (2007) for a discussion of the terms of trade, relative price of non-traded goods and the real exchange rate.

[6]See Galstyan (2007), Lane and Milesi-Ferretti (2002).

[7]The inclusion of non-traded varieties may have an effect on the terms of trade through distributional

On the data side we have 6 digit import data from COMTRADE. The data are provided in values and volumes. The choice of 89 countries for the period from 1999 to 2004 is based on the proper availability of both value and volume measures.[8]

4.3.1 Import prices

We follow the methodology of Feenstra (1994). As in by Broda and Weinstein (2006), assume that the preferences over an aggregate import good are given a by two level utility function. We define a 3 digit category as a good, while the higher level digits and import sources as varieties. At the upper level of aggregation, we define the aggregate imports of country i at period t as

$$M_t^i = \left(\sum_{g \in G} C_{g,t}^{i\,\frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}} \tag{4.4}$$

where M_t is the volume of total imports, $C_{g,t}$ is the volume of imports of good g, $\gamma > 1$ is the elasticity of substitution between the goods, G is the set of all imported goods, and the superscript i labels the country.[9]

At the lower level of aggregation, denoting the volume of imports of variety j of good g to country i at period t by $c_{gj,t}^i$, we define the preferences of importing country by

$$C_{g,t}^i = \left(\sum_{j \in I_{g,t}} d_{gj,t}^{i\,\frac{1}{\theta_g}} c_{gj,t}^{i\,\frac{\theta_g - 1}{\theta_g}} \right)^{\frac{\theta_g}{\theta_g - 1}} \tag{4.5}$$

where $C_{g,t}^i$ is the aggregate import good g, $d_{gj,t}^i$ is the taste or quality parameter for variety j of good g, $I_{g,t}$ is the set of varieties of good g that country i imports at time t, and $\theta_g > 1$ is the elasticity of substitution between varieties. Defining $s_{gj,t}^i = c_{gj,t}^i p_{gj,t}^i / \sum_{j \in I_{g,t}} \left(c_{gj,t}^i p_{gj,t}^i \right)$ as the share of imports of a variety j of good g to country i, the familiar first order condition is$s_{gj,t}^i = d_{gj,t}^i \, (\left(p_{gj,t}^i / P_{g,t}^i \right)^{1-\theta_g}$, and in relative terms

$$\frac{P_{g,t}^i}{P_{g,t-1}^i} = \frac{p_{gj,t}^i}{p_{gj,t-1}^i} \left(\frac{s_{gj,t}^i}{s_{gj,t-1}^i} \right)^{\frac{1}{\theta_g - 1}} \left(\frac{d_{gj,t}^i}{d_{gj,t-1}^i} \right)^{\frac{1}{1-\theta_g}} \tag{4.6}$$

where $p_{gj,t}^i$ is the nominal price of imported variety j of good g in country i, and $P_{g,t}^i$ is

effects in the labor market.

[8]In the regression analysis Andorra, Faeroe Islands, French Polynesia are dropped out due to missing GDP in 2000 USD data. See Appendix A for more details on data cleaning procedure.

[9]We assume that the number of goods in two consecutive periods is constant. Thus the new goods that appear and remain through the next period are considered with one year delay.

the welfare based price index for CES preferences.

Let $I_g \subset (I_{g,t} \cap I_{g,t-1})$ be the set of varieties that are imported in two consecutive periods, where $I_{g,t} \cap I_{g,t-1} \neq \emptyset$. Define the share of variety j in this set as $\mu^i_{gj,t} = c^i_{gj,t}p^i_{gj,t} / \sum_{j \in I_g} \left(c^i_{gj,t}p^i_{gj,t}\right)$, and $\lambda^i_{g,t} = \sum_{j \in I_g} \left(c^i_{gj,t}p^i_{gj,t}\right) / \sum_{j \in I_{g,t}} \left(c^i_{gj,t}p^i_{gj,t}\right)$. Following Feenstra (1994) and Sato (1976), the log change weights are defined as

$$w^i_{gj,t} = \left(\frac{\mu^i_{gj,t} - \mu^i_{gj,t-1}}{\ln \mu^i_{gj,t} - \ln \mu^i_{gj,t-1}}\right) / \sum_{j \in I_g} \left(\frac{\mu^i_{gj,t} - \mu^i_{gj,t-1}}{\ln \mu^i_{gj,t} - \ln \mu^i_{gj,t-1}}\right) \tag{4.7}$$

Assuming that $d^i_{gj,t} = d^i_{gj,t-1}$ for $j \in I_g$, our import price index for good g is constructed as

$$\frac{P^i_{g,t}}{P^i_{g,t-1}} = \left(\frac{\lambda^i_{g,t}}{\lambda^i_{g,t-1}}\right)^{\frac{1}{\theta_g - 1}} \prod_{j \in I_g} \left(\frac{p^i_{gj,t}}{p^i_{gj,t-1}}\right)^{w^i_{gj,t}} \tag{4.8}$$

As explained by Feenstra (1994), the effect of new and disappearing varieties on the price index depends on two variables: (i) the elasticity of substitution between the varieties; and (ii) the weight of new goods in total expenditures. The effect of new varieties is non-negligible when the elasticity of substitution is small. Larger elasticity of substitution reduces the first term in the equation above, and causes the true price index to be very close to the "conventional" price index. It is obvious that the smaller the share of new varieties in the aggregate expenditures, the smaller the bias due to an ignorance to the extensive margin, as can be seen in the equation above.

After the goods price index is corrected for new and disappearing varieties, the aggregate import price index is constructed as

$$\frac{P^i_{M,t}}{P^i_{M,t-1}} = \prod_{g \in G} \left(\frac{\lambda^i_{g,t}}{\lambda^i_{g,t-1}}\right)^{\frac{w^i_{g,t}}{\theta_g - 1}} \prod_{g \in G} \left(\prod_{j \in I_g} \left(\frac{p^i_{gj,t}}{p^i_{gj,t-1}}\right)^{w^i_{gj,t}}\right)^{w^i_{g,t}} \tag{4.9}$$

where we have used equation (4.8), the definition of the ideal log-change price index of Sato (1976), and

$$w^i_{g,t} = \left(\frac{\mu^i_{g,t} - \mu^i_{g,t-1}}{\ln \mu^i_{g,t} - \ln \mu^i_{g,t-1}}\right) / \sum_{g \in G} \left(\frac{\mu^i_{g,t} - \mu^i_{g,t-1}}{\ln \mu^i_{g,t} - \ln \mu^i_{g,t-1}}\right) \tag{4.10}$$

and $\mu^i_{g,t} = C^i_{g,t}P^i_{g,t} / \sum_{g \in G} \left(C^i_{g,t}P^i_{g,t}\right)$.

The first product in equation (4.9) represents geometric average of relative lambdas. Thus, even though at the level of goods new or disappearing varieties can add enormous adjustment to the conventional price index, at the aggregate level this effect may be dampened: new varieties tend to reduce the true price index, while disappearing varieties increase it. The second product in equation (4.9) represents the geometric average of conventional price indices of goods.

4.3.2 Export prices

The construction of the export price index follows similar lines.[10] We do not specify the production side of the economy, thus to account for new and disappearing exportable varieties we rely on the import price indices of country i's trading partners.

Define $\Omega_{i,t}$ as the set of countries that import from country i, and $\Omega_i \in \Omega_{i,t}...\cup...\Omega_{i,T}$, where $t \in (t, T)$ is the time span in study. We specify the preferences over the aggregate import good of the composite trading partner by a two-level utility function. At the upper level of aggregation, we define the aggregate import good of country i's composite trading partner Ω_i at period t as

$$X_t^{\Omega_i} = \left(\sum_{q \in Q} C_{q,t}^{\Omega_i \frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}} \tag{4.11}$$

where X_t is the volume of total imports, $C_{q,t}^{\Omega_i}$ is the volume of imports of good q and Q is the set of all goods that country i's composite trading partner Ω_i imports.[11] Define Q_i as the set of all goods that country i's composite trading partner Ω_i imports from country i and Q_{Ξ} as the set of goods that Ω_i imports from the rest of the world excluding i. Then

$$X_t^{\Omega_i} = \left(C_{q \in Q_i}^{\Omega_i \frac{\gamma-1}{\gamma}} + C_{q \in Q_{\Xi}}^{\Omega_i \frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}} \tag{4.12}$$

and

$$C_{q \in Q_i}^{\Omega_i} = \left(\sum_{q \in Q_i} C_{q,t}^{\Omega_i \frac{\gamma-1}{\gamma}} \right)^{\frac{\gamma}{\gamma-1}} \tag{4.13}$$

At the lower level of aggregation, the composite consumption preferences over varieties of good q of country i's composite trading partner Ω_i is assumed to be of CES form:[12]

$$C_{q,t}^{\Omega_i} = \left(\sum_{j \in I_{q,t}} d_{qj,t}^{\Omega_i \frac{1}{\theta_q}} c_{qj,t}^{\Omega_i \frac{\theta_q - 1}{\theta_q}} \right)^{\frac{\theta_q}{\theta_q - 1}} \tag{4.14}$$

[10]Neither Feenstra (1994) nor Broda and Weinstein (2006) correct the price index of exports for new and disappearing varieties. We propose a correction along similar to correction of import price index lines as the export price index is necessary for the construction of the terms of trade.

[11]Country i exports and imports the same good if $q = g$.

