

UNIVERSITÀ DELLA CALABRIA

Scuola di Dottorato in Scienze Economiche e Aziendali
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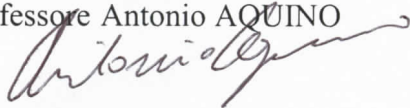
TESI DI DOTTORATO

**FOREIGN TRADE ELASTICITIES FOR
INDUSTRIAL COUNTRIES
1990-2012**

SECS-P/01

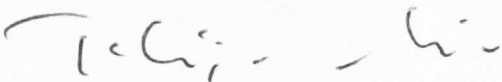
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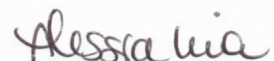
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FOREIGN TRADE ELASTICITIES FOR INDUSTRIAL COUNTRIES

1990-2012

Abstract

Global imbalances are a threat for the global economy and disorderly adjustments as well as errors in forecasting or in the interpretation of results can yield negative outcomes. Focusing on export price elasticities, I argue that the constant complaints about the underbidding behavior of some economies by their major trading partners can disclose further outcomes useful for the study of international interdependencies and trade patterns. Therefore, my main purpose is to provide an overall view of the previous research carried out on trade elasticity issues and to analyze the implications of global current account imbalances. For what concerns exports, price elasticities estimated in the previous literature feature a high variability with values that range from -0.14 to -3.13. Some of these results, in particular, can be considered controversial with respect to one side of the current debate and cause complexity in their interpretation. In order to accomplish the analysis, I apply a cointegration model in an error correction framework to estimate export elasticities covering the period from 1990 to 2012 for countries that represent both surplus and deficit sides of the current debate: Italy, Germany, France, USA, UK, Japan and China. Using these estimates, in combination with the prevalent macroeconomic forecasts related to the issue, I will illustrate how variations in exchange rates and in income can produce effects on exports with the provision of estimates of export price and income elasticities.

Sintesi

Gli squilibri nei pagamenti internazionali rappresentano una minaccia per l'economia globale. Le continue lamentele riguardo le politiche di deprezzamento adottate da alcune economie da parte dei loro maggiori partner commerciali possono lasciare intravedere ulteriori risultati utili per lo studio delle interdipendenze internazionali e per i sentieri di crescita del commercio. L'obiettivo principale di questo lavoro è fornire una visione complessiva delle ricerche svolte sulle problematiche riguardanti le elasticità del commercio internazionale, ed analizzarne le implicazioni per gli squilibri delle bilance commerciali. Per ciò che riguarda le esportazioni, le elasticità dei prezzi stimate nella letteratura presentano una forte variabilità con valori che variano da -0.14 a -3.13. Alcune di queste stime, in particolare, possono essere considerate controverse e sono complesse nella loro interpretazione. Per le stime è stato utilizzato un modello di cointegrazione nell'ambito del Meccanismo di Correzione dell'Errore per stimare le elasticità delle esportazioni per il periodo che va dal 1990 al 2012 per Paesi sia in surplus che in deficit di bilancia dei pagamenti: l'Italia, la Francia, la Germania, gli USA il Regno Unito, il Giappone e la Cina. Utilizzando queste stime illustrerò l'entità dell'impatto sulle esportazioni dei diversi paesi delle variazioni dei tassi di cambio.

CHAPTER 1

INTRODUCTION

1. PREFACE

One of the most important issues in applied International Economics is the effect on trade flows of changes in income and relative prices. The increasing interdependence among countries and their efforts to maximize benefits from international trade makes the import and export demand specifications essential not only for forecasts, planning and policy formulation but also for the quantification of welfare gains from trade (Hamori S., Yin F., 2011). The estimation of income and price elasticity of trade is consequently the heart of innumerable studies on the determinants of import and export demand models. Price elasticities are particularly important for estimating the effects of changes of relative prices on trade flows and for determining to which degree they adjust to these changes.

The “elasticities” approach of the econometric specifications has, in fact, always been used in international economics to determine the causes of trade just for its capacity both to explain the past and to forecast and, consequently, plan the future. The main elements of this model are the elasticity of demand for exports and imports with respect to economic activity, the elasticity of exports and imports with respect to relative prices, and the influence of other factors, including global supply and increased variety and interdependence. Export elasticities, in particular, are often used to show the relative flexibility of certain exporters when facing a loss of competitiveness while the price elasticity of imports reflects consumers’ fidelity to domestic or foreign goods.

All these reasons can only partially explain why the role played by trade elasticities is considered fundamental in translating economic analysis into policy-making.

Given the importance of the issue, economists are interested in understanding how it will evolve in the future and, above all, how empirical models will be useful in forecasting. How, again, empirical models and techniques can improve and overcome some of the fallacies of the past.

The high variability of trade elasticities estimates suggests that there are still gaps in this research area. The aim of this work is to contribute to identify potential explanations for the differences reported in the estimates of these elasticities.

After providing a summarized overall view of the previous research carried out on this topic and illustrating the main issues related to it, I will implement a suitable research activity in order to contribute to the existing literature.

2. OBJECTIVES AND CONTRIBUTIONS OF THE PRESENT STUDY

In spite of the over 50 years of analyses, the estimation of price and income trade elasticities in the international scenario is still an open and highly significant empirical subject; perhaps, this interest can be addressed, among other factors, to questions that do not achieve a total concurrence of results:

- do exports actually expand after depreciations? If so, by how much?
- can exchange rates alone represent a feasible policy to improve the trade balance?
- how important are factors such as the development status of the traders and the different trade patterns?

Price elasticities estimation is one of the most important, controversial and intriguing topics in International trade. The importance and the interest of the issue lies on the fact that performance of the different kind of exchange rate policies and systems depends on the results of these estimations. The topic is controversial because the estimated price elasticities are extremely contrasting not only between one another but also with the concrete experience of many countries like Germany. It is true that countries like the USA and Germany both push other countries (i.e., China) to appreciate their currencies but, while the USA are facing deficit issues, Germany cannot say as well: its export market share has increased in recent years, especially towards Asia, although the financial crisis and although it represents one of the major import countries from China¹.

Something in this context does not figure: or the complaints of the major exporters are without basis, meaning that any sort of exchange rate manipulation is nearly worthless (i.e., exports are not so sensitive to movements in exchange rates at least at an aggregate level) or the low elasticities reported by the literature are, for some reason, inexact. In this perspective,

¹ *Deutsche Bundesbank, OECD, National Accounts database, www.oecd.org.*

it would be useful to estimate export elasticities using appropriate techniques and compare the findings with those of the previous literature.

The motivation for this research is, therefore, explained by the extremely important consequences of trade elasticity estimates and practically began after reading several articles (and the related issues and studies) on the global imbalances and on how (massive) exports are habitually seen as the key for realignments in the international scenarios. The studies were all very interesting from an economic and applicative perspective and, in particular, the undervalued currencies of some countries, like China, seemed to drive to a much larger literature than that which exists, in spite of their appeal to local exporters and policy-makers. This represents the starting point and inspiration of the study: the estimation of trade elasticities. During the course of the study, an increasing focus on export functions occurred and, in particular, export price elasticities: these are the objects of the present analysis.

On the one hand, from an economic point of view, the constant complaints about the underbidding behavior of these undervalued economies by their major trading partners could have been seen, indeed, as a signal and could have disclosed further outcomes useful for the study of international interdependencies and trade patterns.

On the other hand, from an empirical point of view, both research articles and reference texts provided alternative methods for deciding on the model structure and this was also a challenging aspect: the over fifty years of econometric development in time series analyses offer different milestones for the building of an appropriate model. Indeed, despite the immense literature, and perhaps, as a consequence of this, there are different approaches all equally justified, probably correct and dimly liable to objection. The drawback is a lack of uniformity not only in the models applied but even in the results of the estimations. This leads to another important consideration: due to the highly relevant use of trade elasticities, if the results of the estimation vary through sample periods, methods and models, there is the need for a continual re-estimation.

In an attempt to address all the above mentioned issues, it was decided to undertake this analysis which it was hoped would contribute to the existent literature.

The analysis required an extensive literature review in different directions. The primary direction was to identify all the problems that arise when dealing with trade elasticities.

Clarifying the present debate on the role of trade elasticities in the international market and if/how it can provide improvements in deficit countries is the direct extension of the first direction.

The final direction was to identify suitable techniques. In order to do so, over fifty years of time series econometric sophistication have been reviewed.

The objectives of this research are to:

- review trade elasticity literature both from a theoretical and an empirical perspective;
- identify contradictions and/or discrepancies in the estimates of export price elasticities in the published literature in a comparative framework and for chosen countries;
- describe and justify an appropriate model within a cointegration framework approach;
- summarize, interpret and discuss the elicited results and the techniques used for the estimation.

This research contributes to the body of knowledge by:

- summarizing the literature on export elasticities by describing the most established approaches ;
- estimating export price elasticities for seven countries over the period 1990-2012;
- identifying possible contradictions between the low aggregate export price elasticities and the widespread belief that the only way to increase exports and, thus, improve the trade balance is through exchange rate operations;
- providing a comparative framework of analyses.

3. OUTLINE OF THE RESEARCH

The present research addresses the export elasticity estimation and, in particular, the emphasis of this study is the estimation of export price elasticities within a Vector Error Correction Mechanism (VECM) framework. These models have been used extensively in empirical studies over the last decade and theoretical improvements are continuously being added to the literature. A more detailed description of VECMs will be carried out in Chapter 3.

Chapter 2 introduces a literature review that is organized by listing the different economic and, especially, econometric approaches to the estimation of international trade elasticities. This chapter provides a discussion of some of the issues involved in the estimation of the price elasticities of the demand for exports (and imports) according to the existing literature

and its evolution over the years and some selected estimates. This is required in order to provide a general and detailed (although not exhaustive) outlook of the body of work.

Chapter 3 outlines the methodology and the model used in this study. Export price and income elasticities will be estimated for the *G6* countries (namely: Italy, France, Germany, UK, USA, Japan) and for one of the BRICS, i.e., China, for a period that covers the last two decades.

The effort is to accomplish a comparative setting of results useful for an extensive observation and comprehension of the different outcomes. The comparative setting pertains to the entire development of the study.

The discussion and the interpretation of the results as well as the conclusions of this study are presented in the final sections of this chapter.

Figure 3 briefly illustrates the research outline:

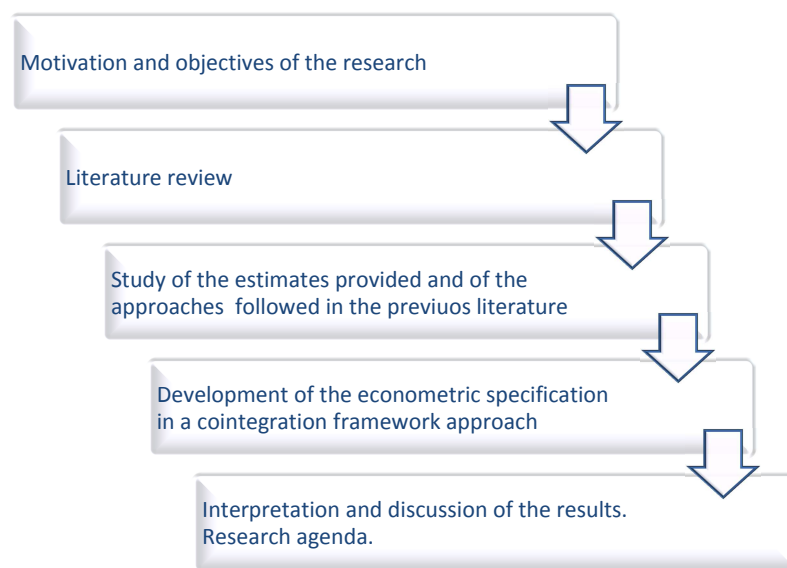


Figure 1.3. Research outline

CHAPTER 2

LITERATURE REVIEW

1. INTRODUCTION

The purpose of this section is twofold:

- to provide an overview of the previous empirical literature within the international trade elasticities context;
- to act as a gateway to the methodology and the econometric specification applied in the present analysis.

Some preliminary remarks are necessary before starting.

First of all, in order to provide a fluent overview of the literature, it was decided to analyze the different studies proceeding by the main empirical and theoretical approaches followed and not by a chronological sequence: the existing literature, in fact, is very extensive - covering a period of over fifty years - and arranging the numerous researches by date would have made it very complicated to offer a general and overall outlook of the issue. In addition, taking into account the results of earlier empirical studies – equally important – an emphasis was reserved on the empirical contributions of the recent years.

Secondly, the econometric sophistication of time series goes hand in hand with the development of the international trade elasticities theories. For this reason, they are treated together.

Finally, this section is not to be considered exhaustive in including all the methodologies and cases studied up to now but rather it has to be read as a detailed summary which is intended to provide a background to the recent economic developments in times series econometrics and, in particular, in the estimation of international trade elasticities.

2. INTERNATIONAL TRADE ELASTICITIES: CONCEPT AND DEFINITION

Trade elasticities measure the responsiveness of demand or supply to changes in income, prices or other variables. The two main elasticities are the income elasticity and the price elasticity of demand. The income elasticity measures the percentage change in the quantity

demanded resulting from a one-percent increase in income with E = elasticity, Q = quantity demanded, I = income and P= relative price (H. Escaith, N. Lindenberg, S. Miroudot, 2010):

$$E_I = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta I}{I}} = \frac{I}{Q} * \frac{\Delta Q}{\Delta I}$$

The price elasticity measures the percentage change in the quantity demanded resulting from a one-percent increase in relative price:

$$E_P = \frac{\frac{\Delta Q}{Q}}{\frac{\Delta P}{P}} = \frac{P}{Q} * \frac{\Delta Q}{\Delta P}$$

2.1 The historical background

The estimation of trade elasticities has a very long history from both a theoretical and an empirical point of view. It is nonetheless firm that few papers cover all the issues raised in the econometric literature (Sawyer W. C., Sprinkle R. L, 1996).

2.1.1 *The theoretical literature*

The forerunner of the great amount of research concerning the estimation of trade elasticities is Orcutt (1950). Beginning with his paper, the large body of literature in this field has involved issues referring not only to how the elasticities are used and how they are determined but also to the development of the econometric specifications. These papers were first surveyed by Stern *et al.* (1976) and Goldstein and Khan (1985) and, since the 1970s, the literature has continuously evolved, entailing different issues related to trade elasticities.

The theoretical model underlying the estimation of trade elasticities is an imperfect substitutes model, that is, a model in which it is assumed that exports and imports are imperfect substitutes for domestically produced goods. Goldstein and Khan (1985) provide a detailed discussion of this model. In an imperfect substitutes model, the foreign demand for goods and services is determined by three main factors: foreign income, the prices of domestic goods

and services, and the prices of goods and services that compete with domestic goods and services in the foreign market. Similarly, the domestic demand for foreign goods and services is determined by the country's income, the prices of foreign goods and services, and the prices of goods and services that compete with foreign goods and services in the domestic market.

The income elasticity of demand for imports measures to what extent changes in an importing country's income have an effect on changes in its imports. In the same way, the income elasticity of demand for exports measures to what extent changes in foreign countries' incomes affect the exporting country's exports.

Usually import and export elasticities with respect to income are positive, that is: an increase in a country's income leads it to buy more from foreign countries.

An income elasticity of imports or exports that is equal to one implies that imports or exports increase at the same rate as income.

Divergences from this imply long-term imbalances in the global economy. Specifically, an income elasticity for imports greater than one implies that, at the margin, domestic consumers have a stronger preference for foreign goods than for domestic goods. This means that if prices do not adjust, imports increase more than proportionately to income growth. This case is particularly meaningful for countries that, on an international scale, experience a higher income growth rate (nota: emerging economies) since, compared to others, these countries will be encouraged to develop their demand of imports and this may possibly outweigh their exports: specifically, in many East Asian economies in which most of imports are used for re-exports, an increase in exports may entail, to some extent, a similar increase of imports. As a matter of fact, many of the imports into these countries are parts and components or capital goods that are used to assemble goods for re-export to the rest of the world. An exchange rate appreciation that reduces exports will also reduce the demand for imported goods that are used to produce exports (Thorbecke, 2010).

On the other hand, economic theory predicts that the volume of imported goods will decrease, while the volume of exported goods will increase, when the relative prices of a country's products decline, i. e. when its real exchange rate depreciates. The problem is: what happens to the value of exports and imports as a consequence of a country's real exchange rate depreciation? The answer depends upon the size of price elasticities of exports and imports.

2.1.2 The empirical model

The empirical literature goes back to at least Kreinin (1967) or Houthakker and Magee (1969) followed by Khan (1974), (1975), Goldstein and Khan (1976), (1978), Wilson and Takacs (1979), Warner and Kreinin (1983), Haynes and Stone (1983), Bahmani-Oskooee (1986), Marquez (1990) and Mah (1993). This plethora of studies of the past have all estimated trade elasticities using the OLS, 2SLS method or Instrumental Variables methods. (M Bahmani-Oskooee, F. Niroomand, 1998).

It is indisputable that the empirical literature on trade elasticities is vast and that most of the attention is addressed to the forecasting properties of the estimates. Most econometric estimations indicate that price elasticities fall in a range of 0 to -4.0 , while income elasticities fall between 0.17 and 4.5². Since the values of price elasticities vary considerably, the recent literature questions the effectiveness of real devaluation in affecting exports and imports. According to Rose (1990, 1991) and Ostry and Rose (1992), a real depreciation does not impact significantly on the trade balance; Reinhart (1995), Senhadji and Montenegro (1998), Senhadji and Montenegro (1999) provide instead, strong support to the view that depreciations improve the trade balance. It seems that low econometric estimates of price elasticities are unreliable for the purpose of forecasting the effect of a depreciation, and there is a strong presumption that these elasticities lead to a considerable underestimation of its effectiveness (Algieri B., 2004).

Modeling the time series behavior of imports and exports is an longstanding issue of economists as well as of econometricians; well along with their research, their main questions concern:

- the *type* of traded commodity, that is, if it is a homogeneous or a differentiated good;
- the *main purpose* to which the traded good is designed for, that is, if it is used as a factor of production or as a final product;
- the *institutional or legal structure* of the environment in which the trade takes place;
- the *aim* of the modeling analysis, or better, if the intention is to forecast or to test hypotheses;
- the *typology of data available*, that is, if data are annual, quarterly, monthly, etc.;

² Algieri B., (2004), *Price and Income Elasticities of Russian Exports*, The European Journal of Comparative Economics, Vol. 1, n. 2, 2004, pp. 175-193.

- the level of aggregation, that is, if the data are aggregated or disaggregated (and the entity of the disaggregation).

The appropriate model, indeed, relies on all the above mentioned factors.

2.1.3 The Imperfect Substitutes Model

Since the amount of export (and import) adjustments depends on the sensitivity to price and income variations, it is important to estimate the price and income elasticity of a country's exports. The theoretical basis of the empirical analysis is the Imperfect Substitutes Model. The basic assumption of the model is that neither exports nor imports are perfect substitutes for domestic products. Such a hypothesis is confirmed by empirical evidence. If domestic and foreign goods were perfect substitutes, a given country would be either an exporter or an importer. Since the world market is characterised by the presence of bilateral trade and the coexistence between imports and domestic production, the hypothesis of perfect substitution can be rejected (Algieri, 2004).

Moreover, a large body of empirical studies (Kravis and Lipsey (1978); Kravis and Lipsey) have shown that price differentials can be surprisingly large for the same product in different countries, as well as between the domestic and export prices of a given product in the same country. In other words, the *law of one price* (LOP) fails dramatically in practice, even for products that are usually traded in international markets. The LOP states that prices in different parts of the world for a given product should be the same when expressed in a common currency. All this said, the finite price elasticities of demand and supply that the imperfect substitutes models postulates can, therefore, be estimated for traded goods.

The imperfect substitutes model³ (Goldstein, Khan 1985; Hooper and Marquez, 1995) of the home country's exports to, and imports from, the rest of the world (*) is formalized by a set of equations:

$$M^d = \gamma (Y, P^M, P) \quad \gamma_1, \gamma_3 > 0, \gamma_2 < 0 \quad (1)$$

$$X^d = \pi(Y^* e, P^X, P^*e) \quad \pi_1, \pi_3 > 0, \pi_2 < 0 \quad (2)$$

$$M^s = \varphi[P^{M^*} (1+S^*), P^*] \quad \varphi_1 > 0, \varphi_2 < 0 \quad (3)$$

³ The model described is the faithful copy of what quoted in Goldstein, M., Khan, M. S. (1985), Income and price effects in foreign trade, in: Jones R. W., Kenen P. B. Handbook of International Economics, Amsterdam, North Holland (1985), pp. 1042-1099.

$$X^s = \xi[P^X (1+S), P] \quad \xi_1 > 0, \xi_2 < 0 \quad (4)$$

$$P^M = P^{X*} (1+T)e \quad (5)$$

$$P^{M*} = P^X (1+T^*)/e \quad (6)$$

$$M^d = M^s e \quad (7)$$

$$X^d = X^s \quad (8)$$

The eight equations identify the quantities of imports demanded by the home country (M^d), the quantity of exports demanded by the world from the home country (X^d), the quantity of imports supplied by the rest of the world to the home country (M^s), the quantity of the home country exports to the rest of the world (X^s), the prices in domestic currency paid by the importers (P^M and P^{M*}) and the prices in domestic currency paid to the exporters (P^X and P^{X*}). The level of nominal income (Y, Y^*), the prices of domestic commodities produced within the regions (P, P^*), proportional tariffs (T, T^*), subsidies to imports and exports (S, S^*) and the real exchange rates (e) are the explanatory variables.

Foreign demand for goods and services is determined by three main factors: foreign income, the prices of domestic goods and services, and the prices of goods and services that compete with domestic goods and services in the foreign market.

Similarly, the domestic demand for foreign goods and services is determined by the country's income, the prices of foreign goods and services, and the prices of goods and services that compete with foreign goods and services in the domestic market.

In the imperfect substitutes model the demand functions for exports and imports describe the quantity demanded as a function of the level of monetary income in the importing country, the imported product's own price, and the price of domestic substitutes. By considering a logarithmic utility function, the income (γ_1 and π_1) and price elasticity (γ_3 and π_3) of substitutes are assumed to be positive, while the price elasticity of the traded product is assumed to be negative (γ_2 and π_2).

Let us assume the demand function to be homogeneous of degree 0, equation 1 can be written in the following way:

$$M^d = \gamma (Y/P, PM/P) \quad \gamma'_1 > 0, \gamma'_2 < 0$$

where

Y/P = real income

and

PM/P = real import price

Considering an n-country model, the symmetry between the demand function for imports and the demand function for exports vanishes. Imports compete, in fact, only with goods produced within the country. Exports compete both with goods produced in the imported country and with exported goods by third countries. The equation 2 is corrected with prices of competing goods.

X^d / X^*

$$d = \pi (P^* X^d / P^* X^{*d})$$

where X^{*d} is the demand for exports to the rest of the world from third countries.

The supply functions depend on the prices of exported and domestic goods and on subsidies. The price elasticities of exported and local commodities (φ_1 and ξ_1) are assumed to be positive, the price elasticities of substitutes (φ_2 and ξ_2) are supposed to be negative. The equilibrium conditions are represented by the last two equations. The implicit hypothesis is that prices move in order to equate demand and supply over time.

The imperfect substitutes model, by presenting both demand and supply side equations, allows to identify simultaneous relationships among quantities and prices. Orcutt (1950) and Goldstein and Kahn (1985), have highlighted this characteristic but, nonetheless, a multitude of time series works on export and import equations have considered the supply side only by assumption.

In the early 1990s, the standard methodology to estimate import (Eq. 1) and export demand (Eq. 2) was based on the assumption of an infinite supply-price elasticity for imports and exports (φ_1 in Eq. (3) and ξ_1 in Eq. (4)). Under this hypothesis, PM and PX were viewed as exogenous and thus estimated by single equations.⁴

⁴ If the supply elasticities were instead, less than infinite, the problem would be more difficult because one should either calculate the complete structural system of simultaneous equations or solve the reduced form for quantities and prices as functions of the exogenous variables in the system (Algieri, 2004).

Since the late 1990s, economic researchers have improved more and more their approach to the analysis and have applied cointegration analyses or Fully-Modified-OLS methodologies to deal with simultaneity problems and to overcome endogeneity and serial correlation biases.

According to the literature examined in this study, therefore, the basic linear specifications for the export (2.1) demand function⁵ can be expressed as follows:

$$\text{Log } X_t = a + b \text{Log } (PX/PXW)_t + c \text{Log } Y_t + \varepsilon_t \quad (2.1)$$

Where X_t = volume of exports, PX_t = export prices, PXW_t = world export price level, Y_t = world income and ε is an error term. The price elasticity is given by b^6 .

A complete model will include other explanatory variables affecting demand besides income and prices. Houthakker and Magee (1969), for example, include control variables for domestic or world GDP, to estimate the income elasticity of imports. Recently, Algieri (2011) included an unobserved component (UC) to model the export equation⁷.

2.1.4 The development of time series econometrics

Since the 1970s, the empirical literature evolved as a consequence of the rapid development of times series econometrics and of the need to consider the idea that trade flows do not respond instantly to changes in relative prices (and also in income and exchange rates). New theoretical and technical outcomes led to a vast number of papers beginning with Stern et al. (1976). Starting from the 1990s until today, the cointegration analysis and all the concepts related to it have become an important frame model.

As a result, the early specifications have experienced over fifty years of econometric sophistication, surveyed in Marquez (Marquez, 2002). In the last years, namely, Marquez (2002) or Kwack et al (2007) report some estimates for 8 Asian economies, including Hong Kong, the Philippines, whereas Cheung *et al.* (2009) estimate Chinese trade elasticities. The *new* models:

⁵ The import demand function is: $\text{Log } M_t = a + b \text{Log } (PM/PD)_t + c \text{Log } Y_t + \varepsilon_t$ where M_t = volume of imports, PM_t = import prices, PD_t = domestic price level, Y_t = domestic income. The price elasticity is given by b .

⁶ The income elasticity is given by c .

⁷ Algieri B. (2011), *Modelling export equations using an unobserved component model: the case of the Euro Area and its competitors*, *Empirical Economics*, 2011, Vol. 41, n. 3, pp. 593-637.

- include differences between short and long run elasticities;
- ponder the importance of heterogeneity between traded goods;
- study the stability of trade relationships;
- cope with endogeneity issues.

In particular, most of the researchers have tried to reduce endogeneity and this attempt is clear in all this recent (and vast) empirical literature. The effort consists mainly in introducing simultaneous equations and cointegration analysis. The main notion behind the cointegration analysis is that if a linear combination of a set of nonstationary variables (such as those in the import demand model) is stationary, those variables are said to be cointegrated. Indeed, recent developments in econometric literature have shown the non-stationarity of most macro data and this substantially invalidates the OLS, 2SLS and Instrumental Variable techniques results⁸. The Johansen (1988) Johansen – Juselius cointegration approach (1990) and the Engle – Granger (1987) two step approach have been used more and more to reveal the existence of long-run relationships and, in addition, produce empirical results that are not spurious (Marquez, 1990; Gagnon, 2003; Hooper, Johnson and Marquez, 1998); J.S. Mah, 2000).

2.1.5 Relative prices and exchange rates: a complete pass-through

Thus far, enunciating the classical model provided by the literature, relative prices have always been mentioned as one of the most important variables of the export demand function. At this point, the question that could arise is how relative prices link to exchange rates and why recent models include real exchange rates rather than including (directly) relative prices of exported goods.

A last question to examine when talking about the export concerns, therefore, the relative prices. The main assumption made in this study (and according to the literature) is that there is a complete pass-through between relative prices and real exchange rates: that is, exchange rate fluctuations translate into proportional movements in the domestic price level and, therefore, pass-through is equal to one; this simplification offers the opportunity to gauge the price elasticity estimates using the real effective exchange rates without taking into account

⁸When data are nonstationary, inferences based on the standard techniques are no longer valid because they suffer from the “spurious regression” problem, see M Bahmani-Oskooee, F. Niroomand, (1998).

other factors that can determine divergent fluctuations and, most of all, without invalidating the estimates.