[12]We impose equality of elasticities across countries since: (i) this is the main assumption in two country theoretical models; (ii) this assumption increases the efficiency of our empirical estimates of the elasticity of substitution in a panel setting.

where $I_{q,t}$ is the set of varieties of good q that Ω_i imports at time t, $d^{\Omega_i}_{qj,t}$ is a taste or quality parameter, and $c^{\Omega_i}_{qj,t}$ stands for the volume of imports of variety j of good q. Define $I_{qi,t}$ as the set of varieties of good q that the composite trading partner of country i imports from country i, and $I_{q\Xi,t}$ as the set of varieties of good q that the same trading partner imports from the rest of the world excluding i. Then

$$C^{\Omega_i}_{q,t} = \left(C^{\Omega_i \frac{\theta_q - 1}{\theta_q}}_{j\in I_{qi,t}} + C^{\Omega_i \frac{\theta_q - 1}{\theta_q}}_{j\in I_{q\Xi,t}} \right)^{\frac{\theta_q}{\theta_q - 1}} \tag{4.15}$$

and

$$C^{\Omega_i}_{j\in I_{qi,t}} = \left(\sum_{j\in I_{qi,t}} v^{\Omega_i \frac{1}{\theta_q}}_{qj,t} c^{\Omega_i \frac{\theta_q - 1}{\theta_q}}_{qj,t} \right)^{\frac{\theta_q}{\theta_q - 1}} \tag{4.16}$$

Thus the price index of good q consistent with the equation above is defined as the export price index of good q of country i that is corrected for changing varieties (both new digit categories and export destinations). This price index is derived as in the previous subsection. Let $I_{qi} \subset (I_{qi,t} \cap I_{qi,t-1})$ be the set of varieties that are imported in two consecutive periods, and $I_{qi,t} \cap I_{qi,t-1} \neq \emptyset$. Then the price index takes the following form:

$$\frac{P^{\Omega_i}_{q,t}}{P^{\Omega_i}_{q,t-1}} = \left(\frac{\lambda^{\Omega_i}_{q,t}}{\lambda^{\Omega_i}_{q,t-1}} \right)^{\frac{1}{\theta_q - 1}} \prod_{j\in I_{qi}} \left(\frac{p^{\Omega_i}_{qj,t}}{p^{\Omega_i}_{qj,t-1}} \right)^{w^{\Omega_i}_{qj,t}} \tag{4.17}$$

where $\lambda^{\Omega_i}_{q,t} = \sum_{j\in I_{qi}} \left(c^{\Omega_i}_{qj,t} p^{\Omega_i}_{qj,t} \right) / \sum_{j\in I_{qi,t}} \left(c^{\Omega_i}_{qj,t} p^{\Omega_i}_{qj,t} \right)$, $\mu^{\Omega_i}_{qj,t} = c^{\Omega_i}_{qj,t} p^{\Omega_i}_{qj,t} / \sum_{j\in I_{qi}} \left(c^{\Omega_i}_{qj,t} p^{\Omega_i}_{qj,t} \right)$ and $p^{\Omega_i}_{qj,t}$ is the price of a variety imported from country i by its composite trading partner. The log-change weights are constructed as

$$w^{\Omega_i}_{qj,t} = \left(\frac{\mu^{\Omega_i}_{qj,t} - \mu^{\Omega_i}_{qj,t-1}}{\ln \mu^{\Omega_i}_{qj,t} - \ln \mu^{\Omega_i}_{qj,t-1}} \right) / \sum_{j\in I_{qi}} \left(\frac{\mu^{\Omega_i}_{qj,t} - \mu^{\Omega_i}_{qj,t-1}}{\ln \mu^{\Omega_i}_{qj,t} - \ln \mu^{\Omega_i}_{qj,t-1}} \right) \tag{4.18}$$

We skip the interpretation of this equation as it is similar to the one in the previous subsection. After the goods price index is corrected for new and disappearing varieties, the aggregate import price index is constructed as

$$\frac{P^i_{X,t}}{P^i_{X,t-1}} = \prod_{q\in Q_i} \left(\frac{\lambda^{\Omega_i}_{q,t}}{\lambda^{\Omega_i}_{q,t-1}} \right)^{\frac{w^{\Omega_i}_{qj,t}}{\theta_q - 1}} \prod_{q\in Q_i} \left(\prod_{j\in I_{qi}} \left(\frac{p^{\Omega_i}_{qj,t}}{p^{\Omega_i}_{qj,t-1}} \right)^{w^{\Omega_i}_{qj,t}} \right)^{w^{\Omega_i}_{q,t}} \tag{4.19}$$

where we have used equation (4.17), the definition of the ideal log-change price index of Sato (1976), and

$$w_{q,t}^{\Omega_i} = \left(\frac{\mu_{q,t}^{\Omega_i} - \mu_{q,t-1}^{\Omega_i}}{\ln \mu_{q,t}^{\Omega_i} - \ln \mu_{q,t-1}^{\Omega_i}} \right) / \sum_{q \in Q_i} \left(\frac{\mu_{q,t}^{\Omega_i} - \mu_{q,t-1}^{\Omega_i}}{\ln \mu_{q,t}^{\Omega_i} - \ln \mu_{q,t-1}^{\Omega_i}} \right) \tag{4.20}$$

and $\mu_{q,t}^{\Omega_i} = C_{q,t}^{\Omega_i} P_{q,t}^{\Omega_i} / \sum_{q \in Q_i} \left(C_{q,t}^{\Omega_i} P_{q,t}^{\Omega_i} \right)$.

4.3.3 Decomposition

Given that we are able to construct the terms of trade series, we can construct the extensive and intensive margins as well. Having the ideal import price index we find the growth of real imports as

$$\frac{M_t^i}{M_{t-1}^i} = \frac{IM_t^i}{IM_{t-1}^i} / \frac{P_{M,t}^i}{P_{M,t-1}^i}$$

where IM_t^i stands for the value of total imports, $P_{M,t}^i$ is the constructed price index of imports and M_t is the volume of imports of country i. Let $IM_t^{i,\prime}$ be the imports of all varieties that do not change their status in two consecutive periods, and define Fisher's ideal price index over this set of varieties as

$$\frac{P_{M,t}^{i,F}}{P_{M,t-1}^{i,F}} = \left(\frac{\sum_{g \in G} \sum_{j \in I_g} p_{gj,t}^i c_{gj,t}^i}{\sum_{g \in G} \sum_{j \in I_g} p_{gj,t-1}^i c_{gj,t}^i} \right)^{1/2} \left(\frac{\sum_{g \in G} \sum_{j \in I_g} p_{gj,t}^i c_{gj,t-1}^i}{\sum_{g \in G} \sum_{j \in I_g} p_{gj,t-1}^i c_{gj,t-1}^i} \right)^{1/2}$$

Then the growth of the intensive margin is equal to

$$\frac{M_t^{i,int}}{M_{t-1}^{i,int}} = \frac{IM_t^{i,\prime}}{IM_{t-1}^{i,\prime}} / \frac{P_{M,t}^{i,F}}{P_{M,t-1}^{i,F}}$$

The growth of the extensive margin is computed as a residual

$$\frac{M_t^{i,ext}}{M_{t-1}^{i,ext}} = \frac{M_t^i}{M_{t-1}^i} / \frac{M_t^{i,int}}{M_{t-1}^{i,int}}$$

Thus we have decomposed the nominal growth rate of total imports into price and quantity components. The latter, in turn, is decomposed into extensive and intensive margins.

$$\frac{IM_t^i}{IM_{t-1}^i} = \frac{P_{M,t}^i}{P_{M,t-1}^i} \frac{M_t^{i,ext}}{M_{t-1}^{i,ext}} \frac{M_t^{i,int}}{M_{t-1}^{i,int}}$$

The decomposition of exports is done along similar lines with

$$\frac{EX_t^i}{EX_{t-1}^i} = \frac{P_{X,t}^i}{P_{X,t-1}^i} \frac{X_t^{i,ext}}{X_{t-1}^{i,ext}} \frac{X_t^{i,int}}{X_{t-1}^{i,int}}$$

where EX_t^i stands for the value of total exports, $P_{X,t}^i$ is the constructed price index of exports, and X_t^i is the volume of exports of country i.

Finally, we define the terms of trade of country i as the ratio between its export and import price indices, $P_{X,t}^i / P_{M,t}^i$. But to construct import and export price indices consistent with equations (4.9) and (4.19) we need estimates of the substitution elasticities.

4.3.4 Estimation of global elasticities: a panel approach

Underlying equation

The estimation procedure closely follows Feenstra (1994), and Broda and Weinstein (2006). Specifying the demand of country i for imports of variety j of good g in first differences yields

$$\Delta \ln s_{gj,t}^i = \phi_{g,t}^i - (\theta_g - 1) \Delta \ln p_{gj,t}^i + \varepsilon_{gj,t}^i \tag{4.21}$$

where $\phi_{g,t}^i = (\theta_g - 1) \Delta \ln P_{g,t}^i$ is common for all varieties of good g, and $\varepsilon_{gj,t}^i = \Delta \ln d_{gj,t}^i$. Assume that the supply curve of variety j of good g for country i is:

$$\Delta \ln p_{gj,t}^i = \varpi_g \Delta \ln x_{gj,t}^i + \xi_{gj,t}^i \tag{4.22}$$

where $x_{gj,t}^i$ is the real value of imports by country i. Rewriting the supply relation in terms of shares, subtracting a similar equation for a variety k from imports and exports, multiplying the error terms and rearranging we get

$$\begin{aligned}\left(\Delta \ln p_{gj,t}^i - \Delta \ln p_{gk,t}^i\right)^2 &= \eta_{g,1} \left(\Delta \ln s_{gj,t}^i - \Delta \ln s_{gk,t}^i\right)^2 \\ &\quad + \eta_{g,2} \left(\Delta \ln s_{gj,t}^i - \Delta \ln s_{gk,t}^i\right) \left(\Delta \ln p_{gj,t}^i - \Delta \ln p_{gk,t}^i\right) + u_{jj,t}^i\end{aligned} \tag{4.23}$$

where $\eta_{g,1} = \rho_g / (\theta_g - 1)^2 (1 - \rho_g)$, $\eta_{g,2} = (2\rho_g - 1)/(\theta_g - 1)(1 - \rho_g)$, $\rho_g = \varpi_g(\theta_g - 1)/(1 + \varpi g \theta_g)$, and $0 \leq \rho_g < 1 - 1/\theta_g < 1$. Equation (4.23) is derived by Feenstra (1994). The error terms of the demand and supply equations are multiplied in order to take advantage of the moment restrictions.

Following Feenstra (1994) assume that the unit values $uv_{gj,t}$ are measured with an error:

$$\Delta \ln uv_{gj,t}^i = \Delta \ln p_{gj,t}^i + \psi_{gj,t}^i \tag{4.24}$$

Then equation (4.23) can be rewritten as:

$$Y^i_{gj,t} = \eta^i_g + \eta_{g,1} X^{i,1}_{gj,t} + \eta_{g,2} X^{i,2}_{gj,t} + \varsigma^i_{gj,t} \tag{4.25}$$

where $\eta^i_g = 2\sigma^2_{\psi^i_g}$, $Y^i_{gj,t} = \left(\Delta \ln uv^i_{gj,t} - \Delta \ln uv^i_{gk,t}\right)^2$, $X^{i,1}_{gj,t} = \left(\Delta \ln s^i_{gj,t} - \Delta \ln s^i_{gk,t}\right)^2$ and $X^2_{gj,t} = \left(\Delta \ln s^i_{gj,t} - \Delta \ln s^i_{gk,t}\right)\left(\Delta \ln uv^i_{gj,t} - \Delta \ln uv^i_{gk,t}\right)$, i indexes countries, g goods and j varieties. The error term is given by

$$\begin{aligned} \varsigma^i_{gj,t} &= u^i_{gj,t} + \left(\left(\psi^i_{gj,t} - \psi^i_{gk,t}\right)^2 - 2\sigma^2_{\psi^i_g}\right) + 2\left(\Delta \ln p^i_{gj,t} - \Delta \ln p^i_{gk,t}\right)\left(\psi^i_{gj,t} - \psi^i_{gk,t}\right) \\ &\quad -\eta_{g,2}\left(\Delta \ln s^i_{gj,t} - \Delta \ln s^i_{gk,t}\right)\left(\psi^i_{gj,t} - \psi^i_{gk,t}\right) \end{aligned}$$

Define $\tilde{q}^i_g = \sum_{j=1}^{n^i_g} \sum_{t=1}^{T^i_{gj}} q^i_{gj,t}/n^i_g T^i_{gj}$. To eliminate the fixed effect η^i_g, subtract $\tilde{q}^i_g$ from both sides of equation (4.25), and define $\ddot{q}^i_{gj,t} = q^i_{gj,t} - \tilde{q}^i_g$.[13] Then equation (4.25) can be rewritten without the fixed effect as

$$\ddot{Y}^i_{gj,t} = \eta_{g,1} \ddot{X}^{i,1}_{gj,t} + \eta_{g,2} \ddot{X}^{i,2}_{gj,t} + \ddot{\varsigma}^i_{gj,t} \tag{4.26}$$

Thus on the left hand side we have the square of the difference of log-changes in unit values between varieties j and k of good g. The first term on the right hand side represents the square of the difference of log-changes in expenditure shares between varieties j and k of good g, while the second term represents the product between the difference of log-changes in unit values between and the difference of log-changes in expenditure shares between varieties j and k of good g. The third term represents the residual.

Econometric procedure

Let T^i_{gj} be the number of years in the sample that a given variety j of good g is imported into country i in any two consecutive periods, and let N be the total number of importers in the sample. Stacking equation (4.26) over time then varieties, and finally countries rewrite the system in vector terms:

$$\ddot{\mathbf{Y}}_{\mathbf{g}} = \ddot{\mathbf{X}}_{\mathbf{g}} \boldsymbol{\eta}_{\mathbf{g}} + \ddot{\varsigma}_{\mathbf{g}} \tag{4.27}$$

where $\ddot{\mathbf{Y}}_{\mathbf{g}}$ is an $L_g \times 1$ vector, $\ddot{\mathbf{X}}_{\mathbf{g}} = (\ddot{\mathbf{X}}^1_{\mathbf{g}}, \ddot{\mathbf{X}}^2_{\mathbf{g}})$ is an $L_g \times 2$ matrix, $L_g = \sum_{i=1}^{N} L^i_g$ is the total number of observations and $L^i_g = \sum_j T^i_{gj}$ is the total number of obser-

[13] The standard fixed effects procedure eliminates the unobserved effect by subtracting $\sum_{t=1}^{T^i_{gj}} q^i_{gj,t}/T^i_{gj}$. Since in our data some varieties change their status in different periods, we subtract $\sum_{j=1}^{n^i_g} \sum_{t=1}^{T^i_{gj}} q^i_{gj,t}/n^i_g T^i_{gj}$ to ensure that the variables are "de-meaned" consistently.

vations per country i. Since the right hand side variables are correlated with the residual, Feenstra (1994) suggests instrumenting $\ddot{\mathbf{X}}$.[14] Define ϱ_g^i as $T_{gj}^i \times 1$ vector of ones and $\mathbf{Z_g}$ as a block diagonal matrix with ϱ_g^i appearing on the diagonal. Since $\sum_{j=1}^{n_g^i} \sum_{t=1}^{T_{gj}^i} q_{gj,t}^i / n_g^i T_{gj}^i \rightarrow \mathbf{E}(q_g^i)$, then it is easy to show that the expectation of the residual term is zero, $\mathbf{E}(\ddot{\varsigma}_\mathbf{g}) = 0$, and the vector of the instruments is orthogonal to the vector of the residuals, $\mathbf{E}(\mathbf{Z_g}'\ddot{\varsigma}_\mathbf{g}) = \mathbf{0}$. A consistent two stage least squares estimator of $\boldsymbol{\eta}$ is given by:

$$\hat{\boldsymbol{\eta}}_\mathbf{g} = \left(\ddot{\mathbf{X}}_\mathbf{g}'\mathbf{Z_g}(\mathbf{Z_g}'\mathbf{Z_g})^{-1}\mathbf{Z_g}'\ddot{\mathbf{X}}_\mathbf{g}\right)^{-1} \ddot{\mathbf{X}}_\mathbf{g}'\mathbf{Z_g}(\mathbf{Z_g}'\mathbf{Z_g})^{-1}\mathbf{Z_g}'\ddot{\mathbf{Y}}_\mathbf{g} \tag{4.28}$$

Pre-multiplying equation (4.27) by $\mathbf{Z_g}(\mathbf{Z_g}'\mathbf{Z_g})^{-1}\mathbf{Z_g}'$ matrix, L_g equations of the following form are obtained:

$$\bar{Y}_{gj}^i = \eta_{g,1}\bar{X}_{gj}^{i,1} + \eta_{g,2}\bar{X}_{gj}^{i,2} + \bar{\varsigma}_{gj}^i \tag{4.29}$$

where each $i-j$ pair equation is repeated T_{gj}^i times, and $\bar{q}_{gj}^i = \sum_{t=1}^{T_{gj}^i} \ddot{q}_{gj,t}^i / T_{gj}^i$. Rewrite equation (4.29) in vector terms, where each cross-sectional unit appears only once, and pre-multiply by a weighting matrix $\mathbf{W_g}$:

$$\mathbf{W_g}\bar{\mathbf{Y}}_\mathbf{g} = \mathbf{W_g}\bar{\mathbf{X}}_\mathbf{g}\boldsymbol{\eta}_\mathbf{g} + \mathbf{W_g}\bar{\varsigma}_\mathbf{g} \tag{4.30}$$

Then the weighted least squares estimator of $\boldsymbol{\eta}_\mathbf{g}$ is given by:

$$\hat{\boldsymbol{\eta}}_\mathbf{g} = \left(\bar{\mathbf{X}}_\mathbf{g}'\mathbf{W_g}'\mathbf{W_g}\bar{\mathbf{X}}_\mathbf{g}\right)^{-1}\bar{\mathbf{X}}_\mathbf{g}'\mathbf{W_g}'\mathbf{W_g}\bar{\mathbf{Y}}_\mathbf{g} \tag{4.31}$$

Note that, since $\bar{\mathbf{X}}_\mathbf{g} = (\mathbf{Z_g}'\mathbf{Z_g})^{-1}\mathbf{Z_g}'\ddot{\mathbf{X}}_\mathbf{g}$ and $\bar{\mathbf{Y}}_\mathbf{g} = (\mathbf{Z_g}'\mathbf{Z_g})^{-1}\mathbf{Z_g}'\ddot{\mathbf{Y}}_\mathbf{g}$, the two estimators are equivalent when the element W_{gj}^i of the weighting matrix is $W_{gj}^i = \sqrt{T_{gj}^i}$.[15] Equation (4.29), estimated by a weighted least squares procedure, forms our estimating equation.