Exchange rate pass-through literature takes its roots from the aforementioned LOP and the Purchasing Power Parity (PPP) literature⁹. According to Anaya (2000), when using a 20-year time period, pass-through estimates for most countries are close to one supporting a long-term stable relationship. This kind of relation fits closely the purposes of the present study and, for this reason, the variable actually included in the model will be the real effective exchange rates.

3. ESTIMATING TRADE ELASTICITIES

The following sections survey some of the approaches used in the estimation of time series variables. The discussion of each topic will be illustrated by examples and empirical analyses of selected references.

3.1 Distributed-Lag and Autoregressive Models approach

The estimation of price elasticities is a fundamental part of the econometric analysis of long-run relations. This category of analysis has been the focus of much theoretical and empirical research in economics. Where the variables in the long-run relation of interest are trend stationary, the general practice has been to de-trend the series and to model the de-trended series as stationary distributed lag or autoregressive distributed lag (ARDL) models.

In this section, after a brief illustration of the theoretical issues underlying the distributed-lag and the autoregressive models, the literature overview will examine how the study of trade elasticities of demand has been treated over the years through empirical contributions.

3.1.1 Modelling time lapses and long-run relations

Time series data entail a variety of issues related to the fact that the regression model includes not only the current value but also the past values of the variables. The lapse of time between a cause and its effect is called a *lag*. The lag may be a specific time (e.g., three months, one year, etc.) but, in many cases, the effects of an economic cause are spread over many months, or even many years. In such cases, we have a *distributed lag*.

⁹ According to Anaya (2000), the Relative PPP (a weak version of the strong PPP) basically implies that the exchange rate and domestic and foreign price levels move proportionately to each other. Namely, strong version of PPP implies that $p_t = e_t p_t^*$ while the relative PPP implies $p_t = \alpha e_t p_t^*$ where α is the real exchange rate or alternatively, is the home currency price level as a percentage of foreign.

Lags occupy a central role in economics, principally when dealing with aggregate data.

When the model includes past values of the regressors (explanatory variables indicated by the X 's), these past values are called *lagged* values and, therefore, the regression analysis is called *distributed-lag model*.

Furthermore, the dynamic behaviour of an economy can reveal itself through a dependence of the current value of an economic variable on its own past values.

When the model includes past values of the dependent variable (Y) among the explanatory variables, it is called an *autoregressive model (AR)*.

We can present a general distributed-lag model with a finite lag of k time periods as:

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \dots + \beta_k X_{t-k} + u_t \quad (2.2)$$

The coefficient β_0 is known as the short-run multiplier because it gives the change in the mean value of Y following the unit change in the X in the same time period. The coefficients β technically can be expressed as the partial derivatives of Y with respect to the X 's¹⁰:

$$\frac{\partial Y_t}{\partial X_{t-k}} = \beta_k$$

In this model, after k periods¹¹, we obtain the long-run (or distributed-lag) multiplier:

$$\sum_{i=0}^k \beta_i = \beta_0 + \beta_1 + \beta_2 + \dots + \beta_k = \beta .$$

The autoregressive model, instead, is expressed as:

$$Y_t = \alpha + \beta X_t + \gamma Y_{t-1} + u_t \quad (2.3)$$

The autoregressive model actually describes the time path of the dependent variable in relation to its past values and for this reason it is properly known as a *dynamic model*.

We have to consider that the real world presents a mixture of short-run and long-run adjustments and that these adjustment times are necessary for the dependent variable (in our case, the export/import volumes) to respond to variations in the explanatory variables (relative

¹⁰ β_0 is the partial derivative of Y with respect to X_t , β_1 with respect to X_{t-1} , β_2 with respect to X_{t-2} , and so forth.

¹¹ In the model [2.2], if the explanatory (input) variable X undergoes a one-off unit change (impulse) in some period t , then the immediate impact on Y is given by β_0 ; β_1 is the impact on Y after one period, β_2 is the impact after two periods, and so on. The final impact on Y is β_k and it takes place after k periods. Hence, it takes k periods for the full effects of the impulse to be realized. The sequence of coefficients ($\beta_0, \beta_1, \beta_2, \dots, \beta_k$) constitutes the impulse response function of the mapping from X_t to Y_t .

prices and income). The fact that the dependence of a dependent variable Y on other variables (the X 's) is rarely instantaneous implies that any kind of analysis that involves time series data needs to consider such lapse of time (the so called *lag*). Very more often, indeed, the effect of a given cause is distributed over a certain period of years. Obviously, for this reason, a closer attention should be paid to the factors which account for distributed lag relationships in order to comprehend the economic theory underlying the nature of the lags and why they occur, first of all.

Generally, there are three main reasons¹² that are used to explain why lags occur:

1. *psychological reasons*, under which we include forces of habit and assumptions on the part of consumers that changes may be only temporary;
2. *technological reasons*, which include factors such as, in a general case, the lack of knowledge about possible substitutes¹³;
3. *institutional reasons*, which include situations in which certain contractual items of expenditure or savings may need to be adjusted before shifts can be made in consumption patterns.

In addition, it is clear that the lapse in reactions can depend on the nature of the variation, that is, if the change is permanent or transitory.

3.1.2 The ARDL model

As above mentioned, another important case is when we find a dependence of the current value of an economic variable on its own past values. Precisely, models of how decision/policy makers' expectations are formed, and how they respond to changes in the economy, result in the value of Y_t depending on lagged Y 's. So, an alternative way to capture the dynamic component of economic behaviour is to include lagged values of the dependent variable on the right-hand side of the regression together with the other exogenous variables.

In time-series econometric modelling, a dynamic regression will usually include both lagged dependent and independent variables as regressors:

¹² Nerlove, (1958).

¹³ "Suppose the price of capital relative to labour declines, making substitution of capital for labour economically feasible. Of course, addition of capital takes time (the gestation period). Moreover, if the drop of price is expected to be temporary, firms may not rush to substitute capital for labor, especially if they expect that after the temporary drop the price of capital may increase beyond its previous level. Sometimes, imperfect knowledge also accounts for lags." (Gujarati, 1995).

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \dots + \alpha_p Y_{t-p} + \beta_0 x_t + \beta_1 x_{t-1} + \dots + \beta_k x_{t-k} + \varepsilon_t \quad (2.4)$$

The above model is called the *Autoregressive Distributed-Lag model*, known as ARDL ($p; k$).

The values of p and k (i.e., how many lags of Y and X will be used) are chosen:

- i. on the basis of the statistical significance of the lagged variables;
- ii. so that the resulting model is well specified (e.g. it does not suffer from serial correlation).

3.1.3 Estimation issues

A distributed-lag model can be estimated by OLS but this approach leads to a certain number of problems. The first question is related to the length of the lag: even though some economical and/or theoretical considerations must be brought forward on the β 's to avoid estimation problems, there is no way to know *a priori* what the maximum length of the lag is supposed to be.

Secondly, in time series data, the successive lags tend to be highly correlated (Gujarati, 1995) and this means that we are dealing with multicollinearity and, consequently, with imprecise estimation.

Finally, since results *are* sensitive to lag-lengths, the search for the optimum lag length can widen the dangerous doors of data mining. Data mining refers to all those activities that have in common, a search over different ways to process or package data econometrically with the purpose of making the model meet certain design criteria (Hoover and Perez, 2000). A ready-mix model does not exist so the general recommendation is to always follow (economic and econometric) theory as a guide for any model building.

3.1.4 Empirical contributions

Some studies¹⁴ (Bahmani-Goswami, 2004) relied on bilateral trade data to provide strong evidence for the support of positive long-run relation between exchange rate and trade

¹⁴ “First, some have followed standard textbook prescription by estimating the well-known Marshall-Lerner (ML) condition. The ML condition states that devaluation improves a country’s trade balance if the sum of the price elasticities of that country’s import and export demands is more than unity. Second, some have argued that estimating the ML condition is an indirect approach. Thus, they have adhered to a direct method of establishing a link between the trade balance and exchange rate (as well as other determinants) following a reduced-form modeling approach. In both the first and the second approaches, researchers have mostly used aggregate data and provided mixed results. Recently, a few studies have concentrated on employing disaggregated data. While the disaggregated approach on a bilateral basis is applicable to reduced-form trade-balance models, it cannot be applied to estimate the trade flow elasticities or the ML condition. This is due to the fact that import and export prices are not available on a bilateral basis to obtain bilateral trade volumes. The remedy here is to establish a

balance. In this sense, the main question is if currency devaluation can be used as a tool to correct trade balances.

When researchers follow the traditional approach to estimate import demand and export demand elasticities using aggregate trade data, the problem is that a significant price elasticity with one trading partner could be more than compensated by an insignificant elasticity with another partner yielding an insignificant trade elasticity. This so-called “aggregation bias” problem requires estimating trade elasticities on a different basis. Indeed, a new body of the literature is emerging and it includes analyses that estimate trade elasticities on bilateral basis.

N. Ketenci and I. Uz, (2011) use an ARDL approach to measure the impact of currency devaluation. The assessing of the impact is carried out using the real exchange rate. The model is applied between the EU and its eight major industrial trading partners and, furthermore, its six major trading regions¹⁵. The ARDL approach is used to determine whether the dependent and the independent variables are cointegrated. The ARDL approach involves two steps for estimating the long-run relationship:

- i. the first step is to examine the existence of long-run relationship among all the variables in an equation;
- ii. the second step (applied only if the first step showed a cointegration relationship) is to estimate the short-run and the long-run coefficients of the same equation.

Cointegration relations between the variables of bilateral import and export functions are found to be due not only to the strong relations between trade and real exchange rate but also to important relations between EU import and EU income and between EU export and partners’ income. The authors also employ an Error Correction Model (ECM) to provide additional evidence of cointegration among the variables.

Since the data for import and export prices on a bilateral level are not available, the authors cannot estimate trade flow elasticities for determining the Marshall-Lerner (ML) condition in their model. Consequently, they establish a direct link between a country’s value of import and export and real exchange rate on the bilateral basis. The direct method of determining

direct link between a country’s inpayments (value of exports) and outpayments (value of imports) and real exchange rate on a bilateral basis” (Bahmani-Goswami, *Exchange rate sensitivity of Japan’s bilateral trade flows*, 2004).

¹⁵ Namely: Canada, China, Japan, Norway, Russia, Switzerland, Turkey and the US; the six major regions are: the NMCs, the CEECs, the EFTA, the NAFTA, the ASEAN and the DACs.

whether currency depreciation is effective in increasing a country's inpayments from a trading partner consists in considering the export value (or inpayments) and determining how sensitive it is to a change in exchange rate; similarly, they consider import value (or outpayments) and try to determine its sensitivity directly to a change in exchange rate.

The authors employ the Akaike Information Criterion (AIC) in order to select the optimum lag length.

As for the diagnostic statistics, the authors' models pass all the following tests:

- the Lagrange Multiplier (LM) test to check for the serial correlation among the residuals;
- the Jarque-Bera statistic to test the normality of the residuals;
- White's test to check the heteroskedasticity of the residuals;
- Ramsey RESET test¹⁶ to check the functional misspecification of each model.

The long-run elasticities of real exchange rate are used as a proxy of price elasticity for determining the ML condition but they result too low so that the long-run coefficient estimates do not provide any empirical evidence that the ML holds.

For the bilateral export demand equation, the expected positive sign of the long-run real exchange rate elasticities occurs only for three partners (on a total of 14) but it is not significant; in other three cases the real exchange rate is significant but has a negative (unexpected) sign. The negative sign means that there is an adverse effect of the currency depreciation on the bilateral export between the EU and the involved trade partners.

For the bilateral import demand equation, the expected negative sign of the long-run coefficients of the real exchange rate occurs in two cases and the coefficients are significant; this indicates that real depreciation of the euro decrease European imports from the regions involved while in other two cases the adverse effect is observed.

However, the real exchange rate elasticities are so low that it is impossible to make a conclusion about the effect of currency depreciation on bilateral trade and, according to these results, it actually can be concluded that EU's imports and exports are insensitive to exchange rate variations¹⁷.

¹⁶ Using the square of the fitted values and distributed as X^2 with 1 degree of freedom.

¹⁷ See also Bahmani-Goswami, 2004.

F. Yin and S. Hamori have recently (2011) analysed China's import demand function employing ARDL and Dynamic Ordinary Least Squares (DOLS)¹⁸ techniques in the estimation of the long-run coefficients of price and income elasticities. The aim of this study is to resolve the issue of trade balance from the perspective of China's policy making in the larger context of global imbalances problems.

The import demand model adopted derives from the imperfect substitution theory according to which the demand for real imports is a function of domestic income or GDP and relative price (import price index deflated by an index of domestic prices)¹⁹.

The choice of the ARDL is motivated by the authors' consideration that, according to recent evidence, it possesses desirable small sample properties and can effectively correct for possible endogeneity of explanatory variables; they also include the estimates from DOLS, regarded as one of the most widely used estimators of cointegrating vectors in applied literature.

Before interpreting the estimated import demand equations, the existence of a long-run import demand relationship is analysed. In order to do so, different bound tests are employed using the Johansen (1991, 1995) approach. Since there is strong evidence of the existence of a long-run relationship among the variables included in the long-run import demand model, they estimate the long-run cointegration relationship (long-run coefficients) for imports using the ARDL and DOLS single equation estimation methods.

The authors employ the Schwarz-Bayesian Information Criterion (SBIC) in order to select the optimum lag length.

The diagnostic tests carried out by the authors are the following:

- autocorrelation tests
- the Jarque-Bera statistic to test the normality of the residuals;
- heteroskedasticity test of the residuals.

¹⁸ See paragraph 3.3 of the current section for the DOLS empirical contributions.

¹⁹ The traditional import demand model is expressed as: $\ln M_t = \alpha_0 + \alpha_1 \ln Y_t + \alpha_2 \ln RP_t + \varepsilon_t$, where \ln is the natural logarithmic form and ε_t is the error term. M_t denotes the volume of imports at time t , Y_t denotes real income at time t , and RP_t denotes the relative price (the import price index deflated by a GDP deflator) at time t . Generally, the hypothesized values of the coefficients of the explanatory variables are $\alpha_1 > 0$ and $\alpha_2 < 0$, which represent the income and price elasticities respectively of import demand.

The estimated residuals did not provide any significant evidence of serial correlation, non-normality or heteroskedasticity in the error term.

The DOLS estimates of the relative price coefficient are higher as compared to those from ARDL. Indeed, the estimated coefficients for income and relative price variables were found to be rather different when different estimation techniques were employed.

For what concerns the policy-making implications, they reported the following considerations: first of all, the estimated long-run elasticity is inelastic and approximately within the range of -0.5 to -1 . Hence, it appears that China cannot depend on using its exchange rate policies to correct the balance of trade problem. The long-run price elasticity is statistically significant, suggesting that if the growth in inflation in China is related to the import price, then China's imports will increase (and the trade balance will get worse). Second, the growth in income has a significant and elastic impact on import demand in the long-run.

3.2 Phillips' Fully Modified Estimator Approach

Senhadji and Montenegro (1999) have conducted a cross-country analysis for a large number of developing and industrial countries of export demand equations to gauge export price and income elasticities. The technique implemented accounts the non-stationarity for the data and is derived from dynamic optimization. In this study, the export demand equation is expressed as follows:

$$\log(x_t) = \gamma_0 + \gamma_1 \log(x_{t-1}) + \gamma_2 \log(p_t) + \gamma_3 \log(gdp_{x_t}^*) + e_t \quad (2.5)$$

where x_t is real exports of the home country; p_t is the export price of the home country relative to the price of its competitors; and $gdp_{x_t}^*$ is the activity variable defined as real GDP minus real exports of the home country's trading partners. Thus, this model is close to the standard export demand function except that the income variable is real GDP minus real exports of the trading partners, rather than the trading partners' GDP. The equation is estimated using both OLS and Phillips' Fully Modified estimator (FM) The fully modified OLS (FM-OLS) approach originally proposed by Phillips and Hansen (1990) which takes into account the non-stationarity in the data as well as potential endogeneity of the right-hand side variables and autocorrelation of the error term. The FM estimation method is, indeed, an approach to regressions for time series taking advantage of data non-stationarity and cointegrating links

between variables. Cointegrating links between variables lead to endogeneity of regressors: the FM estimator is designed to estimate cointegrating relationships by *modifying* OLS with corrections that take into account of endogeneity and serial correlation.

The long-run price and income elasticities are defined as the short-term price and income elasticities divided by one, minus the coefficient estimate of the lagged dependent.

The average long-run price and income elasticities are found to be approximately -1 and +1,5, respectively; the short-run price elasticities present an average of -0,21 and the average short-run income elasticity is 0,41. Thus, exports do react to both the trade partners' income and to relative prices. According to the results of the estimation, exports seem to be much more responsive to changes in relative prices in the long-run than in the short-run. In particular, among the 53 countries investigated, there are Italy, France, Japan, USA, UK and China (5 of the 6 countries analysed in the present research) and their reported FM export price elasticities are:

<i>Country</i>	<i>OLS</i>	<i>FM Long-run</i>	<i>FM Short-run</i>
	<i>Price elasticity</i>	<i>Price elasticity</i>	<i>Price elasticity</i>
Italy	-0.07	-0.13	-0.05
France	-0.01	0.00	-0.02
USA	-0.19	-0.69	-0.03
UK	-0.16	-0.33	-0.12
Japan	-0.25	-1.33	-0.17
China	-0.78	-3.55	-0.63

*Table 2.1 Price and income export elasticities using FM-OLS.
Source: Senhadji A. S., Montenegro C. E. (1999).*

Asian countries show significantly higher price elasticities than both industrial and developing countries. In addition, according to the authors' results, Asian countries benefit from higher income elasticities than the rest of the developing world, corroborating the general view that trade has been a powerful engine of growth for these economies.

3.3 DOLS approach

The Ordinary Least Squares (OLS) method provides estimates of the regression slopes that are consistent and converge at rate T where T is the sample size. When there is correlation between the regression error and the regressors, i.e. endogeneity, OLS estimates have an asymptotic bias which makes inference difficult. In order to overcome this bias, several methods have been proposed, and, besides the FM approach, one of these is the Dynamic OLS model (DOLS). The dynamic OLS (DOLS) approach proposed by Stock and Watson (1993) augments the original regression with lags of the first differences of the regressors. If the lag structure is chosen in a suitable way, the asymptotic bias is removed but the choice of lag remains an important practical issue and often researchers do not have a practical guidance on how to choose them.

In the equation²⁰:

$$Y_t = \alpha + \theta X_t + \varepsilon_t \quad (2.6)$$

θ is the cointegration coefficient and it is the result of an OLS regression.

If X_t and Y_t are cointegrated, the OLS estimator in the regression of the cointegration coefficient in (2.6) will be inconsistent. Generally, the OLS estimator can lead to problems and to wrong results. For this reason, econometricians have developed alternative estimators able to measure the cointegration coefficient. One of these estimators is exactly the DOLS. The DOLS estimator is based on a modified version of equation (2.6) that includes past, present and future values of X_t :

$$Y_t = \beta_0 + \theta X_t + \sum_{j=-p}^p \delta_j \Delta X_{t-j} + u_t \quad (2.7)$$

Therefore in equation (2.7), the regressors are: $X_t, \Delta X_{t+p}, \dots, \Delta X_{t-p}$. The DOLS estimator of θ is the OLS estimator of θ in equation (2.6).

If X_t and Y_t are cointegrated and the sample is numerous enough, then the DOLS estimator is efficient. Furthermore, since X_t and Y_t , being cointegrated, have a common stochastic trend, the DOLS estimator remains consistent even if X_t is endogenous.

²⁰ Stock, J. H., Watson, M. W. (2003), Introduction to econometrics, 1st edition by published by Pearson. pp 545-547.

The Dynamic OLS (DOLS) approach is used by Aziz and Li (2007) to estimate the export and import equations for China using quarterly data from 1995:Q1–2006:Q4. DOLS is chosen because of its small sample property: indeed, Monte Carlo experiments show that with finite sample, DOLS performs well.

According to the authors, using aggregate data, export elasticity to foreign demand is +3.8, and to relative price is –1.6. These estimates are within the range of other studies (Goldstein and Khan, 1985) and satisfy the Marshall-Lerner condition. In the discussion of the results, the authors argue that great cautious is needed when using trade elasticities to estimate the response of the Chinese economy to price and demand shocks. Trade elasticities used in existing studies on such subjects vary widely and such variation reflects not only data and methodological issues involved in estimating elasticities for all countries, including developed countries, but also a continuous structural shift in how production is organized in China. China is shifting away from stereotypical processing trade that involves mostly assembling imported parts and components to domestically sourcing larger portions of the production chain (Aziz and Li, 2007). In conclusion, the fast changing structure of China’s trade also raises questions about how much one can rely on these estimates, especially the interaction between exchange rate and trade composition changes. Any analysis that does not take into account these factors, continuing to be influenced by China’s past trade structure could lead to erroneous outcomes.

The DOLS procedure has been also adopted by Caporale and Chui (1999) to estimate the long-run income and price elasticities of trade for 21 countries, using annual data over the period 1960-1992, in a cointegration framework. According to the authors, faster growing economies have high income elasticities of demand for their exports but lower import elasticities. For what concerns in particular Italy, Germany, France, Japan, USA and UK the export elasticities estimates are:

<i>Country</i>	<i>DOLS Price elasticity</i>	<i>DOLS Income elasticity</i>
Italy	-0.93	2.21
France	-0.08	2.13

USA	-0.63	1.40
UK	-0.19	1.29
Japan	-1.70	2.91
Germany	-0.11	1.87

Table 2.2 Price and income export elasticities using DOLS.
Source: Caporale G.M., Chui M.K.F. (1999).

The estimation for price elasticities in a few cases (among others, France and Germany) are not statistically significant.

3.4 Cointegration and Error Correction Model Approach

The empirical analysis employed in this dissertation relies on the cointegration techniques and, therefore, a more particular and detailed attention will be addressed to this econometric topic.

The econometric modelling of time series data has seen remarkable growth in recent years. The advancements made in the analysis of times series models over the last three decades are partly due to the developments of theoretical models and partly due to the improvements in computational ability. In earlier years, the analysis of time series models was strictly limited mainly by the time available to execute repetitive calculations, but with the advances made in software development most of the models developed in the early 1970s, 1980s and 1990s have become standard in statistical software packages.

In particular, over the last twenty years, one of the time series modelling research directions has been the development of the theory of *cointegrated time series* modelling based primarily on the seminal paper of Engle and Granger (1987). The theory was further developed by many other authors such as: Johansen (1988, 1991), Stock and Watson (1991), Johansen and Juselius (1992) and Pesaran and Shin (1997).

Cointegrated modelling is applied when the series under investigation are nonstationary and to test this circumstance Dickey and Fuller (1979) developed the initial theory and methodology for the stationarity testing of a time series: since then the analysis of nonstationary time series data has generated considerable research interest. Actually, one of the most important assumptions of what can be called the “classical” econometric theory was

that the observed data came from a stationary process, meaning a process whose means and variances are constant over time; thus, the time series y_t is stationary if, for all values and every time period, it is true that:

$$E(y_t) = \mu \quad (\text{constant mean})$$

$$\text{var}(y_t) = \sigma^2 \quad (\text{constant variance})$$

$$\text{cov}(y_t, y_{t+s}) = \text{cov}(y_t, y_{t-s}) = \gamma_s \quad (\text{covariance depends on } s \text{ and not on } t)$$

Actually, economies evolve, develop and change over time in both real and nominal terms and, therefore, forecasts are often badly wrong (Hendry and Juselius, 1999). At the end, the practical problem facing econometricians is to find any kind of relationship that survives long enough to be useful.

Since the late 1990s, it seems clear that stationarity assumptions must be treated with caution or even completely abandoned for most observable economic time series²¹.

Summarizing, it can be said that:

- i. when dealing with time series data, the assumption of stationarity for modeling and inference is crucial: indeed, when data means and variances are non-constant, observations come from different distributions over time, and this leads to difficult problems for empirical modeling;
- ii. the effects of incorrectly assuming constant means and variances when that is false is potentially risky and can induce serious statistical mistakes;
- iii. the sources of non-stationarity and many and can be due to evolution of the economy, legislative changes, technological change, and political disorders;
- iv. empirical analyses can be *transformed* so that stationarity can become a valid assumption: that is, some forms of non-stationarity can be eliminated by transformations.

In conclusion, given that stationarity is an important issue when dealing with time series variables:, it must be clear that, if we are interested in estimating parameters or testing

²¹ “Intermittent episodes of forecast failure (a significant deterioration in forecast performance relative to the anticipated outcome) confirm that economic data are not stationary: even poor models of stationary data would forecast on average as accurately as they fitted, yet that manifestly does not occur empirically”. D. F. Hendry, K. Juselius, (1999).

hypotheses in cases where the set of variables are not all stationary, standard OLS techniques are generally invalid and, thus, inappropriate.

Besides the stationarity issue, another question that arises when regressing a time series variable on another time series variable is that of the so-called spurious regression. This problem takes place when, due to the presence of a trend, it seems as if a relationship between two economic variables exists but this is not true: hence, the results (or their interpretation) are doubtful. More precisely, *spurious regression occurs when a pair of independent series, but with strong temporal properties, is found apparently to be related according to standard inference in a Least Squares regression*²². Spurious regressions can be defined as *nonsense correlations* and may result when one nonstationary time series is regressed against one or more nonstationary time series. Data involving economic time series often tend to move in the same direction, reflecting an upward or a downward trend: the presence of this common trend is simply a spurious association between two time series and not a *true* association: indeed, despite the absence of any genuine long-run relationship between the underlying series, there is found a (spurious) relationship. In these cases, an extremely high R^2 value leads to erroneous considerations. In particular, let us have:

$$\begin{aligned} y_t &= y_{t-1} + u_t & u_t &\sim iid(0, \sigma^2) \\ x_t &= x_{t-1} + v_t & v_t &\sim iid(0, \sigma^2) \end{aligned}$$

where u_t and v_t are serially and mutually uncorrelated.

$$y_t = \beta_0 + \beta_1 x_t + \varepsilon_t$$

since y_t and x_t are uncorrelated we should expect R^2 to tend to zero, but this is not the case: indeed, if two series are growing over time, they can be correlated even if the increments in each series are uncorrelated. These series have no relation to one another yet, when plotted, there seem to be a positive relationship between them.

As aforesaid, one of the aims of this section is to provide an overview of the studies that deal with cointegration techniques and to outline some important empirical contributions. In the

²² Quotation from Phillips P. C. B. (1986), Understanding spurious regressions in econometrics, *Journal of Econometrics*, 33, pp. 331-340.

present study export elasticities have been estimated applying a cointegration technique within an error correction framework²³.

Briefly, explaining the temporal behavior of a set of variables that, on the basis of economic theory share a relationship that holds in equilibrium, if we observe that there are deviations from this equilibrium for all periods for which we have observations, what we need is to examine are the properties of these deviations, i.e., of the disequilibrium errors. The errors can be small on average and remain so over time: that is, if the errors are viewed as random variables, they all have an expected value of zero and the same variance also. These characteristics are typical of a stationary time series. Nevertheless, this is clearly not the case of all macroeconomic variables. Consumers' expenditure and disposable income, for example, whether measured in real or nominal terms, are certainly not stationary series, but instead exhibit trends in their means over time. If these trends are stochastic trends, such that the first difference of the series is trendless, the series in question are said to possess a single *unit root*. It may be the case that a series becomes stationary only after differencing more than once, in which case it has multiple unit roots. Economic theory and visual plots of the time series can provide prior information or hints as to whether a series is expected to have one (or more) unit root, to be certain of this circumstance is necessary to verify it empirically through appropriate tests²⁴.

When the variables are not only stochastically trended (and feasible to become stationary after differencing), but also have common stochastic trends, some suitable linear combination of these variables will be stationary even though the level of each series is not stationary: this is the case of cointegrated variables.

In order to define cointegrated variables, let us have:

$$X_t \sim I(1)$$

$$\text{and } Y_t \sim I(1)$$

$$\text{but } Z_t = Y_t - \beta X_t \sim I(0),$$

23 The explanation of the reasons that justify this choice and the detailed description of the model are provided in Chapter 3.

24 The test used the present study is the ADF Unit Root test. For details, see Chapter 3.

then X_t and Y_t are cointegrated, i.e., there is a long-run relation between the variables and β is the cointegrating vector and expresses the equilibrium relationship between the series Y_t and X_t and u_t was the *departure* from the long-run equilibrium path.

One of the approaches used in literature to test how many cointegration relationships there are is the Johansen procedure. It comprises two tests: the “ λ -max” test, for hypotheses on individual eigenvalues, and the “trace” test, for joint hypotheses. Further on in the present section and in Chapter 3, the Johansen procedure will be explained in detail.

If a single time series variable presents a single unit root then we need to take the first difference of the variable in order to obtain a stationary series. However, the problem is that we are not concerned in a single variable viewed separately from others but rather in the relationship *between* variables. For this reason, it is more useful to consider differencing within the context of a regression model. For example, let X be exports and I be income and consider the model

$$\Delta X_t = \beta \Delta I_t + u_t \quad (2.8)$$

In (2.8) the change in exports from one period to the next is explained by the change in income in the same time window without reference to any equilibrium or long run relationship between consumption exports and income that may exist: that is, the equation (2.8) does not have an equilibrium or long-run solution. If the assumption is that in equilibrium the variables become constant we want to impose

$$X_t = X_{t-1} = X_{t-2} = \dots \text{ and } I_t = I_{t-1} = I_{t-2} = \dots$$

on (2.8). Doing this, (neglecting the disturbance term) gives $0 = 0$ and so does not provide an expression for X in terms of I , does not explain the impact of I on X . Such an expression would be, indeed, the equilibrium solution of (2.8).

If we suppose that the value of X in equilibrium is given by X^* and assume $X^* = f(I)$, we can try to find this long-run solution. It is necessary to introduce a variable that takes into account the level of X in period $t-1$ relative to the equilibrium value of X for the same period ($f(I_{t-1})$). This leads to the following equation:

$$\Delta C_t = \beta \Delta I_t + \theta(C_{t-1} - f(I_{t-1})) + u_t \quad (2.9)$$

in which both short-run and long-run factors are allowed a role to play in determining how X is changed from its value in period $t-1$. The new variable is the period $t-1$ discrepancy between actual X and equilibrium X and, given this, we expect θ to be a negative parameter because it makes the variables *return* to equilibrium (after going away from it)²⁵.

If we assume that f is a linear function and write:

$$X^*_t = f(I_t) = \mathcal{A}_t$$

we obtain

$$\Delta X_t = \beta \Delta I_t + \theta (X_{t-1} - \mathcal{A}_{t-1}) + u_t$$

or

$$\Delta X_t = \beta \Delta I_t + \theta X_{t-1} - \theta \mathcal{A}_{t-1} + u_t$$

suggesting that a regression of ΔX_t on ΔI_t , X_{t-1} and I_{t-1} is required. This kind of econometric specification is called an *Error Correction Mechanism* (ECM).

Summarizing the main features of the ECM, it can be said that:

- the error correction term tells us the speed with which our model returns to equilibrium following an exogenous shock;
- it should be negatively signed, indicating a move back towards equilibrium, a positive sign indicates movement away from equilibrium;
- the coefficient should lie between 0 and 1, 0 suggesting no adjustment one time period later, 1 indicates full adjustment;
- the error correction term can be either the difference between the dependent and explanatory variable (lagged once) or the error term (lagged once), they are in effect the same thing.

In most of the more recent literature, time series econometrics in general and the estimation of trade elasticities in particular are modelled using cointegration techniques and error correction mechanisms.

²⁵ Actually it can also present a positive sign which would be interpreted as follows: the variables have not reached equilibrium value yet.

3.4.1 Empirical contributions to the issue

The late 1990s was the cointegration analysis breakthrough: Bahmani-Oskooee and Niroomand (1998), Bahmani-Oskooee (1998), Bahmani-Oskooee and Brooks (1999), Marquez (1999) and many others employed a (then) so-called long-run method, i.e. a cointegration technique to estimate the long-run trade elasticities.

To establish whether there is a long-run equilibrium relation among the variables of import and export (standard) demand equations, Bahmani-Oskooee and Niroomand (1998) employ Johansen (1988) and Johansen and Juselius (1990) cointegration analysis based on the maximum-likelihood estimation procedure that provides the two tests statistics (λ -max and trace). According to their results, the M-L condition is satisfied for almost all of the 30 countries investigated, indicating that devaluations could improve the trade balance. Using annual data from 1960 to 1992, the long-run price elasticities are reported as follows:

<i>Country</i>	<i>Long-run Export price elasticities</i>	<i>Long-run Import price elasticities</i>
Italy	-0.24	-4.81
France	-6.74	-0.42
USA	-1.60	-0.34
UK	-0.36	-0.28
Japan	-0.49	-0.97
Germany	-0.75	-0.55

Table 2.3 Export and import price elasticities using Johansen and Juselius (1990) cointegration technique. Source: Bahmani-Oskooee M., Niroomand F., (1998).

As it is easy to notice, some of these results are very high (e.g., Italy's import price elasticity and France's export elasticity) and surely need further investigation.

Always in the same year (1998), Bahmani-Oskooee investigated the trade elasticities in the Less Developed Countries²⁶ (LDCs) applying the Johansen and Juselius method and obtaining

²⁶ The countries examined are namely: Greece, Korea, Pakistan, Philippine, Singapore and South Africa.

quite the same results: that is, that the M-L condition is met and that devaluations can actually improve the trade balance.

Marquez (1999) conducted a cointegration analysis for the estimation of long period import elasticities for Japan, Canada and the USA covering a secular period (1890-1992). The author claims that the estimates of trade elasticities and, in particular, of import price and income elasticities are very unstable and all the studies carried out in the previous four decades are far from being successful in such sense. According to the author, the dispersion of the estimates is large enough to question whether they are useful in studying international interdependencies. Reliance on century-long sample reveals, however, that, if the assumption of constancy of expenditure shares is avoided, the results can support the view that income and prices affect imports. Obviously, it can be argued that century-long fluctuations are not relevant because estimated elasticities are used just to translate predictions of prices and expenditures into predictions for imports (and, I would add, for exports) and this achieves more usefulness if the observations are more recent. On the other hand, though, “to predict” is not “to understand” and this can partially explain why there is a need for continual re-estimation.

Hooper and Marquez (2000) estimated and tested the stability of import and export elasticities relating the G7 countries to their respective income and prices. The period covered ranges from 1990 to 1996 and the quarterly data include goods and services. For what concerns the “G6” countries investigated in the present research the long-run (Table 2.4) and the short-run (Table 2.5) estimates are:

<i>Country</i>	<i>Long-run Export price elasticities</i>	<i>Long-run Export income elasticities</i>	<i>Long-run Import price elasticities</i>	<i>Long-run Import income elasticities</i>
Italy	-0.9	1.6	-0.4	1.4
France	-0.2	1.5	-0.4	1.6
USA	-1.5	0.8	-0.3	1.8
UK	-1.6	1.1	-0.6	2.2

Japan	-1.0	1.1	-0.3	0.9
Germany	-0.3	1.4	-0.06	1.5

Table 2.4 Long-run Export and Import elasticities. Source: Hooper P., Johnson K., Marquez J. (2000).

<i>Country</i>	<i>Short-run Export price elasticities</i>	<i>Short-run Export income elasticities</i>	<i>Short-run Import price elasticities</i>	<i>Short-run Import income elasticities</i>
Italy	-0.3	2.3	-0.0	1.0
France	-0.1	1.8	-0.1	1.7
USA	-0.3	1.8	-0.6	2.3
UK	-0.2	1.1	-0.0	1.0
Japan	-0.5	0.6	-0.1	1.0
Germany	-0.1	0.5	-0.2	1.0

Table 2.5 Short-run Export and Import elasticities. Source: Hooper P., Johnson K., Marquez J. (2000).

Thus, as we can see, with exception of Italy, France and Germany (exceptions to the general case), price elasticities for exports and imports satisfy the M-L condition. Among the other main conclusions, according to the authors: trade elasticities are stable enough to help translate economic analyses into policy recommendations and, for what concerns the USA, a real depreciation of the dollar would keep its external deficit from growing wider.

Algieri (2004) measured export demand elasticities for Russia using an Error Correction mechanism within a cointegration framework. The monthly data collected cover a period from 1993 to 2001. Even though this study does not involve the countries examined in the present research, it is interesting to highlight some of its results. In this case, indeed, Russia's long-run price and income elasticities have the expected sign and are highly significant. In particular, the long-run price elasticity is found to be -2.40 and, according to the author, this can be explained by the low proportion of high-technology goods exported by Russia. Furthermore, it emerges that there is a specialization in products that allow less differentiation and, thus, have to undergo to higher price competition from other countries.

Algieri (2010) conducts an analysis for five big Euro countries (France, Italy, Germany, the Netherlands and Spain) and for their three major competitors (Japan, UK and USA) using quarterly data from 1978 to 2009. The author modeled the export equations using an Unobserved Component (UC) model in order to capture underlying non-price competitiveness. Actually, traditional models specify two key determinants of exports: price competitiveness and foreign demand. Nonetheless, empirical evidence and studies suggest that these factors alone are not able to explain exhaustively export performances. The study, therefore, introduces non-price factors (the UC) of competitiveness. These non-price factors include, among others, aspects such as advanced technology, globalization of production and product quality. The methodology adopted allows to capture underlying changes in export performance giving non-price information and, doing so, it overcomes any misspecification.

4. FINAL REMARKS AND SUMMARY TABLE

When dealing with trade elasticities, exchange rates and global imbalances, one of the main problems to face is definitely the definition of an explanatory framework that researches can agree on. This presumes that the first step is to broadly understand the dynamics that rotate around weak currencies and around the bad-tempered economic relations between the major exporting countries (Thorbecke, 210). The review presented in this chapter is selective rather than exhaustive, concentrating on what I regarded as the most important issues and studies related to the estimation of export price elasticities.

This section provides a summarized examination (Table 2.6) of the existent empirical literature on export equations. It is easy to notice that price elasticities vary across studies and according to the estimation technique adopted:

<i>Author (year)</i>	<i>Export Price Elasticity</i>	<i>Country</i>	<i>Estimation period</i>	<i>Level of aggregation</i>	<i>Model/Approach</i>
OECD (2010)	-0.60	USA		Exports of goods and services	Standard export equations
	-0.51	Euro Area	Quarterly data		
	-1.00				
Ca' Zorzi and Schnatz (2007)	0.61	Euro Area	1992:Q1 – 2006:Q1	Exports of goods and services	Standard export equations in ECM framework
Di Mauro and Maurin (2005)	0.58	Euro Area	1992-2003	Exports of goods and services	Standard export equations
	0.54	France			

OECD (2005)	0.42	Germany	1982-2002 (quarterly data)	Exports of goods and services	Standard export equations in ECM framework
	0.42	Italy			
European Central Bank (2004) Banco de España (2003)	-0.60	France	1991:Q1 – 2003:Q3	Extra-area exports of goods and services Volume of manufacturing exports	Standard export equations in ECM framework Standard export equations in ECM framework
	-0.47	Germany			
	-0.60	Italy			
	-0.60	UK			
	-0.60	USA			
	-1.05	Japan			
	-1.5	China			
	-0.26	Euro Area			
OECD (2000)	-0.41	France	1975:Q1 - 2001:Q1		Single equation approach in ECM framework (linear trend or no trends)
	-1.08	Germany	1975 -1997 (semi-annual data)		
	-0.42	Italy			
-0.81	France				
Senhadji and Montenegro (1999)	-1.44	Germany	1960-1993	Exports of goods and non-factor services	OLS and Fully Modified estimates
	-0.98	Italy			
	-1.58	UK			
	-1.41	USA			
	-1.40	Japan			
	-0.68	China			
	<i>OLS (short-run)</i>				
	-0.01	France			
	-0.07	Italy			
	-0.06	Spain			
	-0.16	UK			
	-0.19	USA			
	-0.25	Japan			
	-0.78	China			
<i>FM estimates</i>					
-0.02	France				
-0.14	Italy				
-0.18	Spain				
-0.35	UK				
-0.73	USA				
-1.27	Japan				
-3.13	China				
Caporale and Chui (1999)	-0.08 (DOLS)	France	1960-1992 (annual)	Exports of goods and services	(1) DOLS, (2) ARDL.
	-0.04 (ARDL)				
	-0.11 (DOLS)	Germany			
	-0.10 (ARDL)				
	-0.93 (DOLS)	Italy			
	-0.47 (ARDL)				
	-1.93 (DOLS)	Spain			
	-1.22 (ARDL)				
	-0.19 (DOLS)	UK			
	-0.29 (ARDL)				
	-0.63 (DOLS)	USA			
	-1.36 (ARDL)				
	-1.70 (DOLS)	Japan			

Hooper et al. (1998)	-0.19 (ARDL)				
	-0.2	France	1970-1997 (for France, Germany, Italy); 1960s to 1994Q4 or 1997Q1 for the others	Exports of goods and services	Cointegration vectors and ECM
	-0.3	Germany			
	-0.9	Italy			
	-1.6	UK			
	-1.5	USA			
-1.0	Japan				
Anderton (1991)	-0.32	Italy	1971:Q2 – 1998Q4	Manufacturing export volumes	Standard export demand
	-0.47	UK			
	-0.65	USA			
	-1.11	Japan			
	-0.27	Germany			

Table 2.6 Selected Long-run price elasticities: a comparison of studies and results.
Source: Author's elaboration on Algieri B. (2010).

Even though according to recent trade empirical²⁷ and economic geography studies trade price elasticities are supposed to be rather high, ranging from 3 to 11, price elasticity estimations at aggregate levels lead to lower values of around unity. Furthermore, as we have noticed in the literature review, these estimates vary through studies and techniques.

There can be possibly more than just one explanation to this discrepancy but the most likelihood could be misspecifications in the traditional trade equations as well as measurement errors in export and import prices.

According to the *Comparative analysis of export demand for manufactures in the Euro Area countries* conducted by the Banco de España (2003)²⁸, the differing long-term price elasticities seem to be explained, in general terms, by the productive specialisation of each country. In a context in which manufacturing industry specialisation continues to change dramatically and very unequally across countries, it is reasonable that the sensitivity of exports to price competitiveness should continue to be different in each country. However, it can also be expected that there will be a general trend of elasticities to decrease as countries make progress in improving their competitiveness in ways other than through leadership in costs and in selling prices. In particular, the response of a country's exports to changes in their determining variables largely explains the diversity of results perceived. Such differences

²⁷ See Erkel-Rousse and Mirza (2002) for further details.

²⁸ Banco de España (2003), *Comparative analysis of export demand for manufactures in the Euro Area countries*, Econ Bull July:67–75

will tend to diminish once the processes of commercial integration and productive structure development in the countries that started from a lesser developed level have come to an end.

In an overall perspective, low price elasticities estimates and the current debate on external trade balance adjustment are controversial.

Estimation and re-estimation of trade elasticities is, therefore, not only useful but necessary in order to overcome such drawbacks, to improve the structural modelling process and to keep up to date the trends of trade patterns and of industrial specialization. A continual re-estimation of export (and import) trade elasticities, in addition to a constant development of the empirical modelling techniques, will certainly lead to less puzzled outcomes and can be a solid support in reconsidering the evidence.

CHAPTER 3

ECONOMETRIC ANALYSIS

1. INTRODUCTION

Taking into account an imperfect substitute framework and according to the literature, in order to improve the trade balance it is necessary to reduce imports and/or increase exports (and increase savings) at the same time; to do this, one of the feasible policies could be to work on real exchange rates; many questions can arise: is this kind of policy really effective? How effective is this policy? Is there a boundary value? What is the magnitude of variation supposed to be to have a significant impact on exports? Do exports, at an aggregate level, react differently depending on different factors such as the development status of the traders, the sector or the type of the exported good?

Without doubt, one of the most important issues in empirical research is to design a model which actually represents a certain economic phenomenon, aware of the fact that there is not just *one* right way to model an applied research.

For my purposes, it is necessary to underline that there are many problems that can possibly occur when modelling functions that involve time series economic variables and these issues certainly complicate and make more complex and challenging the process of model building.

One of the most common problems to face when dealing with times series data is the presence of a bilateral causal relationship between two or more variables. Certainly, for reasons that will be clarified in the following paragraphs, the *Vector Error Correction Models* (hereafter VECM) are frequently applied in examining models that can suffer problems due to endogenous variables.

Indeed, to overcome such problems, in order to carry out the estimation of the long-run export elasticities for the seven countries under scrutiny, I apply a VECM analysis in which the interpretation of the estimates can be naturally classified into short-run and long-run effects.

Before explaining the reasons that are at the basis of this choice and before going into detail with the econometric specification, though, it will be definitely useful to illustrate the underlying empirical framework in which the VECM analysis is set. In order to do so, the

next sections will briefly illustrate some of the most popular and used methodologies in the estimation of time series (and, more precisely, of trade elasticities) of the last years.

2. EMPIRICAL BACKGROUND SETTINGS

2.1 Simultaneous equation models

In the recent years, more and more econometricians and economists believe that the use of *vector autoregressive* (VAR) models for macro econometric analysis is one of the most valid alternatives to the common *simultaneous equation models*²⁹ (or SEMs) that were quite used up to twenty (and more) years ago. One of the reasons is that the simultaneous equations models often did not take into consideration the rich dynamic structure in time series data of quarterly or monthly frequency. Another reason concerns the aforementioned endogeneity issue in so far as the assumptions on the exogeneity of some variables are criticized because not fully supported by theoretical considerations. In contrast, in VAR models all observed variables are typically treated as *a priori* endogenous (Lütkepohl, 2005).

When talking about simultaneous equation models we assume that there is a two-way (or *simultaneous*) flow of influence among the economic variables: that is, one economic variable affects another economic variable and is, in turn, affected by it (Gujarati, 1995). Therefore, in these cases, the distinction between dependent and explanatory variables is not very useful: a more valuable distinction is that between endogenous and exogenous variables. The endogenous variables are those that are dependent one from another whereas the exogenous ones are those that are regarded as the real independent and non-stochastic variables.

This explains why, in this kind of model, the regressand in one equation may appear as a regressor in another equation of the system. Disregarding for endogeneity can lead to serious estimation problems such as biased and inconsistent estimators.

In the simultaneous equation models, there are as many equations as the number of endogenous variables and the parameter of each equation is estimated taking into account information resulting from the other equations present in the system. It is necessary to specify

²⁹ *Simultaneous equation models* (SEMs), also called *Structural equation models*, are multi-equation (multivariate) regression models. In these models, variables may influence one-another reciprocally, either directly or through other variables as intermediaries. These structural equations are meant to represent causal relationships among the variables in the model.

that the simultaneous equation models treat some variables as endogenous and others like exogenous *a priori* because this remark is a proper link to the VAR analysis.

2.2 VAR models

The Vector Autoregressive models, unlike the SEMs, do not distinguish *a priori* endogenous and exogenous variables because all variables are treated on an equal basis, i.e., all variables are (treated as) endogenous.

The term *autoregressive* is due to the fact that, among the regressors (right-hand side of the equation) there is the lagged value of the dependent variable while the term *vector* is obviously due to the fact that the model contains the vector of two or more variables.

VARs were introduced initially as a replacement of large scale macroeconomic models estimated usually by OLS and Instrumental Variable regressions, entailing of a huge set of equations estimated separately in which the parameters were then subtracted in other equations.

In a VAR³⁰, consisting of two variables X ,Y the path of Y is explained by the current and past realizations of X (and other variables additively) simultaneously the realizations of X rely on past and current realizations of Y.

The VARS are, therefore, suitably applied when we cannot reject the hypothesis that there exists a bilateral causality among the variables. From a more purely economic point of view, it can be said that these models are especially useful for describing the dynamic behaviour of economic (and financial) time series.

A general 2-variable VAR of order p, that is, a VAR(p) model with two variables (Y and X) presenting a bilateral causality, can be expressed as follows:

$$Y_t = \alpha + \sum_{j=1}^p \beta_j Y_{t-j} + \sum_{j=1}^p \gamma_j X_{t-j} + \varepsilon_{1t}$$

$$X_t = \alpha' + \sum_{j=1}^p \theta_j Y_{t-j} + \sum_{j=1}^p \lambda_j X_{t-j} + \varepsilon_{2t}$$

In this model, p stands for the number of lags and ε is the stochastic error term. If each equation contains the same number of lagged variables in the system, each equation can be estimated using OLS.

³⁰ VARs introduction in the literature was done by Sims (1980) in an influential paper '*Macroeconomics & Reality*'.

Some of the advantages of the VAR model are:

- it represents a simple method;
- there is no need to determine which variables are endogenous and which ones exogenous;
- OLS can be applied to each equation separately.

On the other hand, though, the simplicity of this method can represent its drawback. For example, if there are many lags in each equation, it may not be easy to interpret each coefficient.

2.3 VECM Analysis

Over the recent years, the cointegration and the error correction approaches have been studied intensely in the analyses of time series econometrics. In particular, the Vector Error Correction Model³¹ (VECM) results very appealing for its distinctive and advantageous characteristics:

- i. first of all, it allows the researcher to represent economic equilibrium relationships within a relatively rich time-series specification;
- ii. secondly, it is structured in order to give the possibility to consider all the variables of the model endogenous;
- iii. finally, it overcomes the old dichotomy between (a) structural models that faithfully represented macroeconomic theory but failed to fit the data, and (b) time-series models that were accurately tailored to the data but difficult if not impossible to interpret in economic terms³².

Considering the VAR models as a starting point, it can be said that a VECM:

- is simply a VAR for variables that are stationary in their differences, i.e., I(1);
- a VECM is a VAR with an error correction term incorporated into the model;
- any VAR(p) model can be re-written as a VECM;

³¹ Also known as *Vector Error Correction Mechanism*.

³² Cottrell A., Lucchetti, R.: "J"., (2011), Gnu Regression, Econometrics and Time-series Library, see <http://www.gnu.org/licenses/fdl.html>, Department of Economics and Dipartimento di Economia, Università Politecnica delle Marche.

- a VECM is a restricted VAR model: the VECM specification restricts the long-run behaviour of the endogenous variables to converge to their long-run equilibrium relationships and allows the short-run dynamics.

Figure 3.1 provides a schematic idea of where these models fit in a time series framework. The Vector Error Correction Models (VECM) and are shown in the light blue square.

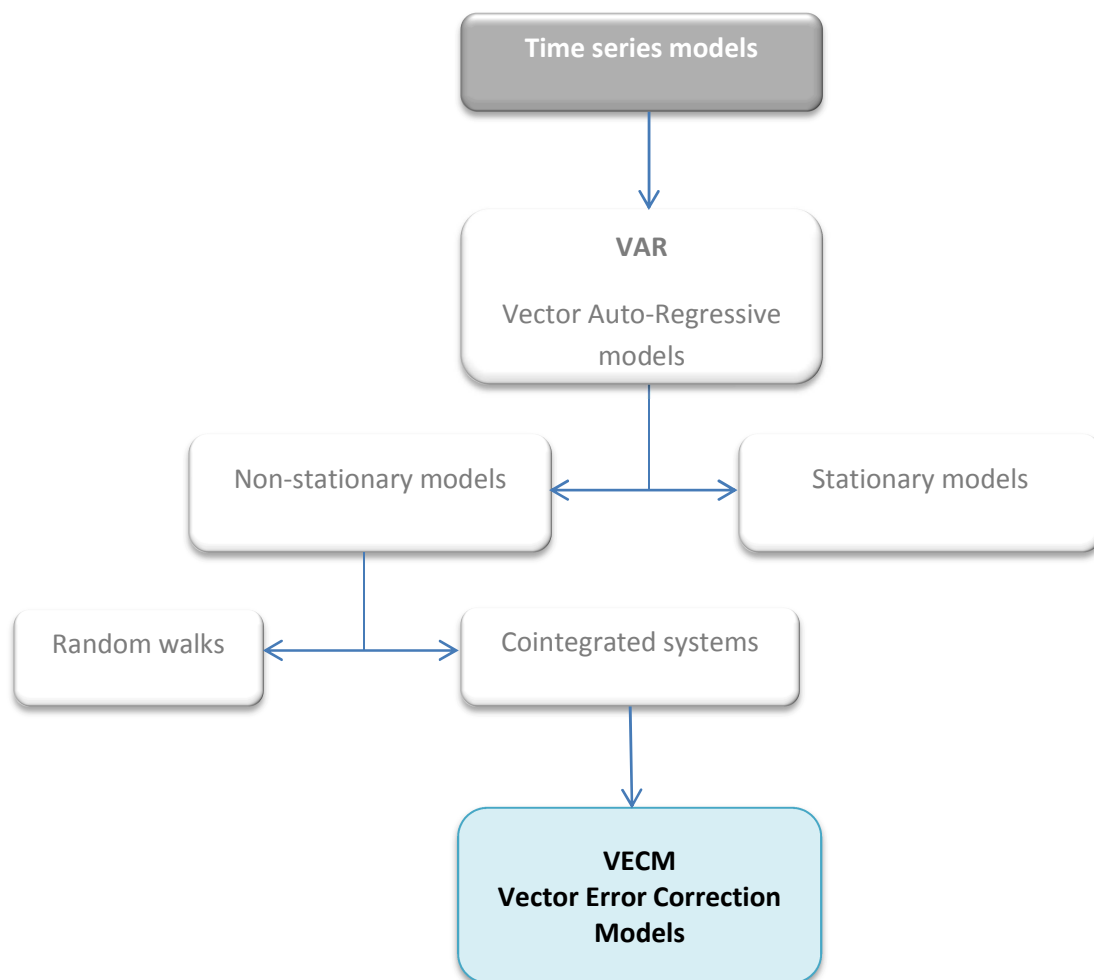


Figure 3.1. VECM scheme

Indeed, once the variables included in the VAR model are found to be cointegrated³³, we will use the VECM: it is important to remember that VECMs are used with non-stationary data

³³ For discussion on cointegration analysis see Chapter 2, paragraph 2.4.

and allow the short-term and long-term relationships to be modelled simultaneously *as long as the variables are cointegrated*.

If a non-stationary series Y_t must be differenced d times before it becomes stationary, then it is said to be integrated of order d : $Y_t \sim I(d)$. So if $Y_t \sim I(d)$ then $\Delta^d Y_t \sim I(0)$, an $I(0)$ series is a stationary series whereas an $I(1)$ series contains one unit root, e.g., $Y_t = Y_{t-1} + \varepsilon_t$.

When the concept of non-stationarity was first considered, a usual response was to independently take the first differences of a series of $I(1)$ variables. The problem with this approach is that pure first difference models have no long-run solution: consider y_t and x_t both $I(1)$. If, for example, we want to estimate the model

$$\Delta y_t = \beta \Delta x_t + \varepsilon_t \quad (3.1)$$

this collapses to nothing in the long run. The definition of the long run that we use is where

$$y_t = y_{t-1} = y; \quad x_t = x_{t-1} = x.$$

Hence, all the difference terms will be zero, i.e., $\Delta y_t = 0; \Delta x_t = 0$.

One way to avoid this problem is to use *both first difference and levels terms*, e.g.:

$$\Delta y_t = \beta_1 \Delta x_t + \beta_2 (y_{t-1} - \gamma x_{t-1}) + \varepsilon_t \quad (3.2)$$

where $EC = (y_{t-1} - \gamma x_{t-1})$ is known as the *Error Correction (EC) term*: it is the error from a regression of y_t on x_t . The error correction component simply says that Δy_t can be explained by the lagged value of the error correction term itself. Indeed, the EC term measures the speed at which prior deviations from equilibrium are corrected. It can also be thought of as an equilibrium error (or disequilibrium term) occurred in the previous period. If it is non-zero, the model is out of equilibrium and *vice versa*.