Having $\hat{\eta}_{g,1} > 0$ and $\hat{\eta}_{g,2}$, the elasticity of substitution is calculated with formulas derived in Feenstra (1994). For $\hat{\eta}_{g,2} \gtrless 0$:

$$\hat{\rho}_g = \frac{1}{2} \pm \left(\frac{1}{4} - \frac{1}{4 + \hat{\eta}_{g,2}^2/\hat{\eta}_{g,1}}\right)^{1/2} \tag{4.32}$$

[14] In the original formulation of Feenstra (1994) the instruments are applied directly to $\mathbf{X}_g^1$ and $\mathbf{X}_g^2$.
[15] i indexes the row for a country while j indexes the row for a variety of good g.

and the elasticity of substitution is

$$\hat{\theta}_g = 1 + \left(\frac{2\hat{\rho}_g - 1}{1 - \hat{\rho}_g}\right)\frac{1}{\hat{\eta}_{g,2}} > 1 \tag{4.33}$$

When $\hat{\eta}_{g,1} < 0$, the conditions derived in Feenstra (1994) are violated and it is possible to compute a non-imaginary value of the elasticity of substitutions in very rare cases. If this value appears imaginary, Broda and Weinstein (2006) suggest a grid search procedure over a given parameter space with a final choice being determined by the minimum residual sum of squares.

The procedure outlined above for good g is repeated continuously for all goods $g \in G$, which in our case are identified by three digit HS1992 categories.

4.3.5 The terms of trade equation

Following our theoretical equation (4.2), our estimating equation is specified as

$$\begin{aligned} \Delta \ln(\text{tot}_t^i) &= \alpha_0^i + \alpha_1 \Delta \ln(\text{exp\_ext}_t^i) + \alpha_2 \Delta \ln(\text{exp\_int}_t^i) \\ &\quad + \alpha_3 \Delta \ln(\text{imp\_ext}_t^i) + \alpha_4 \Delta \ln(\text{imp\_int}_t^i) + \upsilon_t^i \end{aligned} \tag{4.34}$$

where ln(tot) is the log of the terms of trade; ln(exp_ext) the log of the extensive margin of exports; ln(exp_int) the log of the intensive margin of exports; ln(imp_ext) the log of the extensive margin of imports; ln(imp_int) the log of the intensive margin of imports; and i labels the country.

4.4 Results

4.4.1 Disaggregated elasticities, extensive margin, bias and the aggregate elasticity

Figure 4.1 shows the distribution of substitution elasticities at HS3 digit level. Excluding one outlier of 133, the average elasticity of substitution between 3 digit categories is between 9 and 10. This is somewhat larger than the non-weighted average elasticity of substitution of 4 estimated by Broda and Weinstein (2006) at 3 digit SITC level. The two are not actually compatible because of: (i) differences in classification systems; (ii) differences in digits that define varieties; and (iii) differences in the number of countries involved, and thus the number of observations per category.[16] Since we use a panel approach, in our sample the average number of observations per 3 digit category is 93,511,

[16] I am not aware of the data cleaning that Broda and Weinstein (2006) have done. From my own experience with the data, this can have non-negligible effects.

the minimum number of observations per 3 digit category is 542 and the maximum number of observations is 538,523. Assuming that the underlying specifications are correct, our estimates are consistent due to the large number of observations involved. The second important difference that is worth noting is that in all our estimations we always have $\hat{\eta}_1 > 0$, thus our estimates always satisfy the conditions derived by Feenstra (1994) and we never have to do the grid search procedure.

After the decomposition, it is interesting to assess the quantitative effects of ignoring the extensive margin on the price indices. To do this, we regress the log change of the difference between the corrected and the conventional price index, defined as Fishers's ideal price index, on the log change of the extensive margin. The results are reported in column (3) for imports and column (4) for exports of Table 4.1. A one percentage point increase of the extensive margin of imports or exports results in a bias of 0.3 percentage points. Thus the conventional price index will tend to overestimate the price change by 0.3 percentage points a year.

Another interesting question is the magnitude of the elasticity of substitution at a more aggregate level. Assume that all varieties enter a constant elasticity of substitution index. Then equation (4.8) is valid at a more aggregate level. Thus a regression of the log change of the difference between the corrected and conventional price indices on the log change of the relative lambdas, implicitly provides an estimate for the elasticity of substitution between goods. Columns (1) and (2) report the results of this regression with implied aggregate elasticity of substitution. The latter is approximately 3.3 for imports and 3.2 for exports, and is about 3 times smaller than the elasticity of substitution at a more disaggregated 3 digit HS level. This result confirms the finding that the elasticity of substitution is larger the more disaggregated the data.

4.4.2 Distributions of the margins and the terms of trade

Figures 4.2 to 4.5 describe the distribution of the margins of trade for sub-samples of industrial and developing countries.

In the sample of industrial countries, some countries have experienced a decline of the extensive margin but in general the shape of the distribution in Figure 4.2 suggests that there is relatively little improvement in the extensive margin of exports. The average growth rate stands at 0.4 percent while the median at -0.03 percent. In the sample of developing countries, the improvement of the extensive margin is more pronounced. The average growth rate of the extensive margin of exports stands at 3.7 percent, while the median is 0.4 percent. Thus during our sample period no major change in the extensive margin of exports has occurred in either industrial or developing sub-samples.

Figure 4.3 describes the distribution of the intensive margin of exports. In the sample of industrial countries for the period of 2000-2004 the intensive margin of exports has increased by an average of 4.8 percentage points. In the sample of developing countries the expansion of the intensive margin of exports is quite pronounced. Though some countries experience major declines, the average increase of the intensive margin of exports stands at 8.5 percent. The median growth rate of the intensive margin in the sub-samples of industrial and developing countries stands at 3.5 and 5.7 percent respectively.

The distribution shapes of the extensive margin of imports tell a different story. As can be seen from Figure 4.4, in the sample of industrial countries the average growth rate of the extensive margin of imports is 1.2 percent. As opposed to industrial countries, developing countries developing countries experienced a massive expansion in the extensive margin of imports. Being concentrated around 19, the average growth rate of the extensive margin of imports stands at 17.2 percent. The median growth rate in both samples is close to zero. It stands at 0.1 in the sample of industrial countries, and at 0.4 in the sample of developing countries.

Figure 4.5 describes the distribution of the intensive margin of imports. In the sample of industrial countries, the shape of the distribution suggests an increase in the intensive margin of imports. The average for industrial countries stands at 4.2 percent. Part (b) of the same figure suggests a pronounced increase in the intensive margin of imports in the sample of developing countries. Though some countries experience major declines, the average growth rate of the intensive margin of imports stands at 20.6 percent. The median growth rate of the intensive margin in the sub-samples of industrial and developing countries stands at 3.3 and 7.8 percent respectively.

To see actual relevance of the extensive margin of trade flows to the possible bias in the terms of trade, in Figure 4.6 we show the scatter plot of the corrected (vertical line) versus conventional (horizontal line) terms of trade. In the sample of industrial countries the dispersion over the period of 2000-2004 is negligible, with the correlation coefficient being equal to 0.97. This result is expected as the extensive margin of exports grew by 0.4 percent only, while the extensive margin of imports grew by a moderate 1.2 percent. The situation is different in the sample of developing countries. Scatter plot in part (b) of Figure 4.6 indicates relatively large dispersion, and the correlation coefficient is equal to 0.74. This result is expected as the extensive margin of exports grew by almost 4 percent, while the extensive margin of imports by a massive 17.2 percent.

Thus industrial countries on average have not experienced major changes in the extensive margins of either exports or imports. As opposed to them, developing countries on average have experienced a modest increase in the extensive margins of exports and a massive increase in the extensive margin of imports. In contrast to the extensive margin, there has been increase in the intensive margins of both exports and imports in the sample of industrial countries. But this increase is again shadowed by a large expansion of the intensive margin of exports and a massive expansion of the intensive margin of imports in the sample of developing countries.

4.4.3 Regressions

In this subsection we revisit the question on the determinants of the terms of trade.[17]

Industrial countries

Table 4.2 presents our results. In columns (1) and (2) we simply regress the log change of terms of trade on the change in the trade balance to GDP ratio.[18] The coefficient of the change in the trade balance to GDP ratio is negative and significantly different from zero, indicating a consistency with the transfer effect.[19] In the specification without the time effects, a 1 percentage point improvement of the trade balance to GDP ratio is associated with 1.1 percentage point deterioration of the terms of trade in specifications with and without the time effects.[20]

In columns (3) and (4) the log change of the trade balance is regressed on the margins of trade flows. The coefficient of the log change of the extensive margin of exports is statistically insignificant and has a negative sign regardless the inclusion of the time effects. The coefficient on the log change of the intensive margin of exports is statistically significant and has a negative sign in both specifications of the time fixed and no time fixed effects. A 1 percentage point increase in the intensive margin is matched with a deterioration of the terms of trade by 0.3 percentage points regardless of the inclusion of the time fixed effects. This is a classic prediction of the theory: an increase in the intensive margin of exports is matched by a deterioration of the terms of trade. The growth rate of the extensive margin of imports has a positive and statistically significant coefficient. A 1 percentage point increase in the extensive margin of imports is associated with an improvement of the terms of trade by approximately 0.4 percentage points. The coefficient on the growth rate of the intensive margin of imports is statistically significant and has the expected positive sign. A 1 percentage point increase in the intensive margin of imports is associated with an improvement of

[17]To check stationarity of the data we have run a set of panel unit root tests in both samples of industrial and developing countries. The null of non-stationarity is rejected for all of the variables. The test results are available upon request.