Lastly, given that y_t and x_t are cointegrated with cointegrating coefficient γ , then $(y_{t-1} - \gamma x_{t-1})$ will be $I(0)$ even though the constituents are $I(1)$. We can thus validly use OLS to estimate the model.

Any cointegrating relationship can be expressed as an equilibrium correction model. Basically, once showed that the variables under scrutiny are cointegrated, (i.e., there is a long-run equilibrium relationship between them) we can surely think that in the short-run there might be disequilibrium or, in other words, causality can be further sub-divided into long-run

and short-run causality. This is the reason why the error term can be treated as the “equilibrium error” (Gujarati, 1995). This error term can be, hence, used to link the short-run behaviour of the variable to its long-run value. This procedure is known as the Error Correction Mechanism³⁴ and was made popular by Engle and Granger³⁵ in the late 1980s: the mechanism, practically, corrects for disequilibrium and offers the possibility to know the speed to reconcile equilibrium, i.e., it estimates the speed at which a dependent variable Y returns to equilibrium after a change in an independent variable X . Engle and Granger point out that a linear combination of two or more non-stationary series may be stationary. The stationary combination may be interpreted as the cointegration, or equilibrium relationship between the variables. This explains why the VECMs are very relevant in the modern econometrics: indeed, they represent the tie between times series analyses and economic theory, short-run and long-run.

In this framework, the long-run relations are now often separated from the short-run dynamics. The cointegration or long-run relations are often of particular interest because they can be associated with relations derived from economic theory. It is therefore useful to construct models which explicitly separate the long-run and short-run parts of a stochastic process (Lütkepohl, 2005). VECMs known also as *equilibrium correction models* offer an appropriate structure in this sense.

Error correction models can be used to estimate the following quantities of interest for all X variables:

- short term effects of X on Y
- long term effects of X on Y (long run multiplier)
- the speed at which Y returns to equilibrium after a deviation has occurred.

2.3.1. Advantages of using VECMs: highlights

The present analysis applies a cointegration technique based on VECMs to estimate the quarterly demand for exports in some economies present in the international trade scenario.

³⁴ The ECM was first used by J. D. Sargan in “Wages and Prices in the United Kingdom: a study in econometric methodology”, 1964.

³⁵ “Co-integration and Error Correction: representation, estimation and testing”, *Econometrica*, vol. 55, pp. 251-276, 1987.

The reasons of such choice relies on the several objective advantages already quoted³⁶ and on further systematic reasons highlighted as follows.

First of all, the VECM not only is a standard mechanism vastly used and established in the empirical literature but it also likely represents one of the main explanatory models for the theoretical counterpart applied in this study: that is, the imperfect substitutes model. The econometric specification, indeed, is based and is structured on the assumptions of the imperfect substitutes theory.

Secondly, the fact that in this model, relative prices and income enter endogenously into the demand system and that the cointegration rank is not assumed to be known *a priori* but subject to inference leads to significant improvements in the efficiency of the estimates and *suggests that the VECM can be viewed as the “natural” econometric reference model for investigating dynamic demand systems*³⁷.

Finally, in order to extend the present analysis in a forecasting perspective and investigate how the macroeconomic outcomes may differ over a certain period if a different policy had been pursued³⁸, the VECM approach represents the standard approach used in the empirical literature.

For all these reasons, the estimation of long-run and short-run export price elasticities based on VECMs seems to be perfectly suited.

3. ECONOMETRIC ANALYSIS: ESTIMATES OF EXPORT ELASTICITIES

3.1 Outline

The analysis covers a period of over twenty years, from 1990 to 2012, and is conducted for three countries of the Euro Area (EA), namely: Italy, Germany and France; for the three major competitors of the EA: UK, USA and Japan; lastly, for China, that represents the conversation piece of the current debate on devaluation, weak currencies and exchange rate misalignments.

³⁶ *Cfr.* paragraph 2.3, Chapter 3.

³⁷ Quoted from: “A cointegrated VECM demand system for meat in Italy”, L. Fanelli and M Mazzocchi, (2002), *Applied Economics*, 34, pgg 1593-1605.

³⁸ *Cfr.* paragraph 4, Chapter 1.

Actually, the countries can be classified within two wider groups or areas: the *G6*³⁹ (Italy, Germany, France, UK, USA and Japan) and China, as a representative of the BRICS⁴⁰.

The BRICS countries (Brazil, Russia, India, China and South Africa) are experiencing a very solid economic dynamism on the international context and especially for what concerns China, BRICS came to the spotlight because of the global imbalances issue and because, maybe for the first time in history, the question is not whether you are an industrialized or emerging country but if you are a deficit or a surplus country referring to the trade balance.

The present section will provide the estimates of export price elasticities *separately* for each country under scrutiny. This decision relies on the fact that it seems necessary to clarify, specifically for each country, the development and the different steps of the econometric model. At the end of the discussion, summarizing tables will provide the results for each country.

In order to streamline the reading, the specific steps/phases of the modelling process will be illustrated in detail for the first country under study, that is, for Italy; as for the other 6 countries, there will simply be a cross-reference to the same steps/phases of the procedure and to the results, tabulated in the Appendix.

When all countries' export price (and income) elasticities are estimated, I will provide an overall view of the short-run and long-run elasticities within summarizing tables, compare them with the findings of previous research (used as benchmark values) and discuss the results.

3.2 Data

The quantitative equations for the countries under investigation have been modeled using quarterly data ranging from January 1990 to January 2012 (1990:1-2012:1) collected from International Financial Statistics (IFS) and Datastream databases. The total number of observations is therefore, 89 for each series. All data have been indexed with base 2005=100. In order to achieve the estimates of export elasticity, the variables used in the econometric model are the natural logarithms of the original data. All the time series data are seasonally adjusted.

³⁹ Goldstein A.(2011), BRIC. Brasile , Russia, India, Cina alla guida dell'economia globale, Editore Il Mulino. According to Goldstein, G6 is more appropriate than G7 because Canada is "*sui generis*" for different reasons.

⁴⁰ The BRICS countries are namely: Brazil, Russia, India, China and South Africa.

The econometric software package used throughout the analysis is *Gretl*, version 1.9.5.

3.3 Variables

Having elicited the general outlines of the imperfect substitutes model, I will now consider the empirical variables that have been used as the appropriate counterparts to the theoretical ones.

For what concerns the choice of the variables for the construction of the model, according to the literature⁴¹, trade equations can be specified with the volume or with the value of exports as the dependent variable (*Y*). Considering the value of exports as the dependent variable has its advantages on one hand but presents a few drawbacks on the other. The main disadvantage of using the value of exports as the dependent variable is that the exports expressed in values include price and quantity variations while exports expressed in volumes entail only quantity variations.

The explanatory variables chosen are those used in the prevalent existing literature and comprise real exchange rates and the rest of the world's income. For what concerns the use of the real exchange rates, this choice is supported by the fact that, as commonly assumed in the empirical literature⁴², there is the basic assumption that there exists a complete pass-through⁴³ between relative prices and exchange rates.

Given all these issues, the chosen dependent (*Y*) variable is the value of country's exports and the explanatory (*X*) variables are the real exchange rates and the world income; a sketch of all the information on the data is presented in Table 3.1. The variables have been transformed in log form (*l*) in order to express the resultant coefficients as elasticities of the variable included in the model.

	Country	Variable		Definition and Concept	Source	Unit
1	Italy	<i>IT_Rex</i>	<i>X</i>	Real effective exchange rate, Consumer Price Index based	Datastream	Index, 2005=100
		<i>IT_Rex_ULC</i>	<i>X</i>	Real effective exchange rate, Unit Labor Cost Index based	Datastream	Index, 2005=100
		<i>IT_E</i>	<i>Y</i>	Exports of goods & services (real, US\$)	Datastream	Index, 2005=100

⁴¹ Goldstein, M., Khan, M. S. (1985), Income and price effects in foreign trade, in: Jones R. W., Kenen P. B. Handbook of International Economics, Amsterdam, North Holland (1985), pp. 1042-1099.

⁴² Goldstein, M., Khan, M. S. (1985), *op.cit.*.

⁴³ For further details, see Chapter 2, section 2.1.5.

2	France	<i>FR_Rex</i>	X	Real effective exchange rate, Consumer Price Index based	Datastream	Index, 2005=100
		<i>FR_Rex_ULC</i>	X	Real effective exchange rate, Unit Labor Cost Index based	Datastream	Index, 2005=100
		<i>FR_E</i>	Y	Exports of goods & services (real, US\$)	Datastream	Index, 2005=100
3	Germany	<i>GE_Rex</i>	X	Real effective exchange rate, Consumer Price Index based	Datastream	Index, 2005=100
		<i>GE_Rex_ULC</i>	X	Real effective exchange rate, Unit Labor Cost Index based	Datastream	Index, 2005=100
		<i>GE_E</i>	Y	Exports of goods & services (real, US\$)	Datastream	Index, 2005=100
4	UK	<i>UK_Rex</i>	X	Real effective exchange rate, Consumer Price Index based	Datastream	Index, 2005=100
		<i>UK_Rex_ULC</i>	X	Real effective exchange rate, Unit Labor Cost Index based	Datastream	Index, 2005=100
		<i>UK_E</i>	Y	Exports of goods & services (real, US\$)	Datastream	Index, 2005=100
5	USA	<i>US_Rex</i>	X	Real effective exchange rate, Consumer Price Index based	International Financial Statistics (IFS)	Index, 2005=100
		<i>US_Rex_ULC</i>	X	Real effective exchange rate, Unit Labor Cost Index based	International Financial Statistics (IFS)	Index, 2005=100
		<i>US_E</i>	Y	Exports of goods & services (real, US\$)	Datastream	Index, 2005=100
6	Japan	<i>JP_Rex</i>	X	Real effective exchange rate, Consumer Price Index based	Datastream	Index, 2005=100
		<i>JP_Rex_ULC</i>	X	Real effective exchange rate, Unit Labor Cost Index based	Datastream	Index, 2005=100
		<i>JP_E</i>	Y	Exports of goods & services (real, US\$)	Datastream	Index, 2005=100
7	China	<i>CH_Rex</i>	X	Real effective exchange rate, Consumer Price Index based	Datastream	Index, 2005=100
		<i>CH_E</i>	Y	Exports of goods & services (real, US\$)	Datastream	Index, 2005=100
8	World	<i>y</i>	X	World Income (real GDP, US\$)	Datastream	Index, 2005=100

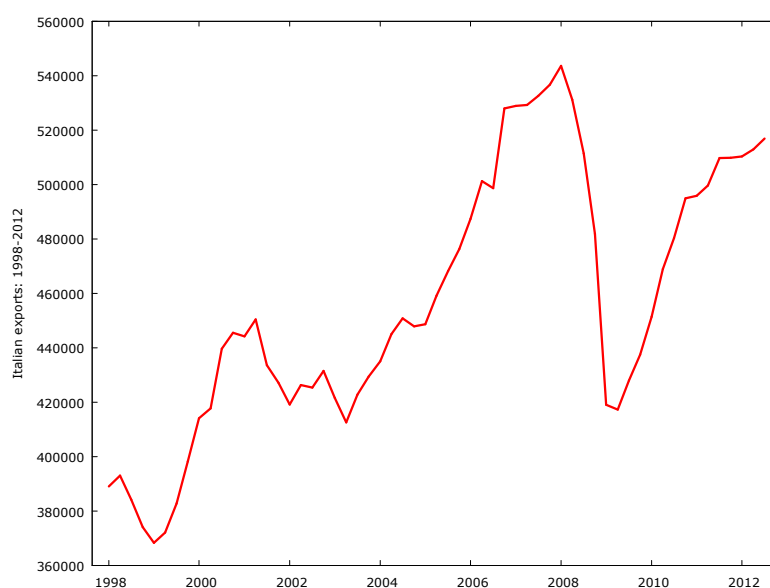
Table 3.1 Data Information

4. ESTIMATES

4.1 Introduction

In the same way as most of the main European countries, since 1998, Italy is experiencing serious macroeconomic imbalances that need to be addressed. In particular, macroeconomic developments in the area of export performance deserve attention as, Italy has been losing external competitiveness in the last decade, due to both cost and non-costs factors, and has been hit hard by the financial crisis. Given the high level of public debt, improving the growth potential and competitiveness should be key priorities. Mainly due to exposure to competition by emerging countries, Italy's share in world export markets in sectors in which it specialises

declined quite considerably in the 2000s⁴⁴. A probably unfavourable product specialisation and geographical destination of exports also explain decreasing competitiveness. With export products that are rather similar to those of emerging economies, Italy has been exposed more than other Euro Area countries to increasing global competition. Italy's exports are also disadvantaged by their still relatively low penetration into fast-growing emerging markets, especially in Eastern Asia. The relatively small size of the Italian firms also probably plays a key role in hampering the reorientation of exports towards new and distant markets.



*Figure 3.1 Italian exports, 1998:1-2012:3.
Source: Author's own elaboration via Datastream database.*

4.2 Preliminary results

Initially, to validate the reasons of my research idea and to roughly test the sensitivity of the variables to variations, I analysed the responses of exports to their main determinants, estimating the export demand price elasticity for Italy using IMF quarterly data for the sample period 1990-2010 and applying static and dynamic models.

I used a log-linear demand function that expresses the elasticity of the dependent variables with respect to the independent variable. The variables involved were: Italian export volumes (*LXVOL*, dependent variable), real exchange rate (*LREX*), and income (*Y*).

⁴⁴ European Commission (2012), In-depth review for Italy, Commission staff working document, SWD, n° 156.

The long-run price and income elasticities are defined as the short-term price and income elasticities divided by one, minus the coefficient estimate of the lagged dependent variable⁴⁵.

Implementing an OLS regression, I obtained:

Dependent Variable: LXVOL
 Method: Least Squares
 Date: 10/11/11 Time: 12:05
 Sample: 1990Q1 2010Q2
 Included observations: 82

	Coefficient	Std. Error	t-Statistic	Prob.
LREX	-0.759651	0.033227	-22.86257	0.0000
LY	1.767712	0.033900	52.14518	0.0000
R-squared	0.958656	Mean dependent var		4.465548
Adjusted R-squared	0.958140	S.D. dependent var		0.212015
S.E. of regression	0.043378	Akaike info criterion		-3.413642
Sum squared resid	0.150532	Schwarz criterion		-3.354941
Log likelihood	141.9593	Hannan-Quinn criter.		-3.390074
Durbin-Watson stat	1.425083			

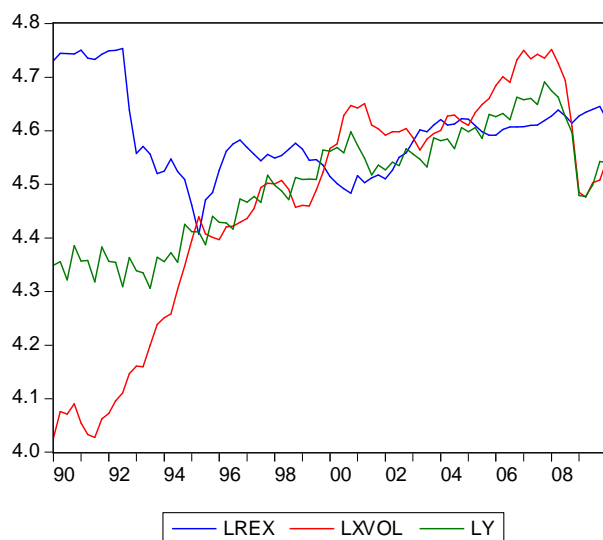


Figure 3.2 (a) Italian exports, 1990:1-2010:2.
 Source: Author's own elaboration on IMF database.

⁴⁵ Hamilton (1994), Time Series Analysis, Princeton University Press.

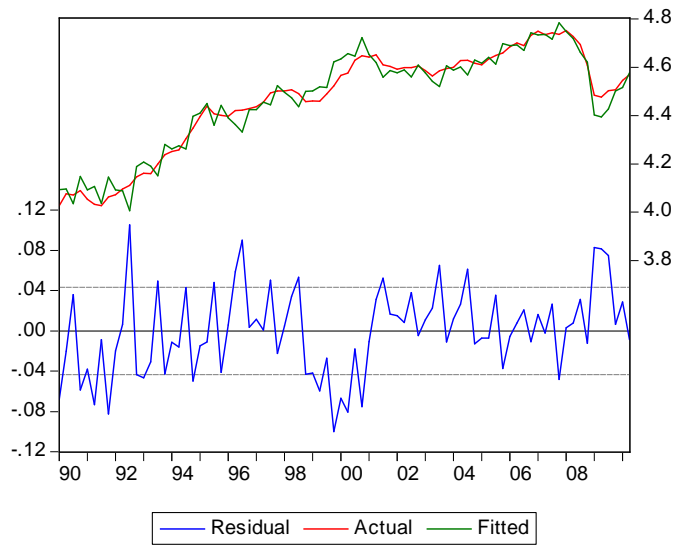


Figure 3.2 (b) Italian exports, 1990:1-2010:2.
Source: Author's own elaboration on IMF database.

Further on, to take into account the adjustment time necessary for the dependent variable (export volumes) to respond to variations in the explanatory variables (that is, relative prices expressed as exchange rates and income), I moved on from a static model to a simple dynamic model introducing time lags in the variables. Precisely, I implemented two different distributed-lag (D-L models) models including variables with different time lags.

In the first model (D-L model 1), besides the explanatory variables considered in the OLS regression, I introduced a third variable that is the lagged (-1) dependent variable and I obtained the following results:

Dependent Variable: LXVOL
Method: Least Squares
Date: 10/11/11 Time: 12:18
Sample (adjusted): 1990Q2 2010Q2
Included observations: 81 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
LREX	-0.247260	0.036296	-6.812389	0.0000
LY	0.587837	0.077059	7.628388	0.0000
LXVOL(-1)	0.663006	0.042674	15.53658	0.0000
R-squared	0.989676	Meandependentvar		4.470971
Adjusted R-squared	0.989412	S.D. dependentvar		0.207534
S.E. of regression	0.021355	Akaike info criterion		-4.818705
Sum squaredresid	0.035572	Schwarzcriterion		-4.730021

Log likelihood	198.1575	Hannan-Quinn criter.	-4.783124
Durbin-Watson stat	1.480203		

As aforesaid, the long-run price and income elasticities are defined as the short-term price and income elasticities divided by one, minus the coefficient estimate of the lagged dependent variable so:

- the long-run export demand price elasticity is equal to:

$$0.24 / (1 - 0.66) = - \mathbf{0.71}$$
- the long-run export demand income elasticity is equal to:

$$0.59 / (1 - 0.66) = + 1.74$$

When I reiterated the regression (D-L model 2) including other lagged variables and corrections for seasonality I obtained the following results:

Dependent Variable: LXVOL
Method: Least Squares
Date: 10/11/11 Time: 12:37
Sample (adjusted): 1990Q4 2010Q2
Included observations: 79 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
LREX	-0.393816	0.091207	-4.317833	0.0000
LY	0.645816	0.079587	8.114544	0.0000
LXVOL(-1)	0.762457	0.062030	12.29177	0.0000
LY(-3)	-0.234194	0.072735	-3.219836	0.0019
LREX(-1)	0.220542	0.100133	2.202485	0.0308
@SEAS(3)	0.029475	0.005615	5.249206	0.0000
R-squared	0.992193	Meandependentvar		4.481038
Adjusted R-squared	0.991658	S.D. dependentvar		0.200046
S.E. of regression	0.018271	Akaike info criterion		-5.094059
Sum squared resid	0.024370	Schwarzcriterion		-4.914101
Log likelihood	207.2153	Hannan-Quinn criter.		-5.021962
Durbin-Watson stat	1.517391			

- the long-run export price elasticity was equal to:

$$0.39 / (1 - 0.76) = - \mathbf{1.625}$$
- the long-run export income elasticity was equal to:

$$0.65 / (1 - 0.76) = + 2.71$$

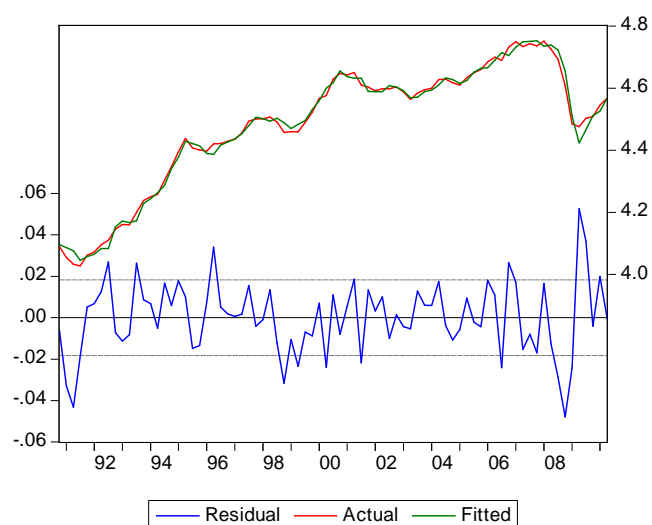


Figure 3.3 Italian exports, 1990:4-2010:2.
Source: Author's own elaboration on IMF database.

Obviously, these results (summarized in Table 3.2) were very approximate and raw but still, they represented a solid starting point for my purposes. Additionally, this preliminary analysis gave me the possibility to compare the results provided by an approach ordinarily used in the past estimation (and before econometric sophistication and development) of trade elasticities with the more developed ones used in the present study and reported in the following sections of this chapter⁴⁶.

Methodology	Short-run export price elasticity	Long-run export price elasticity
OLS	-0.76	-
Distributed Lag model (1)	-0.25	- 0.71
Distributed Lag model (2)	-0.39	- 1.62

Table 3.2. Export price elasticities; Italy, 1990:1-2012:1. Source: Author's own elaborations.

4.3 Export elasticity estimates for Italy

Once collected the data, the first critical step of the analysis is to visually inspect it: indeed, the variables' dynamics can be *informally* investigated through the visual plots and through the autocorrelation function (ACF) correlogram.

⁴⁶ Cfr. Section 4.4, Table 3.9.

The information provided at this first informal level can give a first suggestion of what kind of issue must be addressed: in particular, it can give an indication whether the time series is stationary or not. For example, figure 3.4 shows the ACF correlogram of the Italian exports (expressed in logarithm) l_IT_E up to 30 lags⁴⁷. What we can see is that the ACF correlogram starts at a very high value (0,9662 at lag 1) and becomes smaller very gradually. Even at lag 13, the autocorrelation coefficient measures still about 0,5. This kind of pattern is generally an indication that the time series is non-stationary (Gujarati, 1995). Autocorrelation would be zero at any lag greater than zero if the stochastic process is purely random. The confidence interval ($\pm 1,96$) is delimited by the solid blue lines. The same consideration suits the ACF correlograms of Germany, France, USA, Japan, UK and China (see Appendix 1.A).

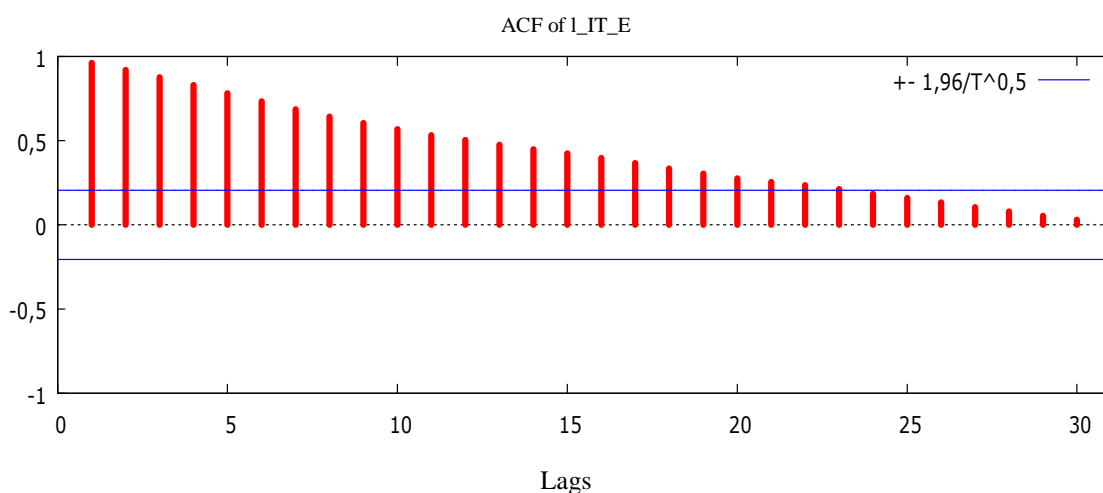


Figure 3.4. ACF correlogram of l_IT_E , 1990:1-2012:1. Source: Author's elaboration.

In the same way, a visual plot of the data (here expressed in logs) is usually one of the first steps in the analysis of any time series (figure 3.5 and 3.6):

⁴⁷ In practice, the maximum length of lags to be use is up to one-third of the sample size.

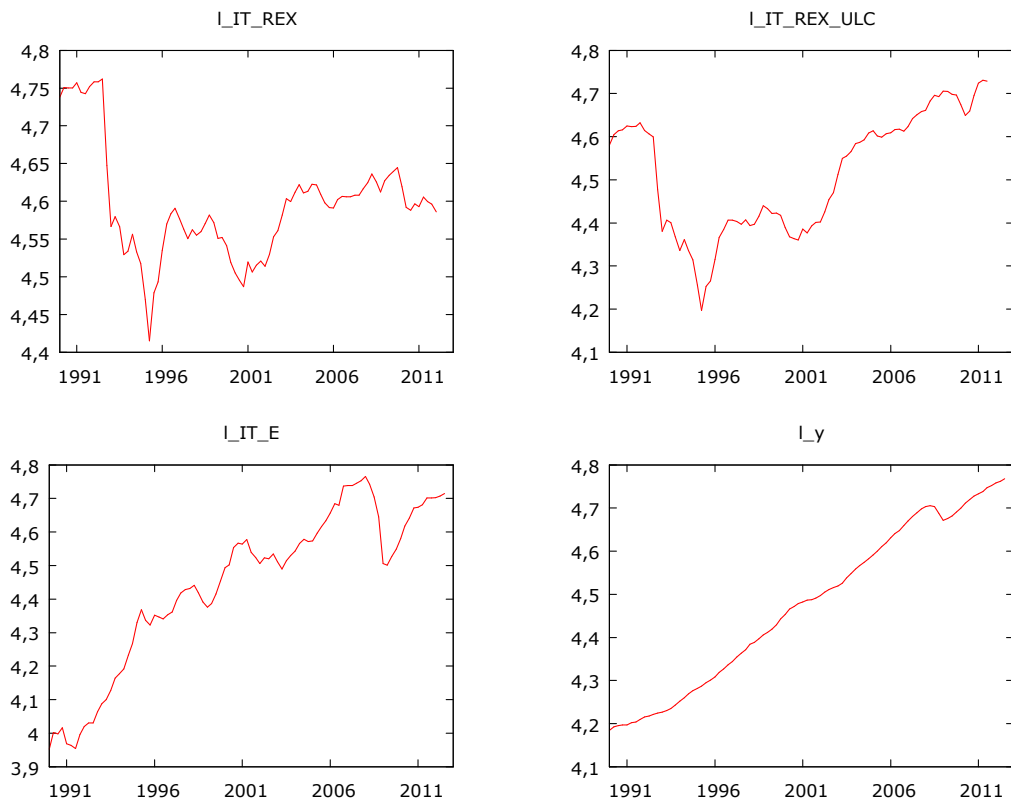


Figure 3.5

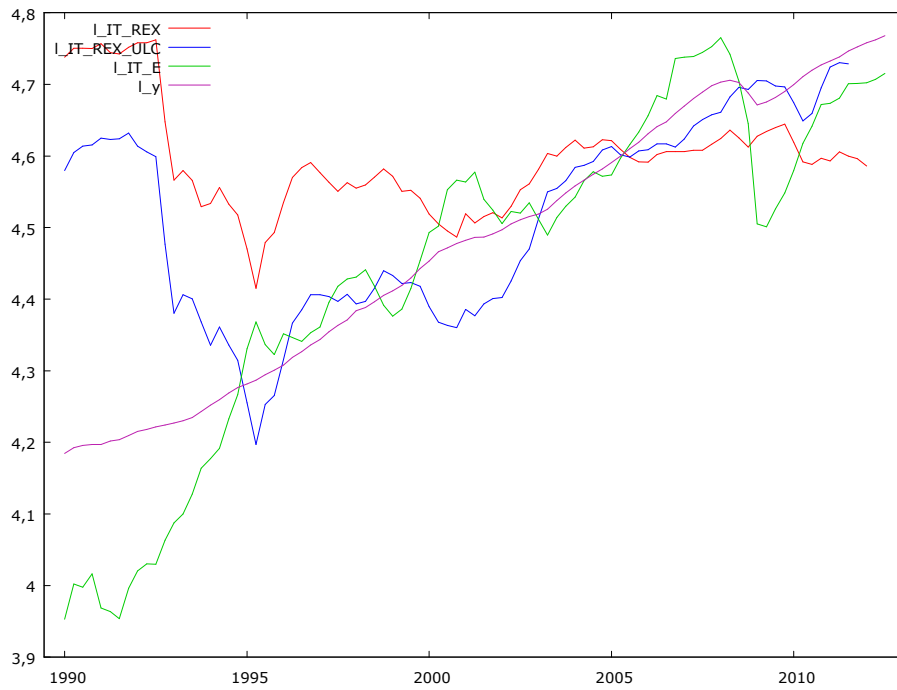


Figure 3.6

Summary statistics are described as follows:

Variable	Mean	Median	Minimum	Maximum	Std. Dev.	Var. coeff.	Asymmetry	Curtosis
I_IT_E	4,44171	4,50553	3,9527	4,76552	0,23398	0,05268	-0,6981	-0,569
I_IT_REX	4,59489	4,59178	4,4151	4,76226	0,07352	0,016	0,69256	0,51748
I_IT_REX_ULC	4,51389	4,55472	4,19705	4,73057	0,13832	0,03064	-0,1873	-1,2213

Table 3.3. Descriptive statistics, Sample period: 1990:1 - 2012:3. Source: Author's own elaboration on Datastream and IFS Databases.

Since at a first visual and informal level⁴⁸ each series seems to be non-stationary, I proceed to a formal level of investigation and implement a unit root test for each variable.

4.3.1 Unit Root Test of stationarity

To test whether the series are non-stationary I implement the Augmented Dickey-Fuller (ADF) test (1981). Under the null hypothesis (H_0) there is the presence of a unit root. The statistic-test is the tau-test (τ) for which the critical values are those tabulated by MacKinnon through Monte Carlo simulations⁴⁹. *Gretl* software package prints out the p-value based on MacKinnon's approximation to the distribution of the τ - statistics: the p-value is, therefore, the value on which I figure the decision of rejecting or accepting the null hypothesis of the presence of a unit root.

The ADF tests in which lags of Δy , are added to avoid the problem of serial correlation of the residuals⁵⁰: indeed, the τ -statistics, computed as ordinary t-statistics, remain *asymptotically valid* in the presence of serial correlation when this is done.

Running the ADF test in levels, Italy's exports, the exchange rate based on the Consumer Price Index and the exchange rate based on the Unit Labor Cost Index series are shown to be all $I(1)$, i.e., integrated of order 1. The tests were executed for three different cases: (i) τ_c , with a constant, (ii) τ_{ct} with a constant and trend and (iii) τ_{nc} without a constant. The results are sensitive to the case applied because the critical values change in the three cases.

Afterwards, the test was repeated using the first differences of each series: the series, differenced only once are shown to be stationary (the null hypothesis of a unit root can be

⁴⁸ See Appendix 1. B for the visual plots of the time series variables.

⁴⁹ MacKinnon J. G. (2010), Critical Values for Cointegration Tests, Queen's Economics Department Working Paper No. 1227, Queen's University.

⁵⁰ "The 'augmented' Dickey-Fuller, or ADF, tests, in which lags of Δy , are added [...] so as to whiten the residuals". MacKinnon, *op cit*.

rejected) so it can be affirmed that the original time series (the one in levels) are integrated of order 1, $I(1)$. The ADF test implemented on original time series (l_IT_E , l_IT_REX and $l_IT_REX_ULC$) for Italy in levels and in first differences are summarized in Table 3.4⁵¹:

Variable	Variant	τ –statistic ADF level	p-value*	τ –statistic ADF first difference	p-value*
l_IT_E	Constant, no trend τ_c	-1,44672	0,5608	-6,24789	0,00000
	Constant and trend τ_{ct}	-2,0832	0,5547	-6,25815	0,00000
	No constant τ_{nc}	1,57885	0,9725	-5,96656	0,00000
l_IT_REX	Constant, no trend τ_c	-2,69871	0,07419	-4,15522	0,00078
	Constant and trend τ_{ct}	-3,39395	0,05212	-3,62381	0,02779
	No constant τ_{nc}	-0,11459	0,6443	-4,2796	0,00000
l_IT_REX_ULC	Constant, no trend τ_c	-0,83832	0,8077	-3,81311	0,00279
	Constant and trend τ_{ct}	-3,08087	0,1108	-3,6079	0,02909
	No constant τ_{nc}	0,32101	0,7783	-3,58096	0,00034

Table 3.4. ADF Unit root tests: comparative settings. MacKinnon (1996) critical values for the null hypothesis $H_0 =$ presence of a unit root. * Asymptotic p-values.

As we can see, the variables in levels are non-stationary so the null hypothesis ($H_0 =$ there is a unit root) cannot be rejected for each series and for each variant of the test (τ_c , τ_{ct} , τ_{nc}). In order to achieve the stationarity of the series, I use the first differences of this variable and then test them for the presence of a unit root. The asymptotic p-values of the tests implemented in the three variants show that we can now reject the null hypothesis of a presence of a unit root. Once cointegration is established, it can be reasonably expected to present an equilibrium relationship between the variables. For this reason, the next step is to gauge the cointegration relationship. The estimation of the cointegration relationship requires the execution of a test to determine the number of cointegrating vectors present in the system, in other words, the *cointegrating rank* of the system. To determine the number of cointegrated vectors the Johansen approach is followed.

⁵¹ The results of the ADF tests for the other countries under investigation are given in Appendix 2.A.

4.3.2 Johansen Cointegration Tests

This is an important phase since it provides the required information to subsequently implement the VECM analysis with, at least, the appropriate rank. The two Johansen tests for cointegration are used to establish the rank are the “ λ -max” test, for hypotheses on individual eigenvalues, and the “trace” test, for joint hypotheses.

Two test statistics are, thus, used to test the number of cointegrating vectors, based on the characteristic roots. For both the null (H_0) is: *at most r* cointegrating vectors.

The trace statistics:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^k \ln(1 - \hat{\lambda}_i)$$

where the alternative (H_1) is: *at most k* cointegrating vectors.

It looks at the trace of $A(1)$ = the sum of eigenvalues. If there is no cointegration, then all $1 - \hat{\lambda}_i$ are zero and trace of $A(1) = 0$. The test is ran in sequence: start from the null of *at most 0* cointegrating vectors up to *at most k* cointegrating vectors against the alternative.

Lambda-max statistics:

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1})$$

where the alternative (H_1) is: *at most r+1* cointegrating vectors. It tests rank $r+1$ by testing if $\hat{\lambda}_{r+1}$ is zero.

Italy’s model presents three variables so the tests can be specified as follows:

Rank	Trace test		λ -max test	
	H_0	H_1	H_0	H_1
0	c = 0	c = 3	c = 0	c = 1
1	c = 1	c = 3	c = 1	c = 2
2	c = 2	c = 3	c = 2	c = 3

where c = cointegrating vectors.

Neither of these test statistics follows a chi-square distribution in general; asymptotic critical values are those tabulated with Doornik's (Doornik, 1998) gamma approximation distribution.

When $r = 0$ there are no cointegrating vectors. If there are k variables in the system of equations, there can be a maximum of $k-1$ cointegrating vectors.

The results for the model that includes l_IT_REX ⁵² are:

Rank	Eigenvalue	Trace test p-value	Lmax test p-value
0	0,21118	30,560 [0,0405]	20,164 [0,0672]
1	0,11414	10,397 [0,2559]	10,302 [0,1963]
2	0,0011112	0,094509 [0,7585]	0,094509 [0,7585]

Table 3.5: Johansen Tests l_IT_REX

The values are examined one row at a time starting from the first row and, as it can be seen, the trace test has a p-value lower than the 5% so we can reject the null of $r = 0$ (even though the λ -max is not that straightforward⁵³): this means we can stop and consider $r = 1$. Indeed, looking at the p-value related to the null: $r = 1$, this cannot be rejected. The same can be said for the second model that comprises $l_IT_REX_ULC$:

Rank	Eigenvalue	Trace test p-value	Lmax test p-value
0	0,21251	29,826 [0,0497]	19,829 [0,0751]
1	0,10448	9,9974 [0,2861]	9,1588 [0,2795]
2	0,010052	0,83853 [0,3598]	0,83853 [0,3598]

Table 3.6: Johansen Tests for $l_IT_REX_ULC$

4.3.3 Estimates

Once ascertained that the variables are integrated of order I (1), the VECM analysis can be executed. For each country there are two different models respectively for the two types of

⁵² See Appendix 2.B and 2.C for the Johansen cointegration tests for Germany, France, USA, Japan UK and China.

⁵³ If results of the two test statistics are not consistent the suggestion is to use the trace statistics: the trace test, indeed, is likely to pick up the correct value of r and have good power. For further details, see K. Juselius lecture notes, <http://www.econ.ku.dk/okokj>.

real exchange rates: one based on the Consumer Price Index (CPI), model A, and the other on the Unit Labor Cost (ULC), model B.

$$A) l_{IT_E} = f(l_{IT_REX}, l_y)$$

$$l_{IT_E} = -0,71l_{IT_REX} + 1,01 l_y:$$

Country	Long-run Price elasticity	Short-run Price elasticity	Long-run Income elasticity	Short-run Income elasticity	ECM Speed of Adj.
Italy	-0,72	-0,05	1,01	0,70	-0,25
<i>s.e.</i>	<i>-0,141100</i>	<i>0,123866</i>	<i>-0,053981</i>	<i>0,815929</i>	<i>0,056667</i>

Table 3.7: VECM system, 4 lags. Obs.: 1990:1-2012:1 (T = 85); Cointegration rank = 1; Exchange rates on Consumer Price Index bases. Source: Own estimations on Datastream and IFS databases. Notes: Aggregation level: value of goods and services; Index 2005=100.

These results⁵⁴ indicate that the long-run export price and income elasticities estimates are, respectively: -0,72 and +1,01.

The short-run export price and income elasticities estimates are, respectively: -0,05 and +0,7.

The Error Correction term coefficient, which is expected to be negative and to lie between 0 and 1, is - 0,25; it is statistically significant and exhibits the expected negative sign. As aforesaid, it indicates the speed at which the variables return to equilibrium after departing for the equilibrium path (after a shock, for example).

The Durbin-Watson test is: 1,96 while the Adjusted R2 is 0,45.

The following graph plots the residuals of the system jointly:

⁵⁴ See Appendix 3 for detailed estimation outputs related to all the countries under investigation.

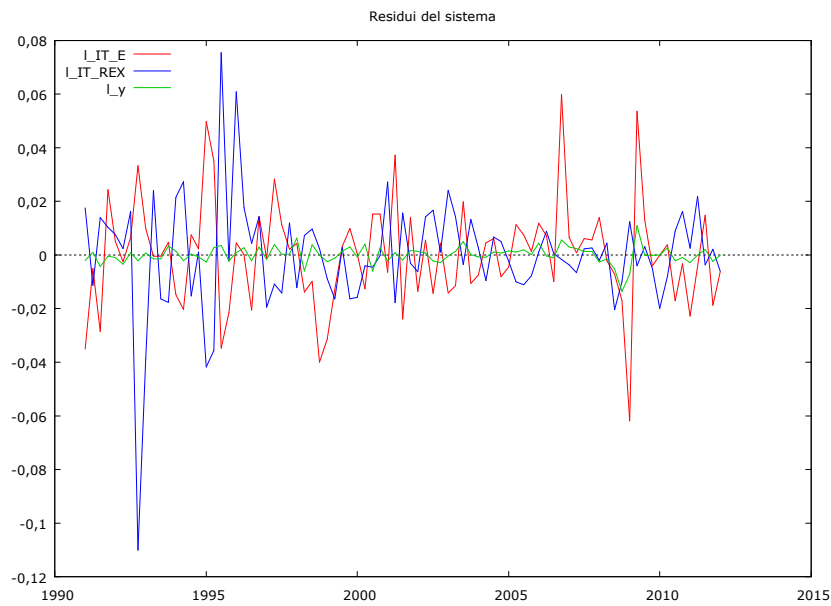


Figure 3.7. Source: Author's own elaboration.

The statistic used to test the presence of serial correlation is the Ljung-Box Q-statistic. In general the test on serial correlation using the Q-statistic has the null hypothesis of "no serial correlations" (up to the lags used for the test, which here are 4):

Serial correlation diagnostic test:

Equation 1:

Ljung-Box Q' = 0,407565 with p-value = 0,982

Equation 2:

Ljung-Box Q' = 4,27906 con p-value = 0,37

Equation 3:

Ljung-Box Q' = 0,10923 con p-value = 0,999

Hence, the test indicates that there is no serial correlation since you cannot reject the null.

Italy presents a long-run price elasticity of -0,72 (Table 3.7), which confirms the general findings. It is interesting to notice that the long-run export price elasticity estimates provided in the present research for Italy, using two different techniques⁵⁵ but the same sample period

⁵⁵ Distributed Lag model and Vector Error Correction model, *cfr.* Chapters 2 and 3.

and the same econometric specification, are almost exactly the same $(-0,71)^{56}$. The main difference concerns the dependent variable: in the first case, I use the value of exports as the dependent variable which includes both price and quantity variations; in the second case, exports are expressed in volumes and, hence, entail only quantity variations.

$$B) l_{IT_E} = f(l_{IT_REX_ULC}, l_y):$$

<i>Country</i>	<i>Long-run Price elasticity</i>	<i>Short-run Price elasticity</i>	<i>Long-run Income elasticity</i>	<i>Short-run Income elasticity</i>	<i>ECM Speed of Adj.</i>
Italy	-0,48	-0,12	1,32	0,60	-0,28
<i>s.e.</i>	<i>-0,083110</i>	<i>0,111288</i>	<i>-0,065614</i>	<i>0,810375</i>	<i>0,065019</i>

Table 3.8: VECM system, 4 lags. Obs.: 1990:1-2012:1 (T = 85); Cointegration rank = 1; Exchange rates on Unit Labor Cost index bases. Source: Own estimations on Datastream and IFS databases. Notes: Aggregation level: value of goods and services; Index 2005=100.

These results show that the long-run export price and income elasticities estimates are, respectively: -0,48 and + 1,32.

The short-run export price and income elasticities estimates are, respectively: -0,12 and +0,6.

The Error Correction term coefficient is -0,28; it is statistically significant and exhibits the expected negative sign.

The Durbin-Watson test is: 1,95 while the Adjusted R2 is 0,46.

The evidence is that the short-run price elasticities are noticeably smaller than the long-run price elasticities in both the cases considered: indeed, in general, the long-run elasticities are roughly twice as high as the short-run elasticities. In the first model, though, the difference between long-run and short-run estimates is much greater.

4.4. Export elasticity estimates for Germany, France, USA, Japan, UK and China.

In this section I present the estimation results for all the seven countries under scrutiny: having estimated the countries' export price⁵⁷ elasticities separately, I provide an overall view of the short-run and long-run elasticities within two summarizing tables. In the following sections, I compare and discuss the results both with the findings of previous studies and with

⁵⁶ Cfr. Chapter 3, section 4.2.

⁵⁷ The income elasticities have been also reported for a broad comprehension of the whole issue.

my findings. Reiterating the VECM equations⁵⁸ for Germany, France, USA, Japan, UK and China, I obtain the following results:

<i>Country</i>	<i>Long-run Price elasticity</i>	<i>Short-run Price elasticity</i>	<i>Long-run Income elasticity</i>	<i>Short-run Income elasticity</i>	<i>ECM Speed of Adj.</i>
Italy	-0,72	-0,05	1,01	3,86	-0,25
<i>s.e.</i>	<i>-0,141100</i>	<i>0,123866</i>	<i>-0,053981</i>	<i>0,815929</i>	<i>0,056667</i>
Germany	-0,11	-0,13	2,18	2,65	-0,25
<i>s.e.</i>	<i>0,179100</i>	<i>0,210564</i>	<i>0,050633</i>	<i>0,994302</i>	<i>0,093337</i>
France	-1,41	-0,27	0,10	3,63	-0,12
<i>s.e.</i>	<i>0,407000</i>	<i>0,153284</i>	<i>0,100790</i>	<i>0,681037</i>	<i>0,027807</i>
USA	-1,21	-0,03	1,38	2,63	-0,23
<i>s.e.</i>	<i>0,190390</i>	<i>0,140229</i>	<i>0,068277</i>	<i>0,980787</i>	<i>0,034103</i>
Japan	-0,55	-0,23	1,34	1,66	-0,28
<i>s.e.</i>	<i>0,123420</i>	<i>0,086874</i>	<i>0,082945</i>	<i>1,319900</i>	<i>0,076372</i>
UK	-0,84	-0,07	1,60	0,02	0,03
<i>s.e.</i>	<i>0,233410</i>	<i>0,140872</i>	<i>0,118090</i>	<i>1,392200</i>	<i>0,044925</i>
China	-1,95	-0,27	5,58	1,87	-0,27
<i>s.e.</i>	<i>0,307520</i>	<i>0,254649</i>	<i>0,140780</i>	<i>0,229376</i>	<i>0,114734</i>

Table 3.9: VECM system, 4 lags. Obs.: 1990:1-2012:1(T= 85); Cointegration rank =1; Exchange rates on Consumer Price Index bases. Source: Own estimations on Datastream and IFS databases. Notes: Aggregation level: value of goods and services; Index 2005=100.

<i>Country</i>	<i>Long-run Price elasticity</i>	<i>Short-run Price elasticity</i>	<i>Long-run Income elasticity</i>	<i>Short-run Income elasticity</i>	<i>ECM Speed of Adj.</i>
Italy	-0,48	-0,12	1,32	0,60	-0,28
<i>s.e.</i>	<i>-0,083110</i>	<i>0,111288</i>	<i>-0,065614</i>	<i>0,810375</i>	<i>0,065019</i>
Germany	-0,21	-0,17	2,06	3,06	-0,19
<i>s.e.</i>	<i>0,106450</i>	<i>0,116483</i>	<i>0,074202</i>	<i>0,828905</i>	<i>0,063510</i>
Francia	-1,20	-0,32	1,06	3,21	-0,23
<i>s.e.</i>	<i>0,152520</i>	<i>0,114040</i>	<i>0,071855</i>	<i>0,602382</i>	<i>0,042725</i>
USA	-0,57	0,08	1,26	2,17	-0,34
<i>s.e.</i>	<i>0,108390</i>	<i>0,119547</i>	<i>1,259200</i>	<i>1,009050</i>	<i>0,048355</i>
Japan	-0,37	-0,06	1,39	-0,32	-0,34
<i>s.e.</i>	<i>0,105960</i>	<i>0,084542</i>	<i>0,099315</i>	<i>1,897500</i>	<i>0,087257</i>
UK	-0,26	-0,09	1,64	0,73	-0,08
<i>s.e.</i>	<i>0,099019</i>	<i>0,139602</i>	<i>0,084836</i>	<i>1,605630</i>	<i>0,094353</i>
China	-	-	-	-	-
<i>s.e.</i>	-	-	-	-	-

Table 3.10: VECM system, 4 lags. Obs.: 1990:1-2012:1(T= 85); Cointegration rank =1; Exchange rates on Unit Labor Cost index bases. Source: Own estimations on Datastream and IFS databases. Notes: Aggregation level: value of goods and services; Index 2005=100.

⁵⁸ $l_{Country_E} = f(l_{Country_REX}, l_y)$ and $l_{Country_E} = f(l_{Country_REX_ULC}, l_y)$.

5. DISCUSSIONS OF THE RESULTS

The VECM results reveal discrepancies with the current debate on weak currencies and with the concrete situation of some of the countries examined like Germany:

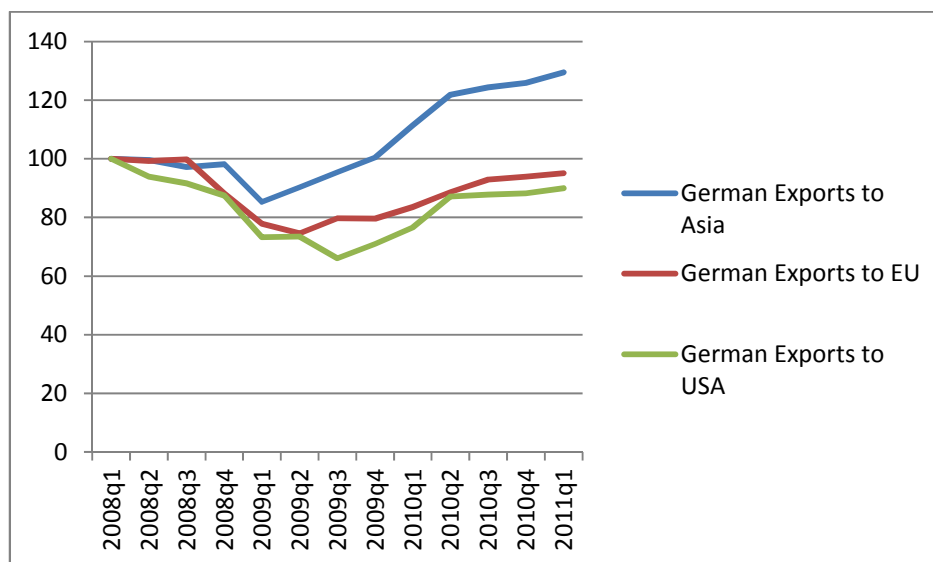


Figure 1.1 Germany: exports to Asia, EU and USA. Index, 2008Q1 = 100
Note: Growth refers to that of real GDP. Exports are of goods and for 2011Q1 refer to January and February 2011.
Source: Deutsche Bundesbank; OECD, National Accounts database, author's elaboration.

In general, it is interesting to notice, indeed, that the results report long-run export price elasticity estimates lower than unity in most cases (Table 3.9). In particular, Germany (-0,11), UK (-0,84) and Japan (-0,55), three of the major exporting countries, present very low values that do not justify policies applied on exchange rates to promote growth through trade balances' surplus and, furthermore, diverge from the line of reasoning of the currency war issues in which they are involved. For what concerns the estimates reported for USA (-1,21) and China (-1,95), they are certainly more plausible and consistent with some results of previous studies but still far from the current debate.

These considerations assume even more importance when looking at the estimates provided using the exchange rate on Unit Labor Cost basis (Table 3.10): all countries, indeed, present very low long-run price elasticity estimates that cannot meet any currency depreciation policy effectiveness.

The aggregation level can possibly be a cause of these low estimates and probably higher disaggregation would lead to more reasonable estimates but, even so, the initial questions remain: how effective is this policy? What is the boundary value beyond which currency depreciation policies can be considered effective? What is the magnitude of variation supposed to be to have a significant impact on exports? Do exports, at an aggregate level, react differently depending on different factors such as the development status of the traders, the sector or the type of the exported good?

The results of this study confirm that there is no simple, consistent relationship between trends in the trade balance and trends in real exchange rates. Furthermore, due to the variability of the results in the previous literature, the export demand price estimates need to be used with great caution and all choices are arbitrary.

The short-run elasticity estimates confirm the general theory as they are smaller than the long-run estimates and this is mainly due to the adaptation period⁵⁹.

One of the reasons why the VECM was adopted was because it comprised the possibility to identify the speed of adjustment to the already mentioned “*equilibrium path*”. The last columns of Tables 3.9 and 3.10 reveal *how much* of the error has been corrected and, at the same time, *how long* will it take to reach the equilibrium value. For example, Italy’s error correction term, -0,25 (Table 3.9), indicates that 25% of the error has been corrected and that it will take other four periods to reach the equilibrium value: since quarterly data has been used, this means that the adjustment will be pursued within one year⁶⁰. The highest speed of adjustment is registered by Japan (-0,28) while the country that will need more time to reach equilibrium is France (-0,12). All values are significant and of the expected sign with exception of UK (+0,03).

Finally, with the exception of France (Table 3.9), the long-run income elasticity estimates are, within limits, higher than the long-run price elasticity ones meaning that export demand is, according to these outcomes, more income elastic than price elastic. A high income elasticity of export demand means that an increase in world income will increase export demand of a country substantially: *ceteris paribus*, this will improve the balance of trade.

⁵⁹ Cfr. Chapter 2.

⁶⁰ $1/0,25 = 4 \cdot 3 \text{ (months)} = 1 \text{ year}$.

5.1 Comparing the export elasticity estimates with those of other studies.

The effort to accomplish a comparative framework is carried out by selecting three previous studies⁶¹ and by comparing their results with those of the present analysis in order to highlight variability, consistencies and/or discrepancies. The studies chosen are described in Chapter 2⁶².

The first study examined was carried out by OECD in 2000 using a single equation approach in ECM framework for a “exports goods and services” level of aggregation, and covering a period from 1975 to 1997. With exception of France and China, the long-run export price estimates (Table 3.11) of this research, column (*e*) are significantly higher than those provided by the present analysis, column (*a*) indicating a much greater price elasticity: for example, Japan (-1,40 compared to -0,55) and UK (-1,58 compared to -0,84). This confirms that different econometric specifications and periods examined lead to different results.

Additionally, having observed that the two studies share the same empirical framework (same methodology and same level of aggregation), a further comparison is carried out by applying the VECM and re-estimating the price elasticities for the period from 1975 to 1997: doing so, the only element that changes, *ceteris paribus*, is the econometric specification. When the VECM is applied in the re-estimation perspective (period 1975-1997), the long-run results (column (*c*)) change radically with respect to the original study (column (*e*)): indeed, in most cases (Italy, Japan, UK and China) they are very similar to those obtained examining the period from 1990 to 2012 and this means that, in this particular case, the *period factor* has a minor impact on the estimation outcomes. In this particular case, therefore, the determinant of variability can likely be the econometric specification:

⁶¹ As reported in Tables 3.11, 3.12 and 3.13.

⁶² Table 2.6, “Selected Long-run price elasticities: a comparison of studies and results”.

Country Variable		VECM 1990-2012		VECM 1975-1997			OECD (2000) 1975-1997	
		(a)	(b)	(c)		(d)		(e)
		Long-run Price elasticity	Short-run Price elasticity	Long-run Price elasticity	<i>Standard error</i>	Short-run Price elasticity	<i>Standard error</i>	Long-run Price elasticity
Italy	l_IT_REX	-0,72	-0,05	-0,76	0,04801	-0,11	0,16183	-0.98
Germany	l_GE_REX	-0,11	-0,13	-2,71	1,05060	-0,49	0,22477	-1.44
France	l_FR_REX	-1,41	-0,27	-2,35	1,09230	-0,49	0,12116	-0.81
USA	l_US_REX	-1,21	-0,03	-0,03	0,13660	-0,06	0,08088	-1.41
Japan	l_JP_REX	-0,55	-0,23	-0,50	0,09780	-0,02	0,05454	-1.40
UK	l_UK_REX	-0,84	-0,07	-1,02	0,41150	-0,14	0,06278	-1.58
China	l_CH_REX	-1,95	-0,27	-1,15	0,32930	-0,17	0,17175	-0.68

Table 3.11: (a), (b):VECM system, 4 lags. Obs.: 1990:1-2012:1(T= 85); Cointegration rank =1; Exchange rates on Consumer Price Index bases; (c), (d): VECM system, 4 lags. Obs.: 1975:1-1997:1(T= 68); Cointegration rank =1; Exchange rates on Consumer Price Index bases; (e): Sources: Own estimations on Datastream and IFS databases for (a), (b,) (c), and (d); OECD (2000) Modelling manufacturing export volumes equations: a system estimation approach, for (e). Notes: Aggregation level: value of goods and services.