[18]As of now we should be cautious in our interpretation of the relationship between the trade balance and the terms of trade because of possible endogeneity issues. By this regression we do not claim causality in either direction but a relationship between the two.

[19]See Galstyan (2007), Lane and Milesi-Ferretti (2002, 2004) for a detailed treatment of the transfer effect.

[20]The time effects are included to account for global shocks since the regression does not include all countries, but sub-samples only.

the terms of trade by 0.3 percentage points regardless of the inclusion of the time fixed effects.

Thus the expansion of the intensive margin of exports and the decline in the intensive margin of imports are matched with a deterioration of the terms of trade. The expansion of the extensive margin of exports and the decline of the extensive margin of imports are also matched with a deteriorating terms of trade, at least in the short run.

In the next step we average the variables of interest over our sample period and run a cross-sectional regression. Table 4.3 presents the results of the "medium run regression". In column (1) the average log change of the terms of trade is regressed on the average change in the trade balance to GDP ratio only. The coefficient is negative and statistically significant. A 1 percentage point improvement of the trade balance to GDP ratio over a medium term is associated with a decline of the terms of trade by 1.2 percentage points. In the next specification we regress the average log change of the terms of trade on the margins of trade. The extensive margin of exports now has a positive sign, but is statistically insignificant. The intensive margin of exports has again a negative sign, and is statistically significant. The coefficient is equal to -0.3, implying a 1 percentage point increase in the extensive margin of exports is associated with a deterioration of the terms of trade by 0.3 percentage points. The extensive margin of imports now has a negative sign, but is statistically insignificant. The intensive margin of imports has a positive sign, which is again insignificant.

Thus the expansion of the intensive margin of exports and the decline in the intensive margin of imports are associated with a deterioration of the terms of trade. The expansion of the extensive margin of exports and the decline of the extensive margin of imports are now matched with an improvement of terms of trade.

Developing countries

Columns (5)-(8) of Table 4.2 presents our results for developing countries. In columns (5) and (6) the regression of the log change of terms of trade on the change in the trade balance to GDP ratio results in a negative, but statistically insignificant coefficient.

In columns (7) and (8) the log change of the terms of trade is regressed on the margins of trade flows. The coefficient on the log change of the extensive margin of exports is statistically significant and has a negative sign with both time effects and without them. A 1 percentage point increase in the extensive margin of exports results in 0.1 percentage point deterioration of the terms of trade. The coefficient on the log change of the intensive margin of exports is statistically insignificant and has a negative sign in both specifications of time fixed and no time fixed effects. The growth rate of the extensive margin of imports has a positive and statistically significant coefficient.

A 1 percentage point increase in the extensive margin of imports is associated with an improvement of the terms of trade by approximately 0.1 percentage points. The coefficient on the growth rate of the intensive margin of imports is statistically significant and has the expected positive sign. A 1 percentage point increase in the intensive margin of imports is associated with an improvement of the terms of trade by 0.2 percentage points in both specifications of the time fixed effects.

Thus the expansion of the intensive margin of exports and the decline in the intensive margin of imports is matched with a deterioration of the terms of trade. The expansion of the extensive margin of exports and the decline of the extensive margin of imports are also matched with a deteriorating terms of trade, at least in the short run.

In the next step we average the variables of interest over our sample period and run a cross-sectional regression in the sample of developing countries. Columns (3)-(4) of Table 4.3 present the results of the "medium run" regression. In column (3) the average log change of the terms of trade is regressed on the average change in the trade balance to GDP ratio only. The coefficient is negative and statistically insignificant. In the next specification we regress the average log change of the terms of trade on the margins of trade. The extensive margin of exports still caries a negative sign, and is statistically significant. A 1 percentage point growth rate of the extensive margin of exports is associated with 0.6 percentage point deterioration of the terms of trade. The intensive margin of imports has again a negative sign, and is statistically significant. The coefficient is equal to -0.3 implying a 1 percentage point increase in the extensive margin of exports is associated with a deterioration of the terms of trade by 0.3 percentage points. The extensive margin of imports still has a positive sign, but is statistically insignificant. The intensive margin of imports has a significant and positive coefficient equal to 0.22.

Thus the expansion of the intensive margin of exports and the decline in the intensive margin of imports are matched with a deterioration of the terms of trade. The expansion of the extensive margin of exports and the decline of the extensive margin of imports are also matched with a deteriorating terms of trade, even in the medium run.

4.5 Discussion

A well known fact is that an increase in the intensive margin of exports is associated with a deterioration of the terms of trade, while an increase in the intensive margin of imports is associated with an improvement of the terms of trade.[21] Using

[21] Acemoglu and Ventura (2002) have found this effect in a two stage regression. Epifani and Gancia (2006) extend the sample size relative to Acemoglu and Ventura (2002) until 2000. Their terms of trade regressions follow essentially the logic of Acemoglu and Ventura, and so does the result. It is worth

actual intensive margin, we have found this in both samples of industrial and developing countries.

In the sample of industrial countries we have found a positive and statistically significant coefficient on the extensive margin of imports. We also found this result in the sample of developing countries. In addition we have found that an increase in the extensive margin of exports results in a deterioration in the terms of trade in the sample of developing countries. What is less known is that an increase in the extensive margin of exports may result in a deterioration of the terms of trade.[22] We concentrate on the explanation of imports, keeping in mind that the results for exports are explainable along similar lines.

If the growth rate of the extensive margin of imports has a positive and statistically significant coefficient, this results is not at odds with theory, as one would expect. The sign of the coefficient on the extensive margin depends on the relative elasticities. If the elasticity of exports with respect to the extensive margin is greater that the elasticity of imports, then an increase in the extensive margin will result in a deterioration of the terms of trade.

The reason is the following. An increase in the extensive margin of imports results in an increase in the price of imports and a deterioration in the terms of trade, as domestic consumers love variety. But this increase in the extensive margin is matched with an increase in the income of the trading partners, who in turn increase their imports due to a higher income stream. The increase in foreign demand for domestic exports drives up the price of exports, improving the domestic terms of trade. The aggregate effect on the terms of trade depends on these competing two effects. In our case, the domestic price of exports increases more than the price of domestic imports and the terms of trade improve.

In the sample of industrial countries, the sign of the coefficient on the extensive margin of exports and imports changes when we look at medium run instead of short run, but becomes insignificant. This suggests that in the short and medium run the changes in the extensive margins of trade flows have different effects on the terms of trade. In the sample of developing countries no such difference is found between short and medium runs. We are not in a position to judge the long run consequences of the

noting that Gagnon (2005) used the same methodology but failed to get a negative coefficient on the relative GDP growth rates.

[22] Debaere and Lee (2002) relate the terms of trade to the domestically produced export goods relative to foreign import goods, market potential and the relative GDP per capita. The results of the regressions are more or less economically and statistically significant coefficients. Relative output has a negative sign, consistent with the intensive margin, while the market potential has a positive sign. Both GDP per capita and R&D, proxying the extensive margin, have a positive sign. The results are not directly comparable with ours because of: (i) differences in sample periods; (ii) right hand side variables, which are assumed to be proxies. In our case the variables of the margins proxy themselves.

adjustment for these countries as we do not have data for a long enough time period.

The small size of the bias in construction of the price indices, which is due to ignoring the extensive margin, can be explained with not long enough time periods as well. If the period in study was long enough, the extensive margin would have time to evolve more, and the possible bias could have been larger. On the other hand, new varieties tend to decrease the price index, while the disappearing varieties tend to increase the price index relative to the conventional one. At the aggregate level, those two effects partly cancel out, thus dampening the effect of the varieties on the aggregate price index.

Finally, the definition of varieties along our lines may not be capturing true varieties, and this could partly drive our results. Nevertheless, we believe that our methodology is a good departure point for the study of the terms of trade.

4.6 Conclusions

This paper contributes to the debate of the terms of trade empirically. First, using panel data technique and 6 digit HS1992 import data, we estimate a range of substitution elasticities to construct the terms of trade series corrected for varieties. The estimated elasticity of substitution between varieties is equal to 9, while the elasticity of substitution at the level of goods is equal to 3.

Second, we propose a decomposition strategy of trade flows into extensive and intensive margins. We find that ignoring the extensive margin in the construction of aggregate price indices results in an overestimation of the actual price index by 0.3 percentage points annually.

Third, we test how the terms of trade respond to changes in intensive and extensive margins. We find that an increase in the intensive margin of exports is associated with a deterioration of the terms of trade. We also find that an increase in the extensive margin of exports results in a deterioration of the terms of trade, at least in the short run.

The results can be used in constructing finely tuned models that would allow the elasticities of substitution to change between short, medium and long term. The paper also adds value to policy issues such as the expansion of a country's output along the extensive margin to escape adverse terms of trade effects. We have shown that in the short run these effects also exist.