Even in the second case, my analysis is compared to the results of a study carried out by OECD in 2005 and covering a period from 1982 to 2002. Both the methodology and the econometric specifications are different with respect to the present study but, nevertheless, a comparison is made in order to exclude the impact of the time factor. In this case the results, column (e), are lower than the first study, resulting more similar to the estimates provided using VECM for the period 1990-2012, column (a). Obviously, when applying the second form of comparison, using a VECM for the period from 1982 to 2002, the estimates vary greatly and it is difficult to recognize similarities (Table 3.12, columns (a) and (c)). In this case, trying to find the determinants of variability is a challenging task although, dropping the time factor, the variability can be addressed to the methodology and/or to the econometric specification:

Country		VECM 1990-2012		VECM 1982-2002				OECD (2005) 1982-2002
		(a)	(b)	(c)		(d)		(e)
		Long-run Price elasticity	Short-run Price elasticity	Long-run Price elasticity	<i>Standard error</i>	Short-run Price elasticity	<i>Standard error</i>	Long-run Price elasticity
Italy	l_IT_REX	-0,72	-0,05	-2,06	0,58640	-0,34	0,13794	-0.60
Germany	l_GE_REX	-0,11	-0,13	-0,11	0,34681	-0,56	0,19366	-0.47
France	l_FR_REX	-1,41	-0,27	-0,04	0,40155	-0,53	0,10457	-0.60
USA	l_US_REX	-1,21	-0,03	-3,02	0,61097	-0,08	0,07834	-0.60
Japan	l_JP_REX	-0,55	-0,23	-0,02	0,08976	-0,07	0,05023	-1.05
UK	l_UK_REX	-0,84	-0,07	-1,73	0,42764	-0,09	0,07355	-0.60
China	l_CH_REX	-1,95	-0,27	-0,61	0,19265	-	-	-1.5

Table 3.12: (a), (b):VECM system, 4 lags. Obs.: 1990:1-2012:1(T= 85); Cointegration rank =1; Exchange rates on Consumer Price Index bases; (c), (d): VECM system, 4 lags. Obs.: 1982:1-2002:1(T= 84); Cointegration rank =1; Exchange rates on Consumer Price Index bases; (e): Sources: Own estimations on Datastream and IFS databases for (a), (b,) (c), and (d); OECD (2005), The new OECD international trade model for (e). Notes: Aggregation level: value of goods and services.

In the last example, I compare my results with those of Hooper *et. al.* (2000). The authors of this research estimated and tested the stability of import and export elasticities relating the G7 countries to their respective income and prices. The period covered ranges from 1990 to 1996 and the quarterly data include goods and services. The methodology and the econometric specification are different and, as expected, they obtain different results (Table 3.13, column (e)) that are generally higher (doubled for Japan and UK) when comparing columns (e) and (a)):

Country		VECM 1990-2012		VECM 1990-1996				Hooper <i>et</i> <i>al.</i> (2000) 1990-1996
		(a)	(b)	(c)		(d)		(e)
		Long-run Price elasticity	Short-run Price elasticity	Long-run Price elasticity	<i>Standard error</i>	Short-run Price elasticity	<i>Standard error</i>	Long-run Price elasticity
Italy	l_IT_REX	-0,72	-0,05	-1,57	0,31498	-0,23	0,23118	-0.9
Germany	l_GE_REX	-0,11	-0,13	-0,57	0,43982	-0,56	0,43325	-0.3
France	l_FR_REX	-1,41	-0,27	-0,25	0,26485	-0,09	0,42869	-0.2
USA	l_US_REX	-1,21	-0,03	-0,58	0,15838	-0,14	0,12763	-1.5
Japan	l_JP_REX	-0,55	-0,23	-0,61	0,20780	-0,01	0,09942	-1.0
UK	l_UK_REX	-0,84	-0,07	0,07	0,12179	-0,21	0,12417	-1.6
China	l_CH_REX	-1,95	-0,27	-1,49	0,21752	-0,35	0,27757	-

Table 3.13: (a), (b):VECM system, 4 lags. Obs.: 1990:1-2012:1(T= 85); Cointegration rank =1; Exchange rates on Consumer Price Index bases; (c), (d): VECM system, 4 lags. Obs.: 1990:1-1996:1(T= 28); Cointegration rank =1; Exchange rates on Consumer Price Index bases; (e): Sources: Own estimations on Datastream and IFS databases for (a), (b,) (c), and (d); Hooper P., Johnson K., Marquez J. (2000), Trade elasticities for the G-7 Countries for (e). Notes: Aggregation level: value of goods and services.

In conclusion, as in many other studies, one consistent result is that the main driver of trade flows is found to be income and the comparative framework provided confirms the general findings of my research and suggests that trade imbalances are more complex than the single question of exchange rate levels. The impacts of exchange rates on trade should be regarded in the context of many underlying factors, including trade patterns and supply chains. Exports generally include a high import content and the impact of exchange rate depreciation or appreciation on any finished product is therefore multifaceted. If it is true that an exchange rate depreciation makes exports of final products “cheaper”, it also makes imported components “more expensive” for domestic producers: the problem is once again the measurement of the correct entity of depreciation needed to achieve the required results in terms of trade balance improvements.

5.2 Summary

International trade estimates are an important contribution for any analysis of the aggregate effects of changes in income and relative prices but, obviously, they do not guarantee that a particular result will in fact occur in response to the above mentioned changes. It is also clear that the knowledge of elasticity magnitudes is important to deal with the unavoidable (and, to a certain degree, predictable) changes they produce on a country’s trade balance and level of income and employment.

Trade elasticities could be (and, actually are) used by policy-makers to estimate the exchange rate variation that would be required to eliminate or reduce trade balance deficits and, in the same way, to take decisions on currency depreciation or appreciation⁶³.

For what concerns the present debate on Asian currencies (appreciation against depreciation policies), it can be said that, if we start from a situation of imbalanced trade (deficit or surplus in the trade balances) and if the aim is to reduce or eliminate the deficit through variations in real exchange rates, the Marshall-Lerner condition (see Appendix 4) is not sufficient as one of the assumptions of this condition (i.e., a real appreciation reduces trade balance if the sum of elasticities, in absolute values, of the demand for import and export are greater than 1) is that we start from a situation of balanced trade. This analysis examines surplus but also deficit countries and this makes the interpretation of the results more complicated.

⁶³ De Vanssay X. (2003), “The Marshall-Lerner Condition” in 'An Encyclopedia of Macroeconomics' (pp. 461-464) Edited by Brian Snowden and Howard R. Vane (Edward Elgar Publishing 2003).

The controversial debate on global trade imbalances, especially between the EA and China and between the USA and China, highlights the role of exchange rates and of exchange rate misalignments that are perceived as the origin of a series of economic disorders both on domestic and on global basis. These problems are complex and involve a variety of issues such as economic stability and competitiveness.

Generally, the debate focuses on the valuation of the Chinese currency, Renminbi (hereafter RMB) and on how China, artificially⁶⁴ depressing its currency's value and promoting policies that tend to depreciate the RMB or to keep it weak, increases its surplus and generates global imbalances without improving the effective non-price competitiveness factors. It is straightforward that China (and other rapidly developing countries) has enormously increased its share in trade⁶⁵ in the recent years even though industrialized countries have better

⁶⁴ In the sense that China is deliberately manipulating its exchange rate to obtain a competitive advantage. If it is true that every country's aim has always been its development and the achievement of always more profitable economic processes, it is also established that, at the moment, every country wants to grow as fast it can to try to overcome the financial crisis, and one of the ways to achieve this goal could be, a real depreciation, entailing a decrease in the price of labor with respect to other countries.

When trade becomes unbalanced, deficit countries need to raise interest rates to reduce demand for imports and exports, as well as reducing wages to increase competitiveness. Actually, there is no tangible self-regulating system that can lead to quick fixes or that can restore global growth and reduced wages are largely a response to higher unemployment.

Both American and European trade partners are particularly concerned with the self-protecting policies carried out by Asian emerging countries in order to overcome the financial crisis. This kind of behavior is seen as a potentially damaging dynamic that can lead to a global currency war. Indeed, the results from several specifications indicate that a real exchange rate appreciation will surely increase the value of the country's imports but the value of exports can either increase or decrease. A real depreciation is expected to stimulate growth by the expansion of exports and the contraction of imports. More recent literature (Gupta, Mishra, Sahay, 2007) focuses on the negative effects: a sudden stop or reversal of capital inflows during a crisis can slow down growth and the slowdown may be worse if the currency crisis is accompanied by a banking crisis or by competitive devaluation in other countries.

In general, the global rebalancing entails bilateral adjustments that proceed by steps and it is difficult to outline the whole process unmistakably. Internal and external rebalancing are, actually, the two sides of a same problem. The economies face the problem, on foreign and/or domestic basis, according to what they consider a priority. First of all, some economists and policy-makers delimitate the issue identifying two central economies, United States and China, while others think that all Asian economies are involved.

The USA urge an increase in Asian consumption spending without considering the need for more saving in the U.S.; on the other hand, Asian countries think that more saving is needed in the U.S. without considering that this implies an increase in spending in other countries to support global demand. Some consider exchange rate adjustments fundamental, while others do not consider them important (Eichengreen, Rua, 2010).

Finally, mentioning China, for example, its real exchange rate against the dollar has improved and, at the same time, wage growth and inflation have proceeded far faster in China than in America. China's real appreciation against other emerging Asian markets (against which it competes for export), though, has been far less, as those countries have also seen substantial inflation in prices and wages.

It is evident that there is a compound puzzlement; this confusion obviously leads to multiple (and, potentially, contradictory) explanations that need to be unraveled.

⁶⁵ These results, however, are very difficult to interpret because more than half of Chinese exports are classified as "transformation trade", that is, instrumental goods that are imported and processed by China to then be re-exported. Goldstein A. (2011), *op. cit.*

performances and are more competitive⁶⁶ and the common opinion is that this positive trend is due to exchange rate policies.

On the one hand and according to the prevalent literature, the *only* remedy policy to restore global stability is that China has to appreciate its currency. In such sense, though, it is necessary to measure the extent of misalignment but, unfortunately, despite the number of studies attempting to estimate the real “equilibrium” value of the RMB, no consensus has emerged up to now. On the other hand and according to China, the large trade and current account surpluses that China has experienced in the last years and its increasing presence in world markets is due to structural rather than exchange rate factors: e.g., growing surplus of national savings, heavy foreign direct investment (FDI) in re-export operations in China, different trade patterns.

In any direction, the question always turns, though, to the role of China’s real exchange rate, how this can explain its economic performance on the international markets and to the possibility that a RMB appreciation could reduce global imbalances. This is surely the point of view of some deficit countries like USA. To further complicate the problem, China’s undervaluing currency policies have potential implications not only for the industrialized economies but even for the so-called emerging ones and for the developing ones: indeed, some are afraid that a weak Chinese currency (that potentially brings to an increase in Chinese exports) will have a negative outcome as for their industrialization process; others think that the power of China’s growth is the driving force of those economies and, therefore, any development that disadvantages China will penalize them too.

In a general perspective, the main and perhaps obvious conclusion beyond question is that even though the estimation of trade elasticities is far from being a new field of study, there is a need for continual estimation of trade elasticities and, due to the importance of the issue, it must be treated with great caution. Indeed, in spite of the large body of literature and of the development of the econometric specifications, there are still areas where the state of knowledge is rather inadequate. More specifically, for what concerns the responsiveness of exports to changes in the exchange rates, there is the possibility to contribute with further studies because still little is well-established.

⁶⁶ Goldstein A. (2011), *op. cit.*

5.3 Forthcoming research

There are many areas for further research and probably, one of these could be to test potential competing explanations for differences in price elasticities since these differences are crucial for understanding the trade impacts involved and the accomplishment of the consequent macroeconomic policies operated. The effort will be to deepen the study of the determinants of trade price elasticities in order to develop and implement an econometric model free from specification errors and able to capture a range of variables (such as underlying variables) and that can explain some of the discrepancies revealed in the comparison of the estimates provided in this study with the selected estimates used as benchmark values.

It would be also interesting to verify what happens in economies with different patterns and rates of growth (developed, less developed, and emerging) when they are facing both current account adjustments, considering that the response of imports and exports to changes in relative prices and/or exchange rates is hardly instantaneous. This sort of research could be carried out using an indexes-based analysis (e.g., Balassa, Lafay, etc.).

Given that the impact of macroeconomic policies based on time series techniques is often analysed at the level of the overall economy or for highly aggregated sectors, another study could entail the investigation of what happens when there is a very high good/service disaggregation level: that is, if disaggregation improves the overall results. Therefore, the analysis can be expanded examining whether the results change depending on inter commodity differences in elasticities, taking into account different disaggregation levels and/or different kinds of goods (e.g. manufactured, non-manufactured). In particular, to deepen the understanding of the role of exchange rate policies and *currency manipulation* in China's trade imbalance, future work should investigate whether further disaggregation (examining commodity types more finely or conducting sectoral level analyses) can yield greater insights into Chinese trade behavior. For these purposes, a non-stationary panel time-series methodology could be appropriate for highly disaggregated data and for sectoral level studies. The non-stationary panel models have received a lot of attention in the recent years. Under certain assumptions, the hope of the econometrics of non-stationary panel data is to combine the best of two worlds: the method of dealing with non-stationary data from the time series and the increased data and power of cross-section analysis. Nonetheless, the use of such panel data models are not without critics: for what concerns specifically unit root and

cointegration tests, Maddala and Wu (2000) argue that, under specific assumptions, the null hypothesis of a single unit root and the null hypothesis of a panel unit root are quite different. Additionally, when using the vector error correction mechanism, the endogeneity problem is overlooked whereas in the non-stationary panel models, the problem needs to be promptly faced.

Another problem is deciding which measure of the real exchange rate is the most appropriate, since researchers often face a set of trade-offs in this sense. The first is between the theoretically implied measures and the real-world counterparts. The second one is between using the most appropriate measure conceptually, and the one for which the largest volume of data are readily available.

Finally, it would be interesting to study the trade dynamics of the so-called globalization. The exchange rate is the key relative price in international finance; the rapid pace of globalization in goods and asset markets has only enhanced the importance of this variable. Globalization and global supply chains have certainly changed the way trade responds to relative price changes. In particular, higher imported content in exports is likely to lower the sensitivity of trade to changes in the exchange rate: examining whether the re-export issue implicates significant findings. In the case of the Chinese trade flows, there is some reason to believe that the conventional elasticities approach is insufficient. A characteristic of the Chinese economy is its position in the global production chain. Since China plays an important role at the final phase of the international production process, its trade flows might not be much responsive to exchange rate changes. Given the high degree of production fragmentation, an appreciation raises the relative price of exports, but lowers the price of inputs. The appreciation thus only affects the value added component of Chinese exports, and the net effect of a RMB appreciation on global imbalances could be, once again, ambiguous.

CONCLUSIONS

The estimation of export price elasticities is very important in order to evaluate what happens to a country's exports as a consequence of its real exchange rate variation.

Despite the plethora of studies conducted in this research field there is an evident discrepancy in the estimates produced. Trade elasticity estimates of the last fifty (and more) years have provided, indeed, a high variability of results that can appear unstable and dispersive. The sample of studies quoted in the present research confirm that the high variability in the estimates change for numerous reasons. The factors that yield different elasticity estimates are basically:

- different sample periods
- different models/approaches (OLS, ARDL, DOLS, ECM, Cointegration etc.)
- different initial assumptions (constant functions versus fluctuating ones, complete pass-throughs, etc.)
- different levels of aggregation

Estimation of trade elasticities is necessary to improve the structural modelling and but is also fundamental from a policy-making perspective.

From a purely econometric point of view, the techniques used in the past for a long period (before the introduction of the cointegration approach) have often left behind a number of issues such as the response lags (Stern *et al.*, 1976): in the less recent theoretical studies, indeed, it is assumed that prices (and quantities) adjust instantaneously to some given exogenous change; realistically, however, it will take time for adjustment to take place. This means that the related policies implemented on the basis of these predictions (size and time patterns) were, at worst, erroneous. The introduction of explanatory lagged variables takes into account these issues but implies other questions such as multicollinearity. A big contribution in overtaking some of these issues is given, as aforesaid, by the cointegration technique: the introduction of concepts and tools associated with cointegrated data has profoundly altered the technology of Econometrics (Hendry D. F., Juselius K., 2000). Nevertheless, application of cointegration analysis requires careful thought about model specification and interpretation to be sure to avoid forecast failure. In regards to this question, it is interesting to notice that the long-run export price elasticity estimates provided in the

present research for Italy, using two different techniques⁶⁷ but the same sample period, are almost exactly the same:

Model	Export long-run price elasticity estimate
<i>Distributed-Lag model</i>	- 0,71
<i>VECM</i>	- 0,72

Additionally, policy-making is now, more than ever, a challenging task for the economies that have been hit hard by the financial crisis and that are endeavouring a gradual recovery. The high variability of the estimates makes it very difficult to appraise the actual effects of changes of exchange rates (and income) and, although it can be thought that, in spite of its self-evident importance, the estimated elasticities are used *just* to translate (Marquez, 1999) predictions of prices and incomes into predictions for exports (and imports), it is also true that a large dispersion can undermine the usefulness of these estimates in the analyses of international interdependencies, exchange rate misalignments, global imbalances and, in general, in the measurement of policy effectiveness. This is one of the main reasons why this field of study is still unsaturated and explains why there is still the need to identify one or more factors of variability and/or instability: any result in this sense contributes to fill a gap in the empirical literature. A reliable estimate of the level of exchange rate misalignment and of trade (exports, specifically) elasticities gauges the severity of the problem and contributes to formulating the appropriate policy response whereas an imprecise estimate makes it difficult to comprehend the extent and the importance of the problem and to articulate a suitable policy.

As to the current debate on exchange rate manipulation and trade balances, conventional wisdom holds that a trade surplus could be achieved by weakening the associated currency. However, reviewing the standard economic analyses and considering the results of the present research, probably the exchange rate effect is more complicated: in this study, referring to the long-run price elasticity estimates, the 70% of results are lower than one. Statistically significant estimates of price elasticities lower than 1 lead to economic observations that

⁶⁷ Distributed Lag model and Vector Error Correction model, *cfr.* Chapters 2 and 3.

openly clash with the current debate on currency depreciation and on the resulting policies developed to fix global imbalances.

The objective of Chapter 2 was twofold: act as a gateway to the methodology and to the econometric specification applied in the present analysis and provide an overview of the previous empirical literature within the international trade elasticities context. Due to the great number of studies related to this important issue, the different studies have been analysed considering the main empirical and theoretical approaches with an emphasis on the trade elasticities theories and with an overview of selected empirical contributions of the recent years. This section has to be read as a detailed summary that provides a background to the recent economic developments in times series econometrics and, in particular, to the estimation of international trade elasticities but, of course, it is not exhaustive. For a complete coverage of all the relevant studies, probably a meta-analysis of the previous literature, combining the findings from independent studies, would have given a more complete vision of the state of the art.

The results of export elasticities estimates using a VECM methodology are reported in Chapter 3. The results are summarized and comparisons with past studies and outcomes are discussed. Included in the discussion are the arguments for the many contradictory conclusions reached. This section also explains the main advantages of using the above mentioned methodology and provides a detailed explanation of the development of the VECM technique in the empirical literature.

Although the estimates of export price elasticities have been provided on the basis of the Consumer Price Index and of the Unit Labor Cost index, an omission from this study is the lack of a punctual analysis of the unit labor costs dynamics. Further investigation on the countries' (loss of) cost competitiveness measured by the real effective exchange rate based on ULCs could probably extend the comprehension and the true interpretation of the estimation results.

In conclusion, this study confirms that trade price elasticities in the literature are, to a certain extent, puzzling due to their high variability across sample periods, sectors and econometric methodologies and that it seems difficult to obtain more plausible estimates (H. Erkel-Rousse, D. Mirza, 2002) at the moment. The effort should be, first of all, to try to achieve trade equations free from misspecification or measurement errors; secondly, it would be useful to

study the economic dynamics of the economies involved, separating the analysis of the less developed and the emerging countries, who are experiencing fast growth rates (that, for this reason, are dealing with internal rebalancing issues in every economic field), from that of the major trading economies. The new dynamics of emerging economies, in fact, support this somewhat unexpected variability and probably this is due to determinants that, at the moment are still indefinite or totally unknown.

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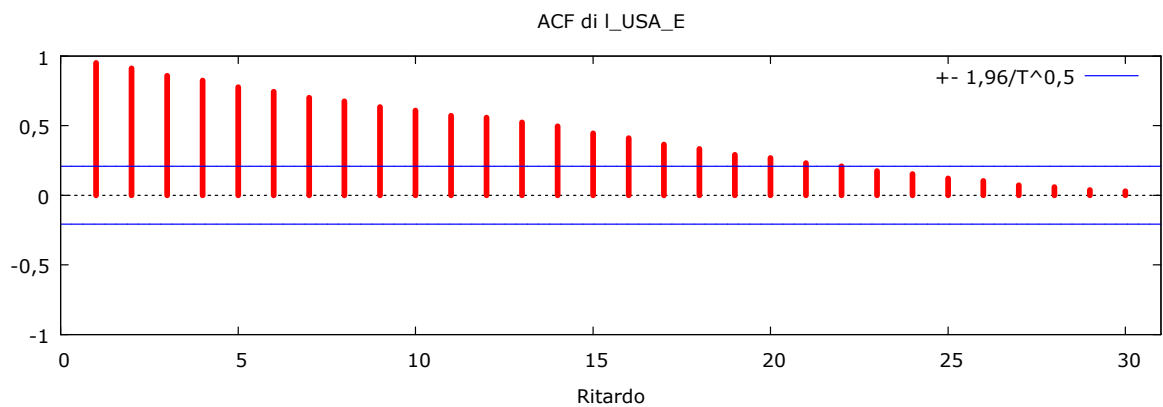
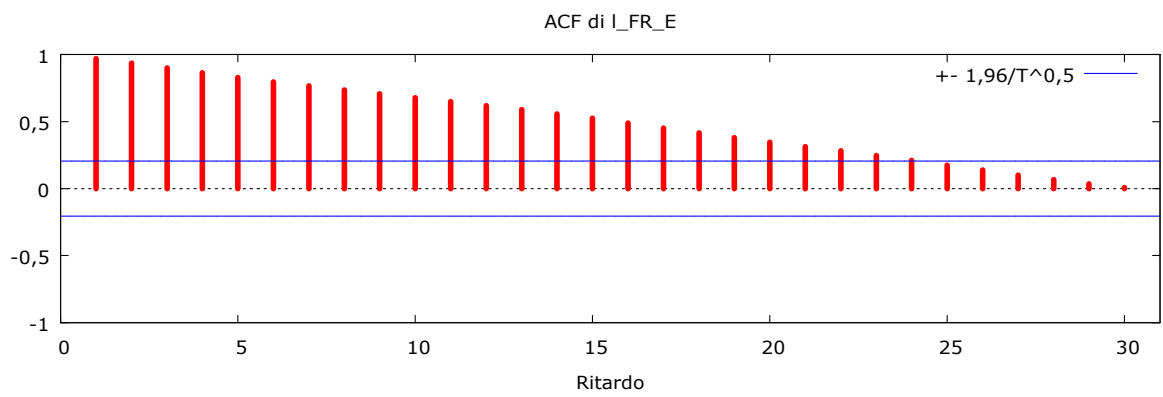
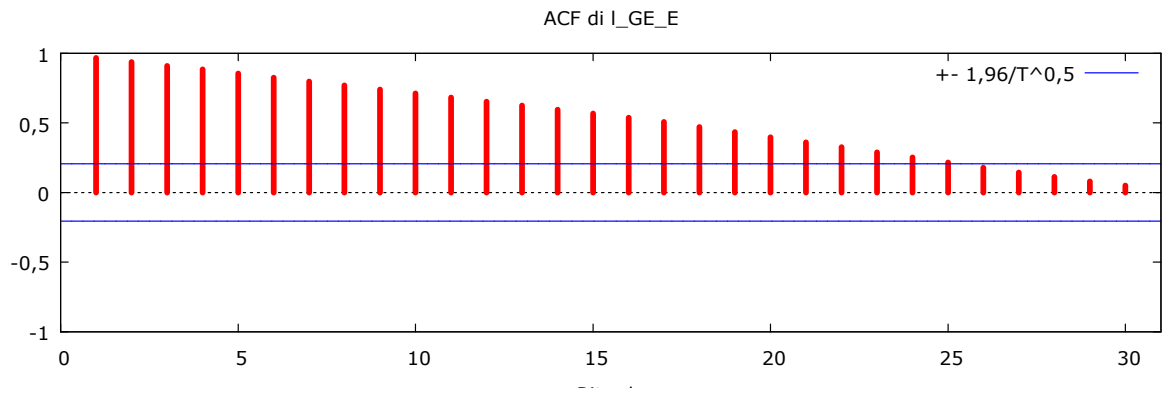
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APPENDIX

APPENDIX 1

1.A) Visual inspection of the data:



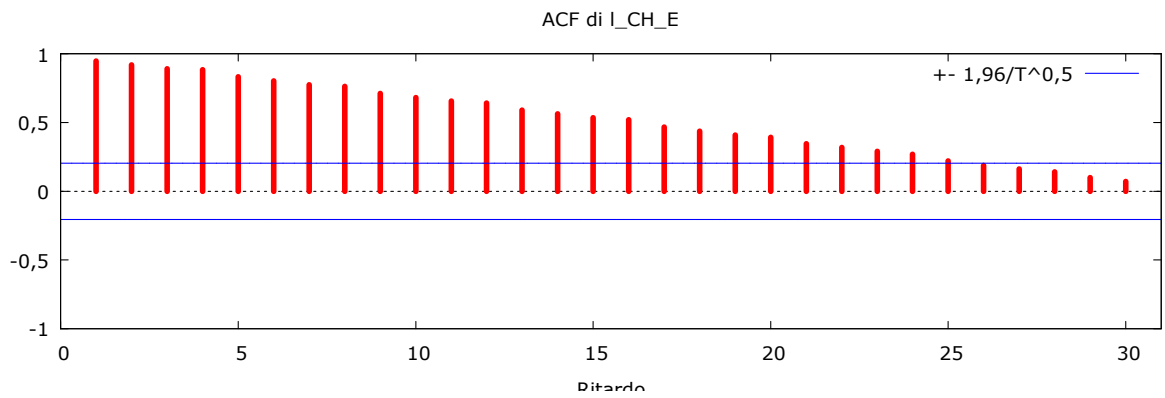
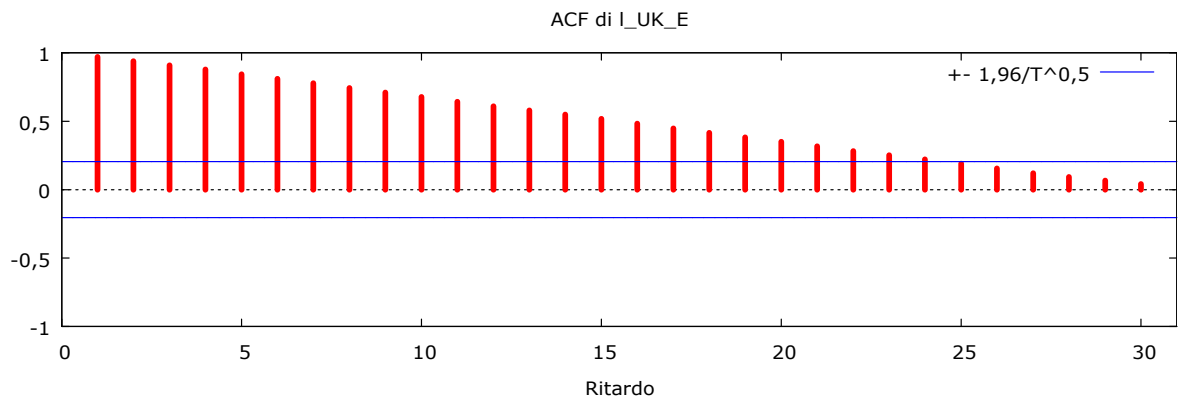
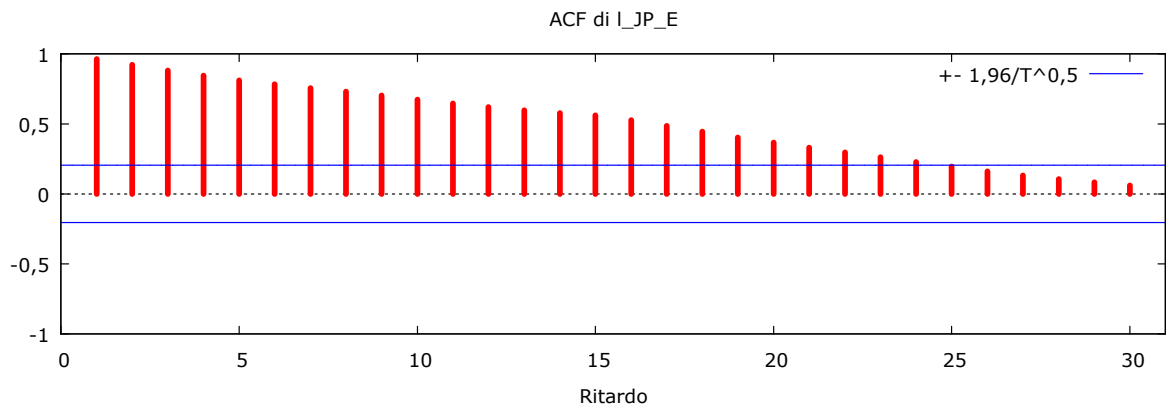
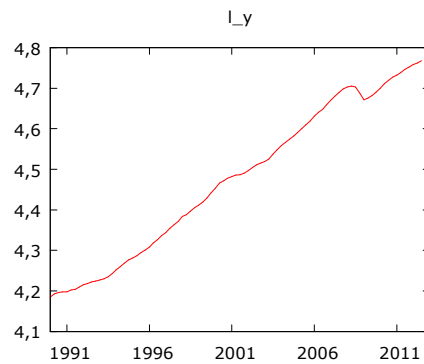
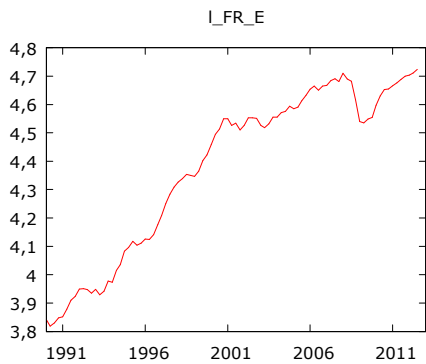
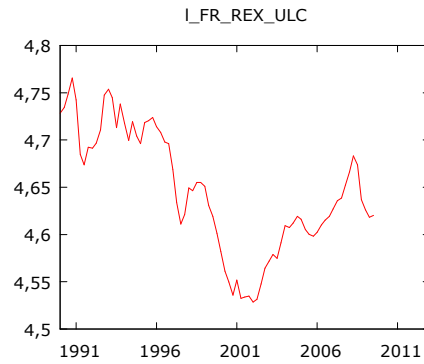
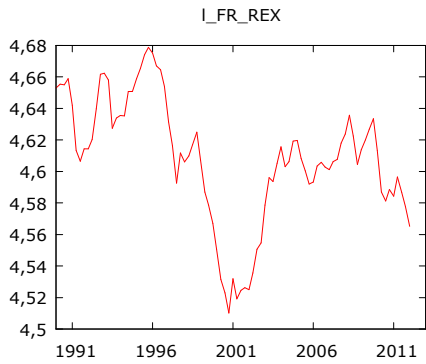
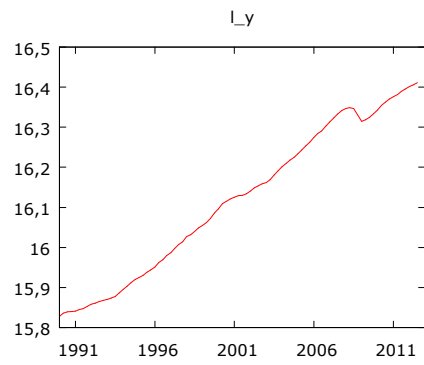
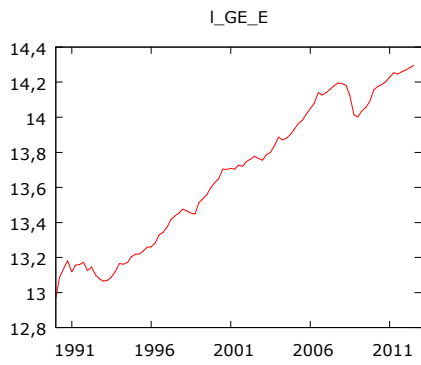
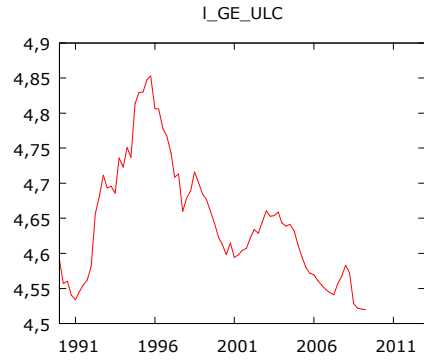
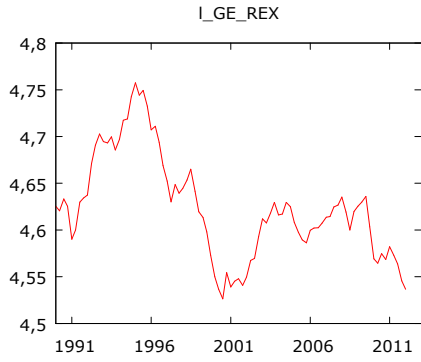
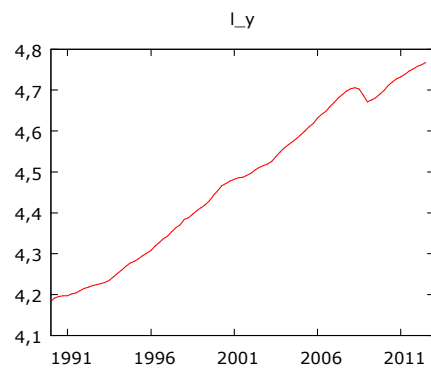
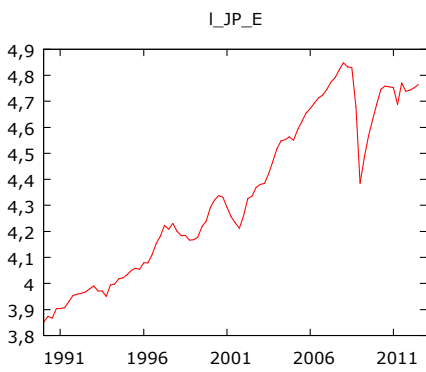
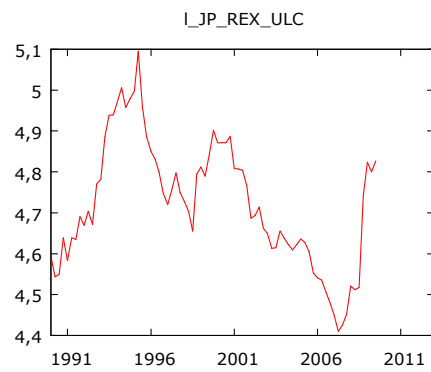
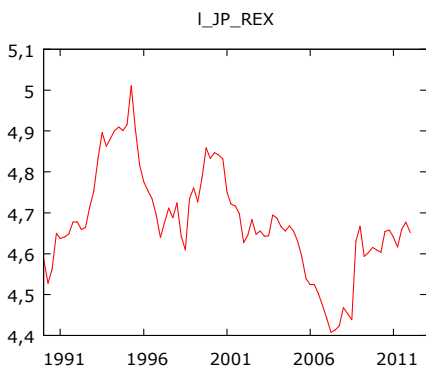
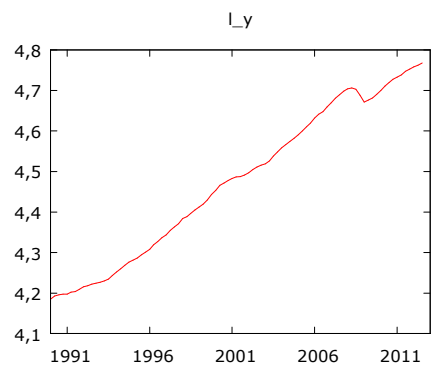
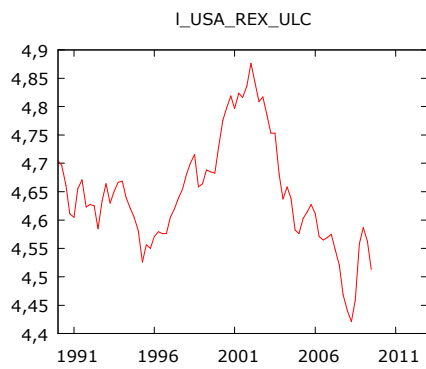
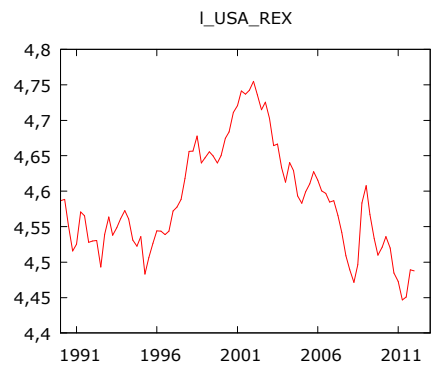
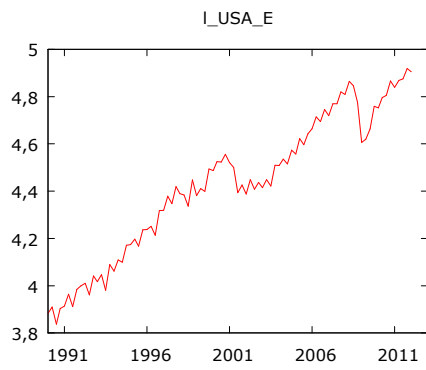


Figure 1.A: ACF for exports. Source: Author's elaboration on Datastream and IFS Databases.

1.B) Plots of the time series variables:





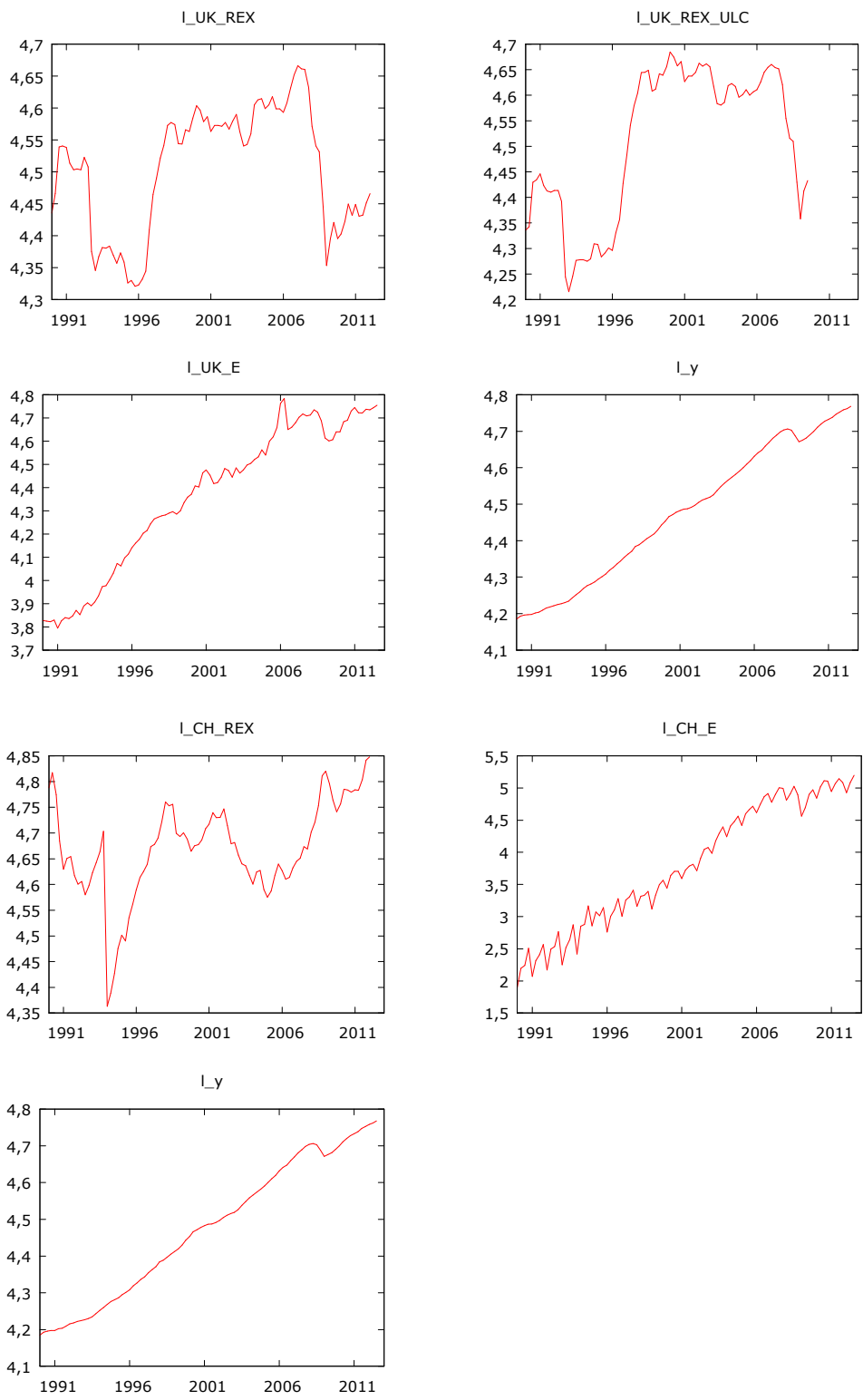
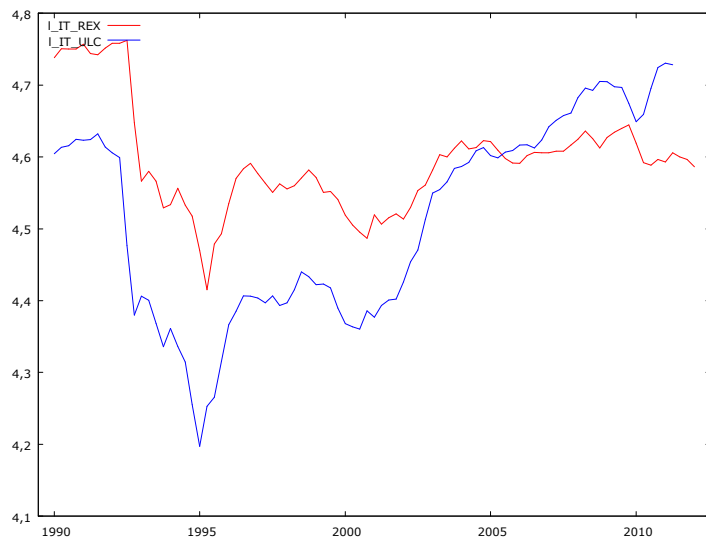


Figure 1.B: Graphs of the time series variables.
 Source: Author's elaboration on Datastream and IMF Databases.

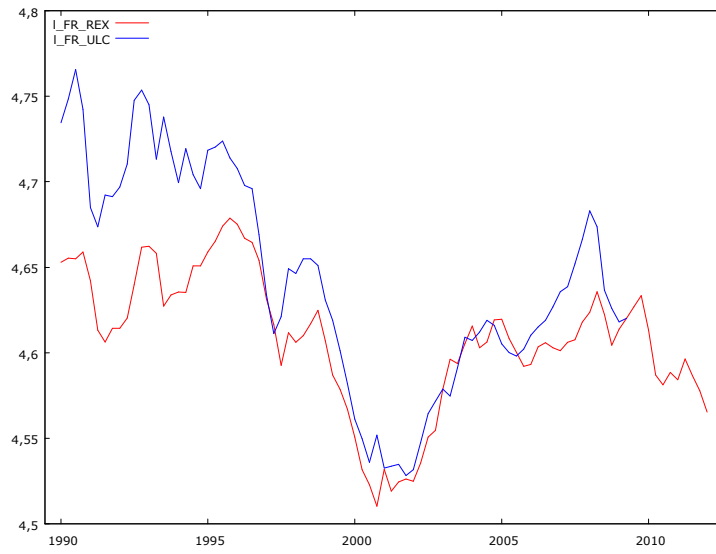
1.C) Plots of the real effective exchange rates (CPI and ULC based):



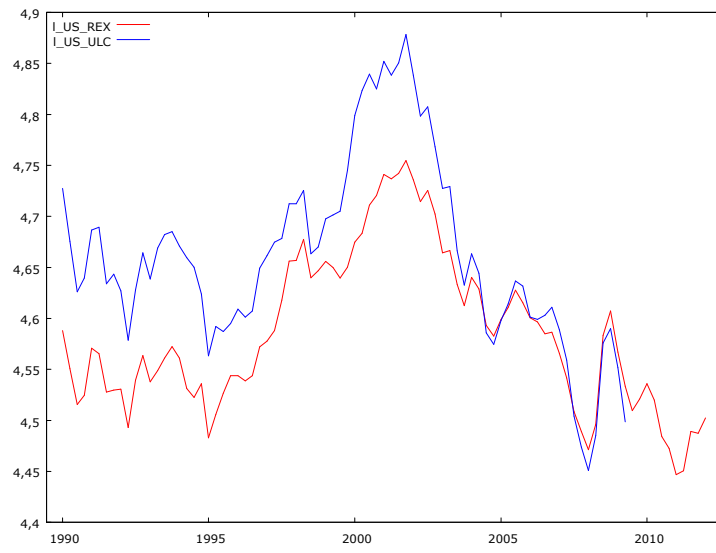
Italy



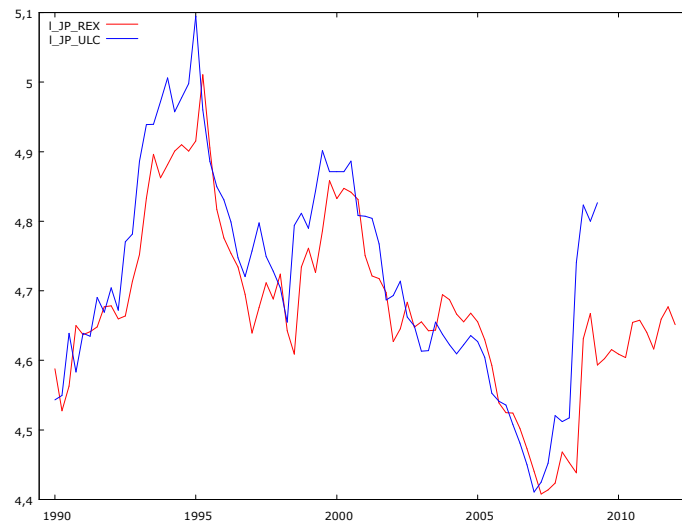
Germany



France



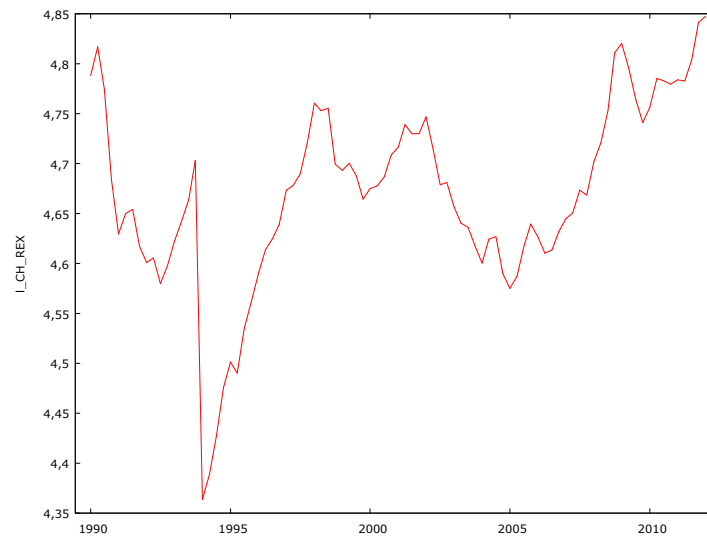
USA



Japan



UK



China

Figure 1.C: Plot of the variables and Real Effective Exchange Rate based on CPI and on ULC.
Source: Author's elaboration.

1.D) Descriptive statistics:

Variable	Mean	Median	Minimum	Maximum	Std. Dev.	Var. coeff.	Asymmetry	Curtosis
I_IT_E	4,44171	4,50553	3,9527	4,76552	0,23398	0,05268	-0,6981	-0,569
I_IT_REX	4,59489	4,59178	4,4151	4,76226	0,07352	0,016	0,69256	0,51748
I_IT_REX_ULC	4,51389	4,55472	4,19705	4,73057	0,13832	0,03064	-0,1873	-1,2213
I_GE_REX	4,62409	4,61947	4,52634	4,75729	0,05522	0,01194	0,48539	-0,3082
I_GE_ULC	4,64505	4,63618	4,51961	4,85281	0,08648	0,01862	0,63491	-0,3521
I_GE_E	13,6691	13,7079	12,966	14,2954	0,41004	0,03	-0,0564	-1,4158
I_FR_REX	4,60781	4,60996	4,5102	4,6787	0,0399647	0,00867326	-0,536431	-0,0906746
I_FR_ULC	4,64535	4,63667	4,52829	4,76559	0,0644898	0,0138826	-0,0466113	-0,990702
I_FR_E	4,37743	4,52569	3,81819	4,72364	0,289851	0,0662149	-0,597264	-1,1416
I_USA_E	4,42494	4,43628	3,83698	4,91811	0,297136	0,0671502	-0,22772	-0,957968
I_USA_REX	4,58586	4,57261	4,44657	4,75483	0,0755895	0,0164832	0,442474	-0,57782
I_USA_ULC	4,64524	4,63453	4,42118	4,87602	0,0970655	0,0208957	0,317851	-0,0705412
I_JP_REX	4,67713	4,65937	4,40757	5,01057	0,12631	0,0270058	0,127295	0,0203702
I_JP_ULC	4,72141	4,71402	4,41037	5,09498	0,153618	0,0325364	0,0978264	-0,613977
I_JP_E	4,34199	4,29294	3,85003	4,84774	0,308248	0,0709924	0,122019	-1,36302
I_UK_REX	4,50463	4,53914	4,32082	4,66645	0,0977882	0,0217084	-0,380447	-1,10351
I_UK_ULC	4,50898	4,58395	4,21509	4,68491	0,145935	0,0323654	-0,515539	-1,2759
I_UK_E	4,35984	4,44467	3,7943	4,78379	0,313297	0,0718598	-0,42604	-1,14532
I_CH_REX	4,66973	4,6733	4,36335	4,84749	0,0945882	0,0202556	-0,704007	1,04158
I_CH_E	3,78938	3,71494	1,88834	5,1992	0,971298	0,256321	-0,135171	-1,30559
I_y	4,47521	4,48611	4,18454	4,76789	0,18733	0,0418595	-0,0475016	-1,37176

Table 1.D: Descriptive statistics; Sample period: 1990:1 - 2012:3. Source: Author's elaboration on Datastream and IFS Databases.

APPENDIX 2

2.A) ADF Unit Root Tests of Stationarity:

Variable	Variant	τ -statistic ADF level	p-value*	τ -statistic ADF first difference	p-value*
I_GE_X	Constant, no trend (τ_c)	-0,43514	0,9009	-4,98326	0,000353
	Constant and trend (τ_{ct})	-2,34585	0,4084	-4,9514	0,000000
	No constant (τ_{nc})	3,24399	0,9998	-0,51066	0,0001
I_GE_REX	Constant, no trend (τ_c)	-1,87141	0,3462	-4,03643	0,001232
	Constant and trend (τ_{ct})	-2,75233	0,2154	-4,06476	0,007022
	No constant (τ_{nc})	-0,565855	0,4724	-4,03214	0,000000
I_GE_REX_ULC	Constant, no trend (τ_c)	-1,85793	0,3527	-4,49938	0,0001
	Constant and trend (τ_{ct})	-2,01076	0,5949	-4,57413	0,00109
	No constant (τ_{nc})	-0,371096	0,5511	-4,5205	0,000000
I_FR_E	Constant, no trend (τ_c)	-1,973	0,2991	-5,06985	0,000000
	Constant and trend (τ_{ct})	-1,09011	0,9293	-5,39984	0,000000
	No constant (τ_{nc})	2,77432	0,9988	-1,68596	0,086950
I_FR_REX	Constant, no trend (τ_c)	-1,99762	0,2881	-6,74981	0,000000
	Constant and trend (τ_{ct})	-2,16242	0,5101	-6,70888	0,000000
	No constant (τ_{nc})	-0,63333	0,4433	-6,74735	0,000000
I_FR_REX_ULC	Constant, no trend (τ_c)	-1,85078	0,3561	-6,41244	0,000000
	Constant and trend (τ_{ct})	-1,88406	0,6628	-6,41638	0,000000
	No constant (τ_{nc})	-0,61705	0,4504	-6,41262	0,000000
I_USA_E	Constant, no trend (τ_c)	-0,03903	0,9539	-3,76467	0,003310
	Constant and trend (τ_{ct})	-3,12653	0,1	-3,75923	0,018650
	No constant (τ_{nc})	2,5127	0,9974	-2,26578	0,022650
I_USA_REX	Constant, no trend (τ_c)	-1,05267	0,7364	-2,43965	0,130800
	Constant and trend (τ_{ct})	-0,87599	0,9571	-7,63994	0,000000

	No constant (τ_{nc})	-0,34589	0,5608	-2,43891	0,014260
I_USA_REX_ULC	Constant, no trend (τ_c)	-1,70342	0,4296	-6,40555	0,000000
	Constant and trend (τ_{ct})	-1,70458	0,7496	-6,39371	0,000000
	No constant (τ_{nc})	-0,52161	0,491	-6,41927	0,000000
I_JP_E	Constant, no trend (τ_c)	-0,6961	0,846	-3,96515	0,001611
	Constant and trend (τ_{ct})	-2,11656	0,536	-3,95401	0,010130
	No constant (τ_{nc})	2,43926	0,9968	-7,04455	0,000000
I_JP_REX	Constant, no trend (τ_c)	-2,06844	0,2577	-3,51542	0,007630
	Constant and trend (τ_{ct})	-3,93359	0,01082	-3,43752	0,046490
	No constant (τ_{nc})	-0,04026	0,6694	-3,54234	0,000391
I_JP_REX_ULC	Constant, no trend (τ_c)	-1,14231	0,7012	-2,79499	0,058950
	Constant and trend (τ_{ct})	-3,18786	0,0868	-3,64337	0,026280
	No constant (τ_{nc})	0,43145	0,8069	-2,393	0,016170
I_UK_E	Constant, no trend (τ_c)	-2,00246	0,286	-4,0191	0,001315
	Constant and trend (τ_{ct})	-1,40523	0,8598	-4,45287	0,001746
	No constant (τ_{nc})	1,90304	0,9868	-1,6311	0,097180
I_UK_REX	Constant, no trend (τ_c)	-2,0531	0,2642	-4,25818	0,000520
	Constant and trend (τ_{ct})	-2,19001	0,4946	-4,21154	0,004235
	No constant (τ_{nc})	-0,21805	0,608	-4,28032	0,000000
I_UK_REX_ULC	Constant, no trend (τ_c)	-1,68906	0,4369	-5,79992	0,000000
	Constant and trend (τ_{ct})	-1,40487	0,8599	-5,86825	0,000000
	No constant (τ_{nc})	0,170702	0,7358	-5,83235	0,000000
I_CH_E	Constant, no trend (τ_c)	-1,01863	0,7489	-3,19051	0,020570
	Constant and trend (τ_{ct})	-1,33535	0,8789	-3,60704	0,029160
	No constant (τ_{nc})	1,29709	0,9513	-2,70457	0,006640
I_CH_REX	Constant, no trend (τ_c)	-2,05186	0,2646	-9,05044	0,000000
	Constant and trend (τ_{ct})	-2,95042	0,1523	-9,19407	0,000000

	No constant (τ_{nc})	0,101098	0,7122	-9,10316	0,000000
I_y	Constant, no trend (τ_c)	-0,18459	0,9381	-4,08991	0,001640
	Constant and trend (τ_{ct})	-3,03175	0,1234	-4,0673	0,009920
	No constant (τ_{nc})	3,27755	0,9998	-2,28942	0,022080

Table 2.A: ADF Unit root tests: comparative settings. MacKinnon (1996) critical values for the null hypothesis $H_0 =$ presence of a unit root. * Asymptotic p-values.