4.7 References

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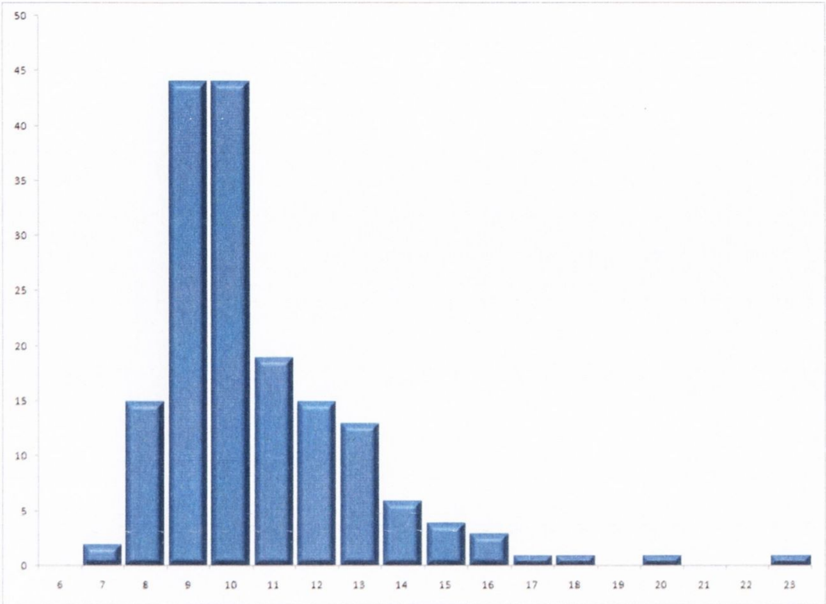
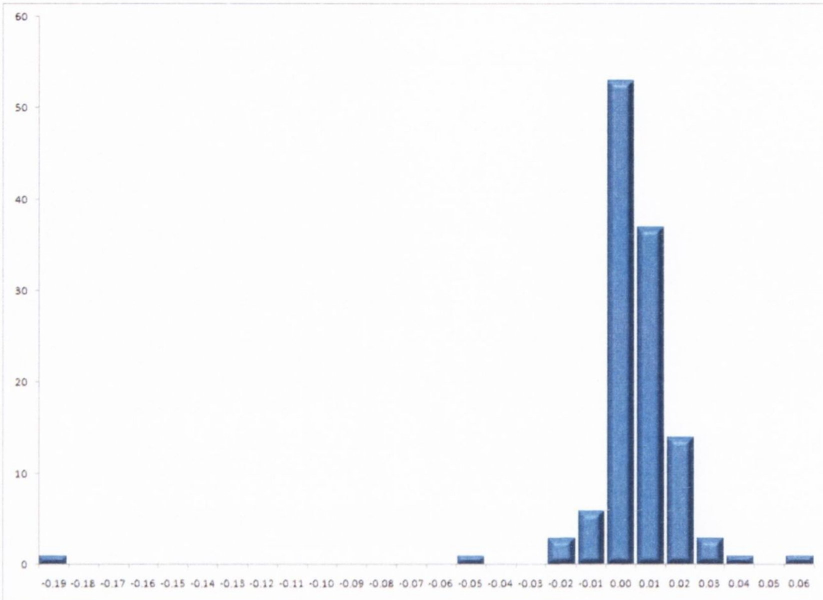
Figure 4.1: Elasticities

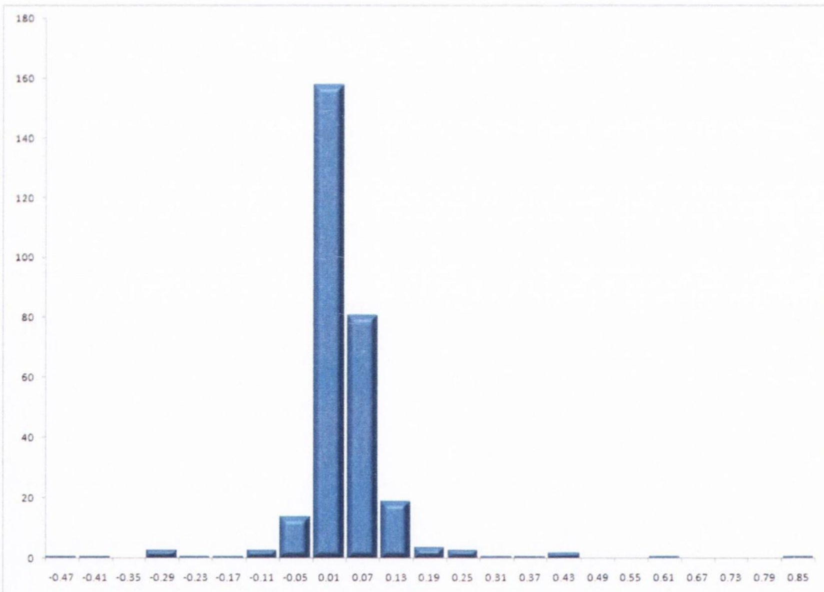


Note: Estimated using 6 digit HS1992 data. The estimation procedure is an extended version of Feenstra (1994) into panel context. The elasticities presented are those at three digit level.

Figure 4.2: Distribution of the rate of change of the extensive margin of exports, 2000-2004

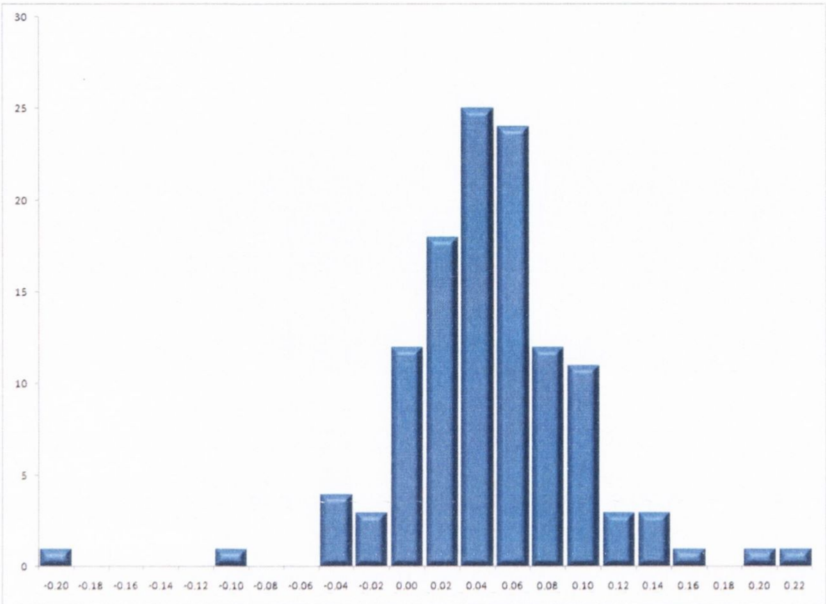


(a) Industrial countries

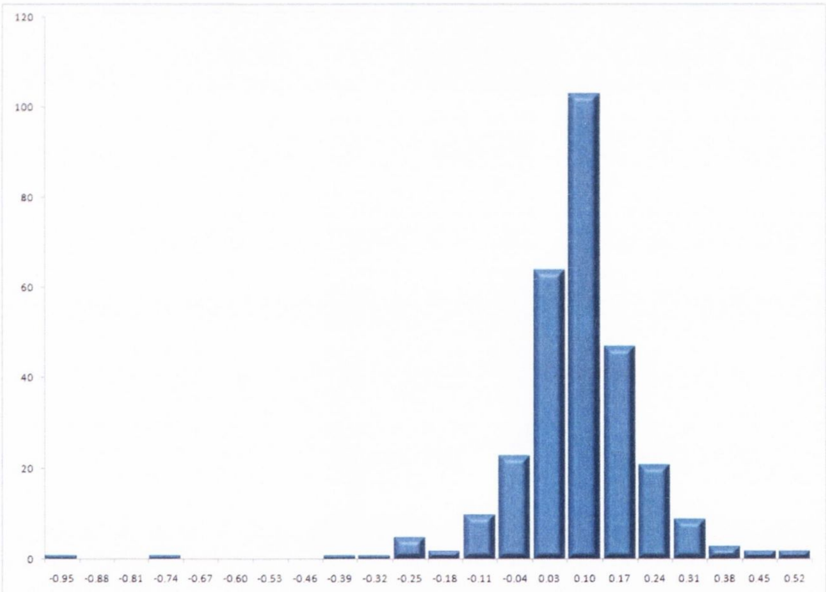


(b) Developing countries

Figure 4.3: Distribution of the rate of change of the intensive margin of exports, 2000-2004

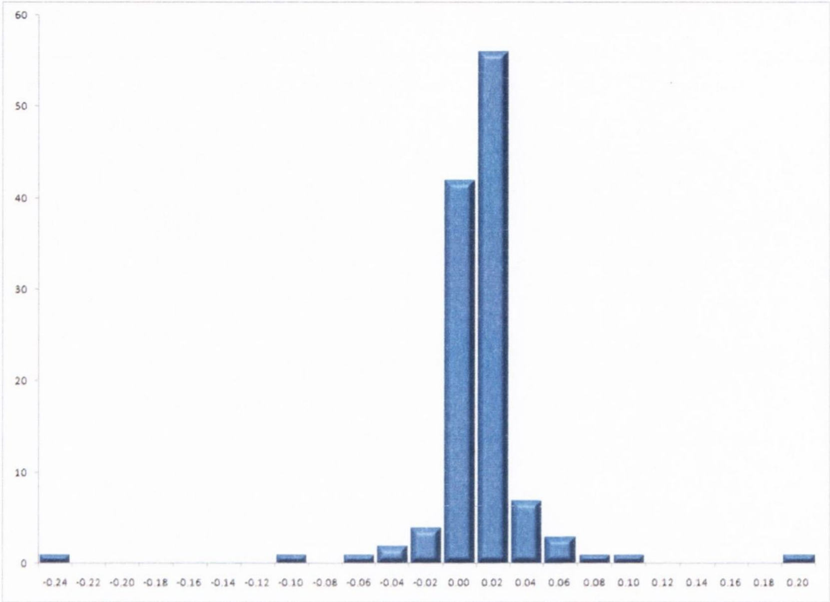


(a) Industrial countries

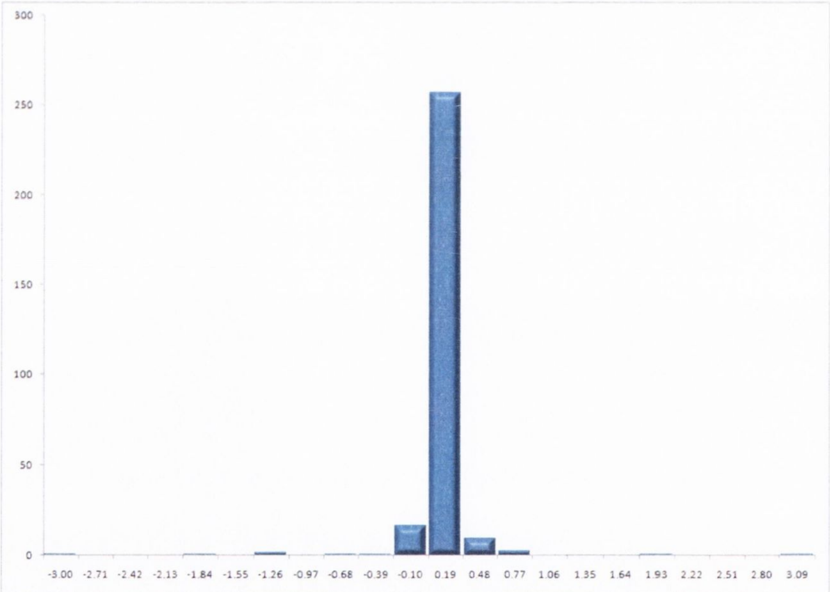


(b) Developing countries

Figure 4.4: Distribution of the rate of change of the extensive margin of imports, 2000-2004

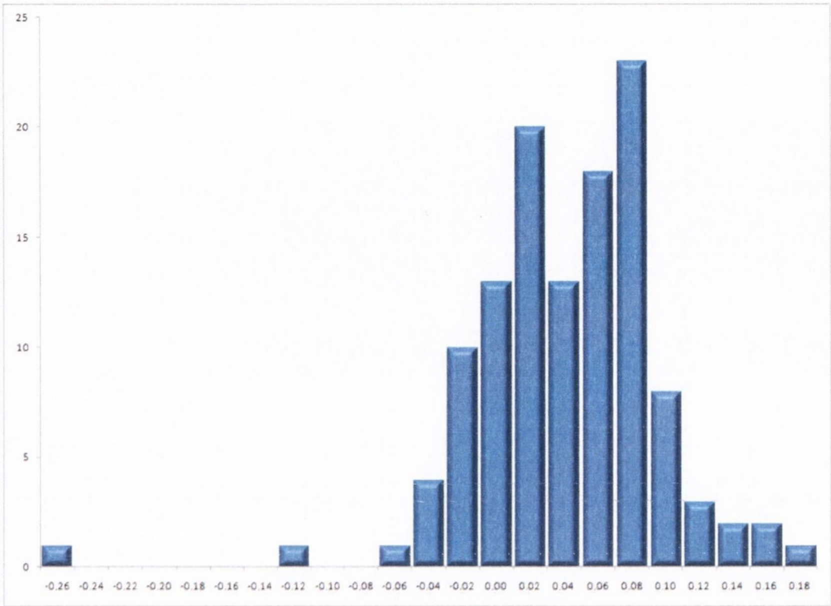


(a) Industrial countries

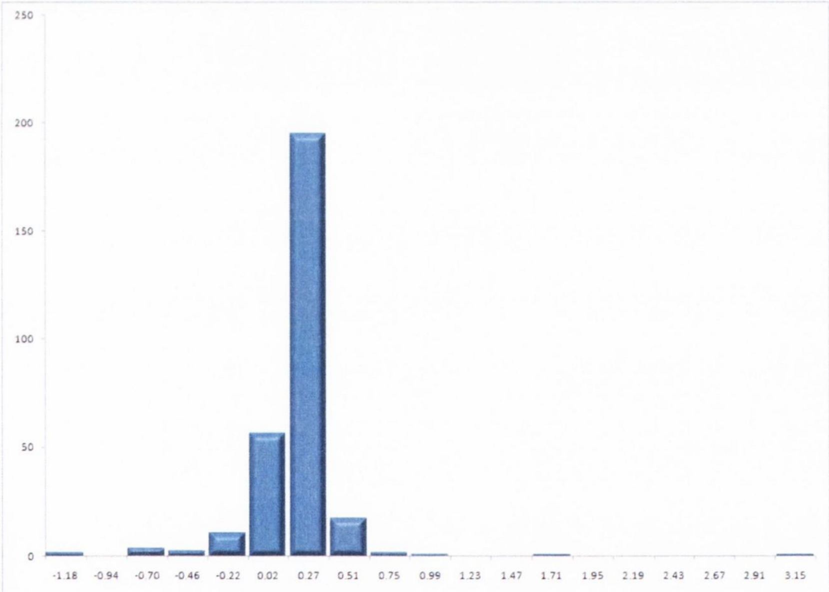


(b) Developing countries

Figure 4.5: Distribution of the rate of change of the intensive margin of imports, 2000-2004

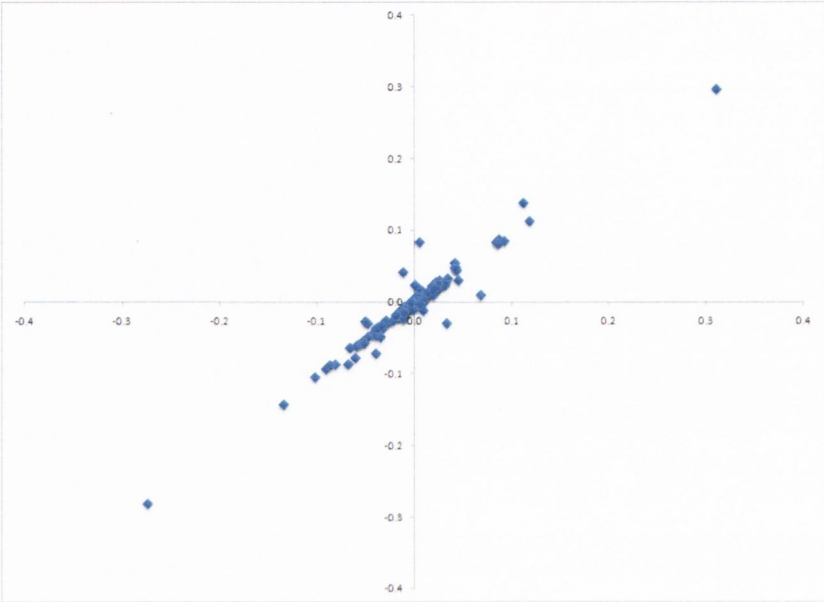


(a) Industrial countries

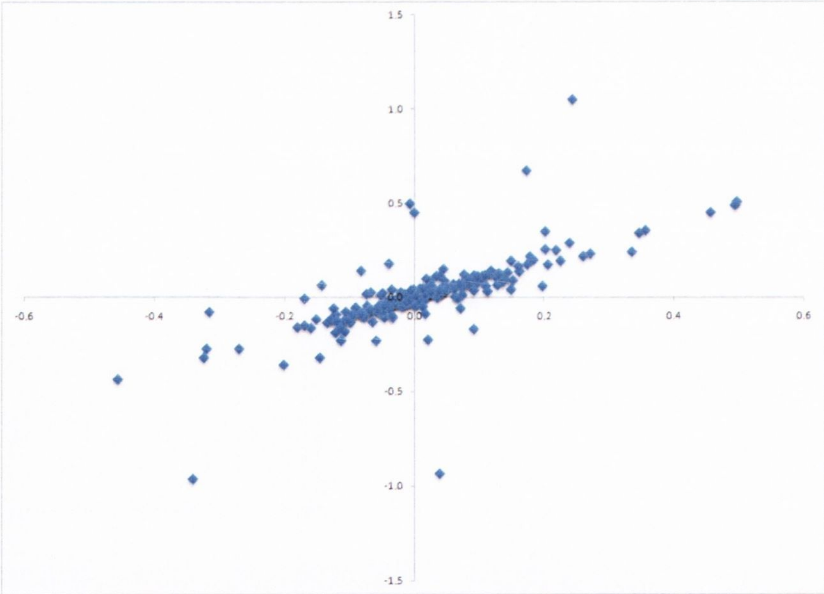


(b) Developing countries

Figure 4.6: Corrected versus conventional terms of trade, 2000-2004



(a) Industrial countries



(b) Developing countries

Table 4.1: Extensive margin, bias and the aggregated elasticity

	(1)	(2)	(3)	(4)
$\Delta \ln(\lambda_t^{imp})$	0.438			
	(0.006)***			
$\Delta \ln(\lambda_t^{exp})$		0.458		
		(0.010)***		
Δln(imp_ext)			-0.309	
			(0.003)***	
Δln(exp_ext)				-0.325
				(0.005)***
Implied aggregate elasticity	3.28	3.18		
Observations	430	430	430	430
Countries	86	86	86	86
R^2	0.93	0.85	0.97	0.93

Note: Estimated with fixed effects. Standard errors in parenthesis.
***,**,* significant at 1, 5 and 10 percent respectively.
In columns (1) and (3) the dependent variable is the log change of the difference between the corrected and conventional import price indices, while in columns (2) and (4) the dependent variable is the log change of the difference between the corrected and conventional export price indices.
The definitions of the variables are as follows: Δ indicates change relative to the previous period; $\ln(\lambda_t^{imp})$ is the log of 1 minus the ratio of the value of imports that is imported in two consecutive periods to the aggregate level imports; $\ln(\lambda_t^{exp})$ is the log of 1 minus the ratio of the value of exports that is exported in two consecutive periods to the aggregate level exports; ln(exp_ext) the log of the extensive margin of exports; ln(imp_ext) the log of the extensive margin of imports. Implied aggregate elasticity is computed as 1 plus the inverse of the coefficient on the $\Delta \ln(\lambda_t^{imp})$ or $\Delta \ln(\lambda_t^{exp})$.

Table 4.2: Fixed effects estimation of the terms of trade regression

Part A: Industrial countries	(1)	(2)	(3)	(4)
Δln(exp_ext)			-0.238	-0.234
			(0.240)	(0.242)
Δln(exp_int)			-0.286	-0.291
			(0.116)**	(0.132)**
Δln(imp_ext)			0.367	0.361
			(0.166)**	(0.167)**
Δln(imp_int)			0.284	0.339
			(0.101)***	(0.112)***
Δtby	-1.061	-1.103		
	(0.249)***	(0.253)***		
Time effect	no	yes	no	yes
Observations	120	120	120	120
Countries	24	24	24	24
R^2	0.16	0.19	0.14	0.17
Part B: Developing countries	**(5)**	**(6)**	**(7)**	**(8)**
Δln(exp_ext)			-0.108	-0.108
			(0.064)*	(0.064)*
Δln(exp_int)			-0.062	-0.076
			(0.046)	(0.047)
Δln(imp_ext)			0.056	0.055
			(0.024)**	(0.024)**
Δln(imp_int)			0.162	0.159
			(0.027)***	(0.027)***
Δtby	-0.057	-0.072		
	(0.047)	(0.047)		
Observations	310	310	310	310
Countries	62	62	62	62
R^2	0.01	0.04	0.16	0.18

Note: Estimated with fixed effects. Standard errors in parenthesis.
***,**,* significant at 1, 5 and 10 percent respectively.
The definitions of the variables are as follows: Δ indicates change relative to the previous period; ln(tot) is the log of the terms of trade; ln(exp_int) the log of the intensive margin of exports; ln(exp_ext) the log of the extensive margin of exports; ln(imp_int) the log of the intensive margin of imports; ln(imp_ext) the log of the extensive margin of imports; tby the ratio of the trade balance in constant 2000 USD to GDP in constant 2000 USD.

Table 4.3: Cross-sectional estimation of the terms of trade regression

	Industrial countries		**Developing countries**	
	(1)	**(2)**	**(3)**	**(4)**
Δln(exp_ext)		0.299		-0.627
		(0.762)		(0.196)***
Δln(exp_int)		-0.325		-0.251
		(0.186)*		(0.117)**
Δln(imp_ext)		-0.125		0.164
		(0.337)		(0.113)
Δln(imp_int)		0.179		0.221
		(0.253)		(0.094)**
Δtby	-1.198		-0.123	
	(0.408)***		(0.079)	
Observations	24	24	62	62
R^2	0.28	0.34	0.04	0.19

Note: Cross-sectional estimation with variables averaged over 2000-2004. Standard errors in parenthesis.
***,**,* significant at 1, 5 and 10 percent respectively.
The definitions of the variables are as follows: Δ indicates change relative to the previous period; ln(tot) is the log of the terms of trade; ln(exp_int) the log of the intensive margin of exports; ln(exp_ext) the log of the extensive margin of exports; ln(imp_int) the log of the intensive margin of imports; ln(imp_ext) the log of the extensive margin of imports; tby the ratio of the trade balance in constant 2000 USD to GDP in constant 2000 USD.

4.8 Appendix A: Data Description

The data used is 6 digit HS1992 from United Nation COMTRADE database and covers period of 1999-2004.

Because of measurement errors in the volumes, we drop observations where the ratio of unit value to its relative period is greater than 3 or smaller than 0.33.

Observation where the volume information is not available in the previous period but is available in the current period are dropped. This is done to eliminate false increase in the extensive margin.

Categories where there in two consecutive period there was no overlap of some varieties were dropped, since the methodology of Feenstra (1994) can not be applied.

4.9 Appendix B: Country List

In the construction of the price indices the countries in the list below are used. In the regression analysis Andorra, Faeroe Islands, French Polynesia are dropped due to missing GDP in 2000 USD data.

Industrial countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom, USA.

Developing countries: Albania, Andorra, Argentina, Azerbaijan, Belize, Bolivia, Bulgaria, Cameroon, China, Hong Kong, Macao, Colombia, Costa Rica, Cote d'Ivoire, Croatia, Czech Republic, Ecuador, El Salvador, Estonia, Faeroe Islands, French Polynesia, Gabon, Gambia, Georgia, Ghana, Grenada, Guatemala, Honduras, Hungary, India, Indonesia, Jamaica, Latvia, Lithuania, Madagascar, Malaysia, Maldives, Mali, Mauritius, Mexico, Morocco, Nicaragua, Niger, Paraguay, Peru, Philippines, Poland, Republic of Korea, Romania, Russian Federation, Saint Lucia, Singapore, Slovakia, Slovenia, TFYR of Macedonia, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Republic of Tanzania, Uruguay, Venezuela.

Chapter 5

General Conclusions

All three essay have one common factor: they address issues in international macroeconomics.

In the second chapter we look on the persistence of international capital flows. So far the existing literature on the persistence of capital flows has concentrated on either the estimates of half life, or constructions of marginal probabilities. To contribute to this literature, we study a wider range of capital flows using three possible approaches to understanding the persistence and the dynamics of the current account and main components of international capital flows.

The probabilistic approach shows, that, in general, deficits and net inflows are more persistent than surpluses and net outflows. This result is robust to either specification of pooled and individual probits. FDI are more persistent than portfolio investments in either state. The latter is more persistent than other investments category in either state. The persistence of the current account is larger than the persistence of the trade balance. Developing countries tend to have a higher persistence of deficits and net inflows than industrial countries. Current account reversals have a significant effect on transition probabilities, particularly in developing countries.

We developed further the non-parametric estimator, proposed by Dias and Marques (2005). The estimation results strongly support the results from probit estimations. The current account, trade balance, FDI, portfolio investments and other investments have a higher probability of remaining in the deficit state, than remaining in the surplus state. FDI is more persistent than the portfolio investments category, while the current account is more persistent than the trade balance in either the deficit or surplus state.

In the case of asymmetric autoregression, we find that surpluses are more persistent than deficits: although the probability of remaining in surplus is lower, the scale of surpluses tends to show more persistence from the scale of deficits.

In the third chapter we address the classical problem of transfer effect, and look at it through the prism of country size. We set up a simple two-country model with endogenous terms of trade and relative price of non-traded goods to study the relation between the real exchange rate, relative price of non-traded to traded goods, terms of trade, external imbalances and country size. The model predicts a positive relation between the absolute value of the sensitivity of relative prices to external imbalance and country size. In particular, trade surpluses are associated with deteriorating terms of trade and a declining relative price of non-traded goods, feeding into a depreciation of the real exchange rate. We find that these effects are stronger for larger countries.

At the empirical level, after controlling for relative productivity, we find a significant effect of external imbalances on relative prices. Estimation for G3 and non-G3 sub-samples reveals a systematic pattern in the sensitivity of relative prices to external imbalances, with the sensitivity being stronger in larger countries. These results, relevant to the speed and the smoothness of external adjustment, are important to both theoretical and policy issues dealing with relative prices and global imbalances.

Since empirical difference between sensitivities of large and small countries are larger than the differences in sensitivities generated by the model, a study of other mechanisms by which country size may affect the magnitude of the transfer effect could be necessary.

The fourth chapter of the thesis contributes to the debate of the terms of trade empirically. First, using panel data technique and 6 digit HS1992 import data, we estimate a range of substitution elasticities to construct the terms of trade series corrected for varieties. The estimated elasticity of substitution between varieties is equal to 9, while the elasticity of substitution at the level of goods is equal to 3.

Second, we propose a decomposition strategy of trade flows into extensive and intensive margins. We find that ignoring the extensive margin in the construction of aggregate price indices results in an overestimation of the actual price index by 0.3 percentage points annually.

Third, we test how the terms of trade respond to changes in intensive and extensive margins. We find that an increase in the intensive margin of exports is associated with a deterioration of the terms of trade. We also find that an increase in the extensive margin of exports results in a deterioration of the terms of trade, at least in the short run.

The results can be used in constructing finely tuned models that would allow the elasticities of substitution to change between short, medium and long term. The paper also adds value to policy issues such as the expansion of a country's output along the extensive margin to escape adverse terms of trade effects. We have shown that in the short run these effects also exist.