2.B) Johansen Cointegration Tests, I_country_REX:

Country	Rank	Eigenvalue	Trace test [p-value]	Lmax test [p-value]
Italy	0	0,21118	30,560 [0,0405]	20,164 [0,0672]
	1	0,11414	10,397 [0,2559]	10,302 [0,1963]
	2	0,0011112	0,094509[0,7585]	0,094509 [0,7585]
Germany	0	0,15163	27,272 [0,0192]	20,554 [0,0164]
	1	0,052168	6,7175 [0,3555]	6,6973[0,2837]
	2	0,00016158	0,02020[0,9304]	0,02020[0,9243]
France	0	0,21128	26,576 [0,1153]	20,175 [0,0670]
	1	0,055034	6,4012 [0,6527]	4,8115 [0,7644]
	2	0,018528	1,5897 [0,2074]	1,5897 [0,2074]
USA	0	0,40456	59,212 [0,0000]	44,068 [0,0000]
	1	0,15169	15,144 [0,0550]	13,983 [0,0535]
	2	0,013559	1,1604 [0,2814]	1,1604 [0,2814]
Japan	0	0,18276	23,949 [0,2092]	17,155 [0,1706]
	1	0,075777	6,7939 [0,6074]	6,6981 [0,5335]
	2	0,0011260	0,095760 [0,7570]	0,095760 [0,7570]
UK	0	0,15558	24,484 [0,1865]	14,374 [0,3487]
	1	0,11128	10,110 [0,2773]	10,028 [0,2143]
	2	0,00096505	0,082069 [0,7745]	0,082069 [0,7745]
China	0	0,16735	20,782 [0,3820]	15,567 [0,2616]
	1	0,038535	5,2149 [0,7848]	3,3403 [0,9118]
	2	0,021813	1,8746 [0,1709]	1,8746 [0,1709]

Table 2.B: Johansen Cointegration Tests for model with exchange rates based on the Consumer Price Index

2.C) Johansen Cointegration Tests, I_country_ULC:

Country	Rank	Eigenvalue	Trace test [p-value]	Lmax test [p-value]
Italy	0	0,21251	29,826 [0,0497]	19,829 [0,0751]
	1	0,10448	9,9974 [0,2861]	9,1588[0,2795]
	2	0,010052	0,83853 [0,3598]	0,83853[0,3598]
Germany	0	0,14262	27,700 [0,0167]	17,541[0,0526]
	1	0,047153	10,159 [0,1124]	5,5063 [0,4171]
	2	0,039988	4,6523 [0,0352]	4,6523 [0,0368]

France	0	0,34297	44,522 [0,0004]	31,502 0,0007]
	1	0,12225	13,020 [0,1142]	9,7799 [0,2315]
	2	0,042284	3,2403 [0,0718]	3,2403 [0,0718]
USA	0	0,43533	54,402 [0,0000]	42,864 [0,0000]
	1	0,12784	11,538 [0,1828]	10,259 [0,1991]
	2	0,016919	1,2798 [0,2579]	1,2798 [0,2579]
Japan	0	0,19847	24,401 [0,1899]	16,593 [0,1996]
	1	0,082638	7,8086 [0,4933]	6,4690 [0,5613]
	2	0,017703	1,3396 [0,2471]	1,3396 [0,2471]
UK	0	0,21313	26,628 [0,1138]	17,977 [0,1343]
	1	0,10687	8,6512 [0,4057]	8,4765 [0,3400]
	2	0,0023261	0,17466 [0,6760]	0,17466 [0,6760]

Table 2.C: Johansen Cointegration Tests for model with exchange rates based on the Unit Labor Cost index.

APPENDIX 3

3.A) Export price and income elasticities estimates using VECM. Summarizing tables:

Country	Long-run Price elasticity	Short-run Price elasticity	Long-run Income elasticity	Short-run Income elasticity	ECM Speed of Adj.
Italy	-0,72	-0,05	1,01	3,86	-0,25
<i>s.e.</i>	-0,141100	0,123866	-0,053981	0,815929	0,056667
Germany	-0,11	-0,13	2,18	2,65	-0,25
<i>s.e.</i>	0,179100	0,210564	0,050633	0,994302	0,093337
France	-1,41	-0,27	0,10	3,63	-0,12
<i>s.e.</i>	0,407000	0,153284	0,100790	0,681037	0,027807
USA	-1,21	-0,03	1,38	2,63	-0,23
<i>s.e.</i>	0,190390	0,140229	0,068277	0,980787	0,034103
Japan	-0,55	-0,23	1,34	1,66	-0,28
<i>s.e.</i>	0,123420	0,086874	0,082945	1,319900	0,076372
UK	-0,84	-0,07	1,60	0,02	0,03
<i>s.e.</i>	0,233410	0,140872	0,118090	1,392200	0,044925
China	-1,95	-0,27	5,58	1,87	-0,27
<i>s.e.</i>	0,307520	0,254649	0,140780	0,229376	0,114734

Table 3.A: VECM system, 4 lags. Obs.: 1990:1-2012:1(T= 85); Cointegration rank =1; Exchange rates on Consumer Price Index bases. Source: Own estimations on Datastream and IFS databases. Notes: Aggregation level: value of goods and services; Index 2005=100.

Country	Long-run Price elasticity	Short-run Price elasticity	Long-run Income elasticity	Short-run Income elasticity	ECM Speed of Adj.
Italy	-0,48	-0,12	1,32	0,60	-0,28
<i>s.e.</i>	-0,083110	0,111288	-0,065614	0,810375	0,065019
Germany	-0,21	-0,17	2,06	3,06	-0,19
<i>s.e.</i>	0,106450	0,116483	0,074202	0,828905	0,063510
Francia	-1,20	-0,32	1,06	3,21	-0,23
<i>s.e.</i>	0,152520	0,114040	0,071855	0,602382	0,042725
USA	-0,57	0,08	1,26	2,17	-0,34
<i>s.e.</i>	0,108390	0,119547	1,259200	1,009050	0,048355
Japan	-0,37	-0,06	1,39	-0,32	-0,34
<i>s.e.</i>	0,105960	0,084542	0,099315	1,897500	0,087257
UK	-0,26	-0,09	1,64	0,73	-0,08
<i>s.e.</i>	0,099019	0,139602	0,084836	1,605630	0,094353
China	-	-	-	-	-
<i>s.e.</i>	-	-	-	-	-

Table 3.A.(1): VECM system, 4 lags. Obs.: 1990:1-2012:1(T= 85); Cointegration rank =1; Exchange rates on Unit Labor Cost index bases. Source: Own estimations on Datastream and IFS databases. Notes: Aggregation level: value of goods and services; Index 2005=100.

3.B) Estimates for Germany:

Model A with l_GE_REX:

VECM system, 4 lags
1991:1-2011:4 (T = 84)
Cointegration rank = 1

<i>l_GE_X</i>	1,0000 (0,00000)
<i>l_GE_REX</i>	-0,11283 (0,17910)
<i>l_y</i>	+2,1814 (0,050633)

These results indicate that the long-run export price and income elasticities estimates are, respectively: -0,11 and +2,18.

The short-run export price and income elasticities estimates are, respectively: -0,13 and +0,25.

The Error Correction term coefficient is -0,25, it is statistically significant and it exhibits the expected negative sign. As aforesaid, it indicates the speed at which the variables return to equilibrium after departing for the equilibrium path (after a shock, for example). Probably, the positive sign indicates that the variable did not depart from equilibrium but rather has still not reached it.

The Durbin-Watson test is: 1,83 while the Adjusted R^2 is only 0,22.

The following graph plots the residuals of the system:

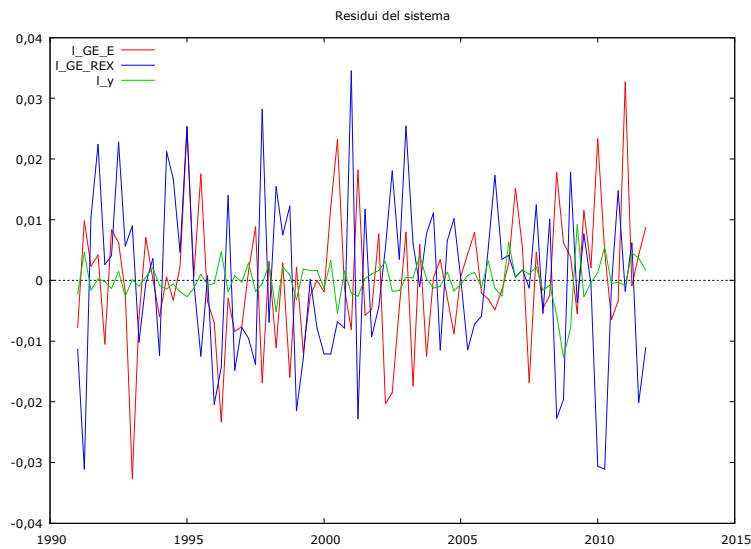


Figure 3.B: Germany, residuals. Source: Author's elaboration.

Model B with l_GE_REX_ULC:

VECM system, 4 lags
 1991:1-2009:3 (T = 75)
 Cointegration rank = 1

l_{GE_X}	1,0000 (0,00000)
$l_{GE_REX_ULC}$	-0,21059 (0,10645)
l_y	+2,0562 (0,074202)

These results indicate that the long-run export price and income elasticities estimates are, respectively: -0,21 and + 2,06.

The short-run export price and income elasticities estimates are, respectively: -0,17 and +3,06.

The Error Correction term coefficient is -0,19, it is statistically significant and it exhibits the expected negative sign.

The Durbin-Watson test is: 1,98 while the Adjusted R^2 is: 0,47.

Serial correlation test:

Equation 1:

Ljung-Box Q' = 1,67946 with p-value = 0,794

Equation 2:

Ljung-Box Q' = 1,24542 with p-value = 0,871

Equation 3:

Ljung-Box Q' = 0,610665 with p-value = 0,962

The null hypothesis of no serial correlation cannot be rejected (critical value for alpha= 0,05: 0,71).

3.C) Estimates for France:

Model A with l_FR_REX:

VECM system, 4 lags
1991:1-2012:1 (T = 85)
Cointegration rank = 1

<i>l_FR_E</i>	1,0000 (0,00000)
<i>l_FR_REX</i>	- 1,4069 (0,40700)
<i>l_y</i>	+0,99785 (0,10079)

These results indicate that the long-run export price and income elasticities estimates are, respectively: -1, 41 and +1,0.

The short-run export price and income elasticities estimates are, respectively: -0,27 and +3,63.

The Error Correction term coefficient is - 0,12, which is statistically significant and exhibits the expected negative sign.

The Durbin-Watson test is: 2,0 while the Adjusted R² is 0,44.

Serial correlation test:

Equation 1:

Ljung-Box Q' = 1,50554 with p-value = 0,826

Equation 2:

Ljung-Box Q' = 0,0826793 with p-value = 0,999

Equation 3:

Ljung-Box Q' = 0,623104 with p-value = 0,96

The null hypothesis of no serial correlation cannot be rejected (critical value for $\alpha= 0,05$: 0,71).

The following graph plots the residuals of the system:



Figure 3.C. France, residuals. Source: Author's elaboration.

Model B with $l_{FR_REX_ULC}$:

VECM system, 4 lags
 1991:1-2009:3 (T = 75)
 Cointegration rank = 1

l_{FR_E}	1,0000 (0,00000)
$l_{FR_REX_ULC}$	-1,2041 (0,15252)
l_y	+1,0556 (0,071855)

These results indicate that the long-run export price and income elasticities estimates are, respectively: -1,20 and +1,06 .

The short-run export price and income elasticities estimates are, respectively: -0,32 and +3,21.

The Error Correction term coefficient is -0,23; it is statistically significant and exhibits the expected negative sign.

The Durbin-Watson test is: 2,1 while the Adjusted R^2 is 0,56.

The following graph plots the residuals of the system for each variable:

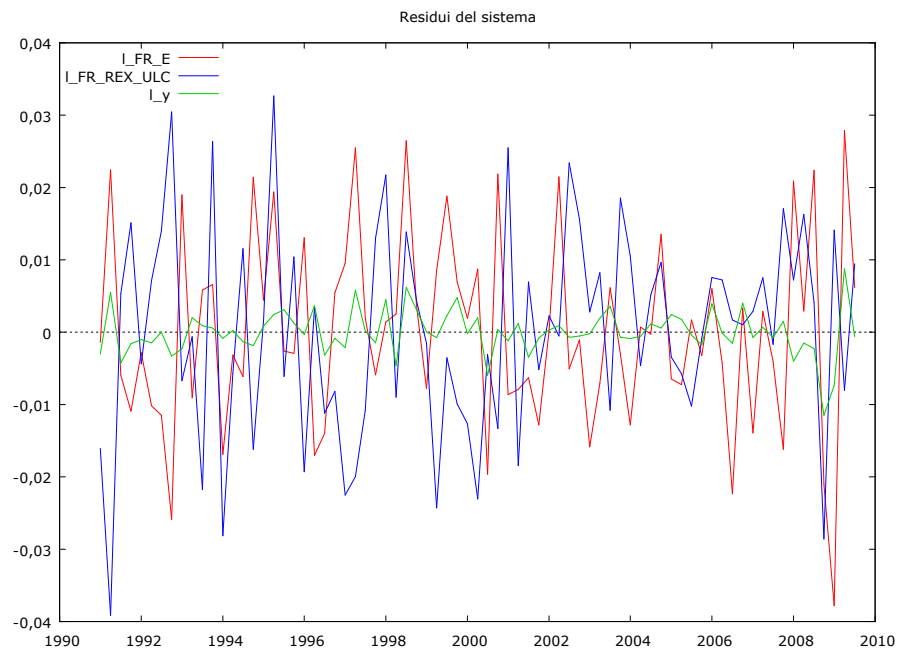


Figure 3.C(1). France, residuals. Source: Author's elaboration.

3.D) Estimates for USA:

Model A with l_USA_REX :

VECM system, 4 lags
 1991:1-2012:1 (T = 85)
 Cointegration rank = 1

l_USA_E	1,0000 (0,00000)
l_USA_REX	-1,2057 (0,19039)
l_y	+1,3804 (0,068277)

These results indicate that the long-run export price and income elasticities estimates are, respectively: -1,21 and +1,38.

The short-run export price and income elasticities estimates are, respectively: +0,03 and +2,63.

The Error Correction term coefficient is - 0,23; it is statistically significant and exhibits the expected negative sign.

The Durbin-Watson test is: 1,68 while the Adjusted R^2 is 0,73.

The following graph plots the residuals of the system for each variable:

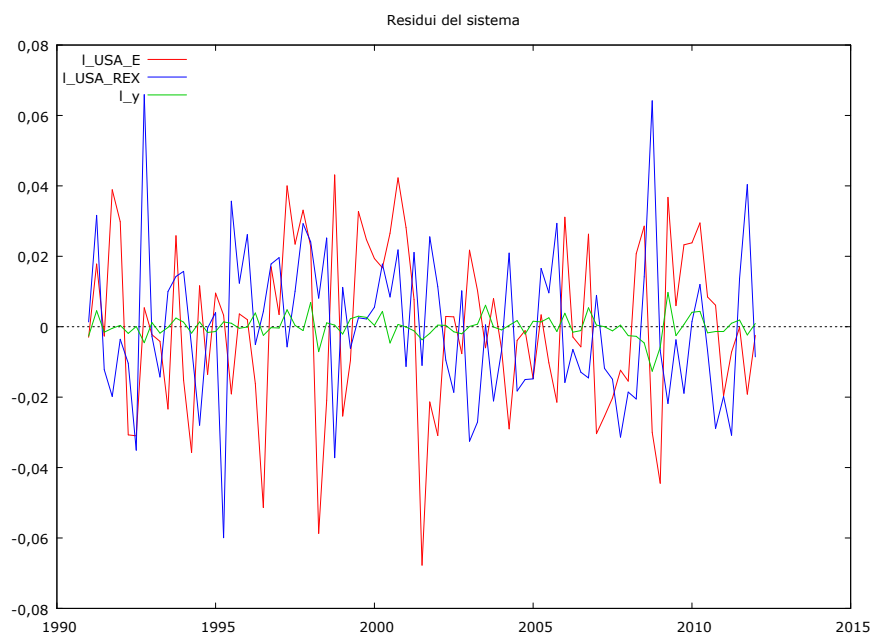


Figure 3.D. USA, residuals. Source: Author's elaboration.

Serial correlation test:

Equation 1:

Ljung-Box $Q' = 4,7949$ with p-value = 0,309

Equation 2:

Ljung-Box $Q' = 2,13921$ with p-value = 0,71

Equation 3:

Ljung-Box $Q' = 0,825071$ with p-value = 0,935

The null hypothesis of no serial correlation of the Q-statistic test cannot be rejected.

Model B with l_USA_REX_ULC:

VECM system, 4 lags
1991:1-2009:3 (T = 75)
Cointegration rank = 1

l_USA_E	1,0000 (0,00000)
$l_USA_REX_ULC$	-0,56960 (0,10839)
l_y	+1,2592 (0,061851)

These results indicate that the long-run export price and income elasticities estimates are, respectively: -0,57 and +1,26.

The short-run export price and income elasticities estimates are, respectively: +0,08 and +2,17. The short-run price elasticity presents, as we can see, a positive unexpected sign.

The Error Correction term coefficient is -0,34; it is statistically significant and exhibits the expected negative sign.

The Durbin-Watson test is: 1,68 while the Adjusted R^2 is 0,73.

The following graph plots the residuals of the system for each variable:

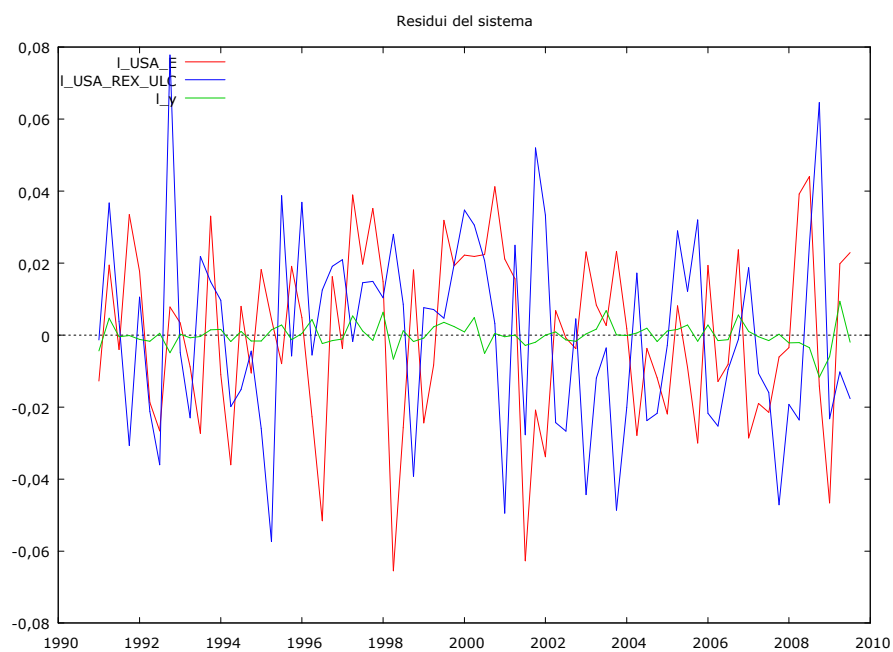


Figure 3.D (1). USA, residuals. Source: Author's elaboration.

3.E) Estimates for Japan:

Model A with l_JP_REX:

VECM system, 4 lags
1991:1-2012:1 (T = 85)
Cointegration rank = 1

l_JP_E	1,0000 (0,00000)
l_JP_REX	-0,54663 (0,12342)
l_y	+1,3425 (0,082945)

These results show that the long-run export price and income elasticities estimates are, respectively: -0,55 and +1,34.

The short-run export price and income elasticities estimates are, respectively: +0,23 and +1,66.

The Error Correction term coefficient is -0,28; it is statistically significant and exhibits the expected negative sign.

The Durbin-Watson test is: 2,02 while the Adjusted R^2 is 0,57.

Serial correlation test:

Equation 1:
Ljung-Box $Q' = 0,144175$ with p-value = 0,998

Equation 2:
Ljung-Box $Q' = 0,201967$ with p-value = 0,995

Equation 3:
Ljung-Box $Q' = 0,262408$ with p-value = 0,992

The null hypothesis of no serial correlation cannot be rejected (critical value for $\alpha = 0,05$: 0,71).

The following graph plots the residuals of the system for each variable:

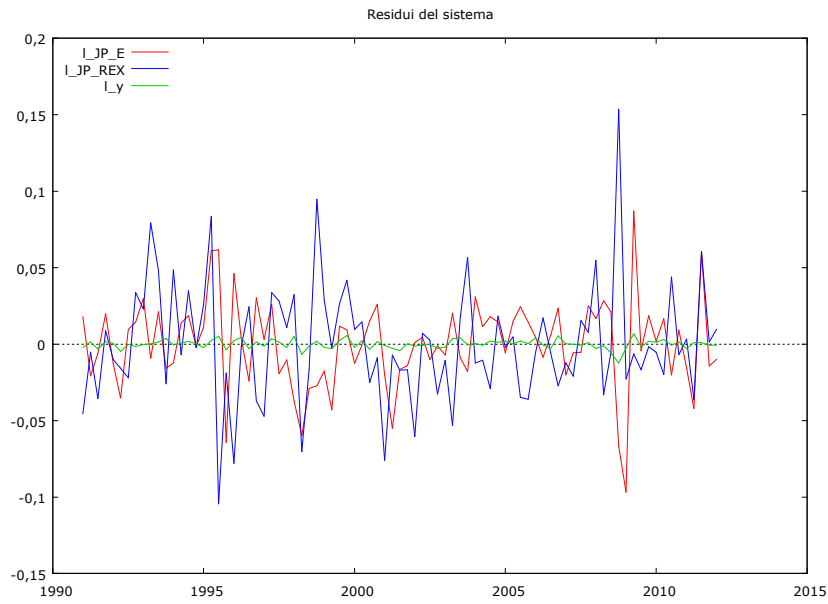


Figure 3.E. Japan, residuals. Source: Author's elaboration.

Model B with $l_{JP_REX_ULC}$:

VECM system, 4 lags
 1991:1-2009:3 (T = 75)
 Cointegration rank = 1

l_{JP_E}	1,0000 (0,00000)
$l_{JP_REX_ULC}$	-0,37445 (0,10596)
l_y	+1,3936 (0,099315)

These results show that the long-run export price and income elasticities estimates are, respectively: -0,37 and +1,39.

The short-run export price and income elasticities estimates are, respectively: -0,06 and +0,32.

The Error Correction term coefficient is -0,34; it is statistically significant and exhibits the expected negative sign.

The Durbin-Watson test is: 1,95 while the Adjusted R^2 is 0,51.

The following graph plots the residuals of the system for each variable:

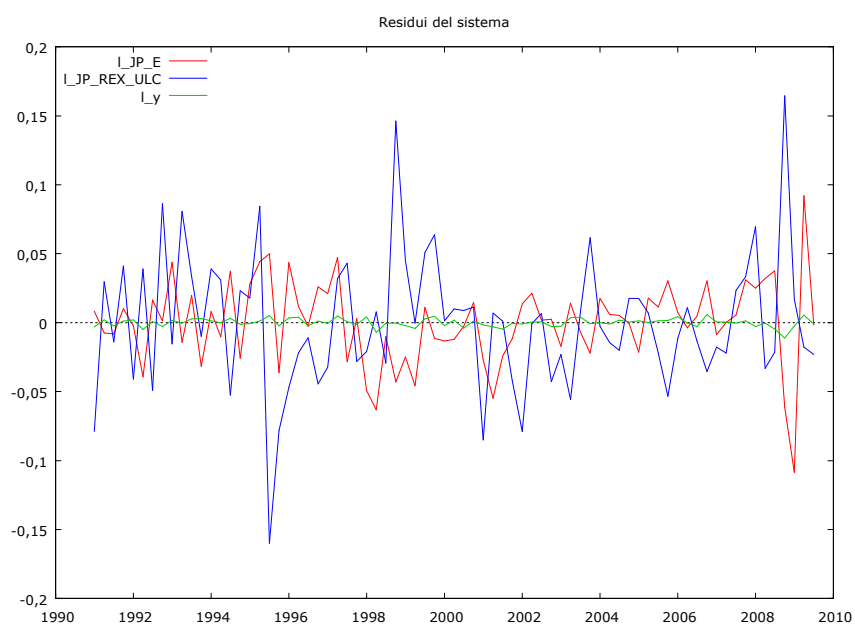


Figure 3.E (1). Japan, residuals. Source: Author's elaboration.

Serial correlation test:

Equation 1:

Ljung-Box Q' = 1,12126 with p-value = 0,891

Equation 2:

Ljung-Box Q' = 4,54334 with p-value = 0,337

Equation 3:

Ljung-Box Q' = 0,910473 with p-value = 0,923

The Q-statistic⁶⁸ has the null hypothesis of "no serial correlations" (up to the lags used for the test, which here are 4). Hence, each p-value indicates that there is no serial correlation since you cannot reject the null.

3.F) Estimates for UK:

Model A with l_UK_REX:

⁶⁸ The critical value is 0,710723 with alpha = 0,05.

VECM system, 4 lags
 1991:1-2012:1 (T = 85)
 Cointegration rank = 1

l_UK_E	1,0000
	(0,00000)
l_UK_REX	-0,83580
	(0,23341)
l_y	+1,5977
	(0,11809)

These results show that the long-run export price and income elasticities estimates are, respectively: -0,84 and +1,60.

The short-run export price and income elasticities estimates are, respectively: +0,07 and +0,02.

The Error Correction term coefficient is + 0,03, but it is not statistically significant and does not exhibit the expected negative sign. The Durbin-Watson test is: 1,99.

The following graph plots the residuals of the system for each variable:

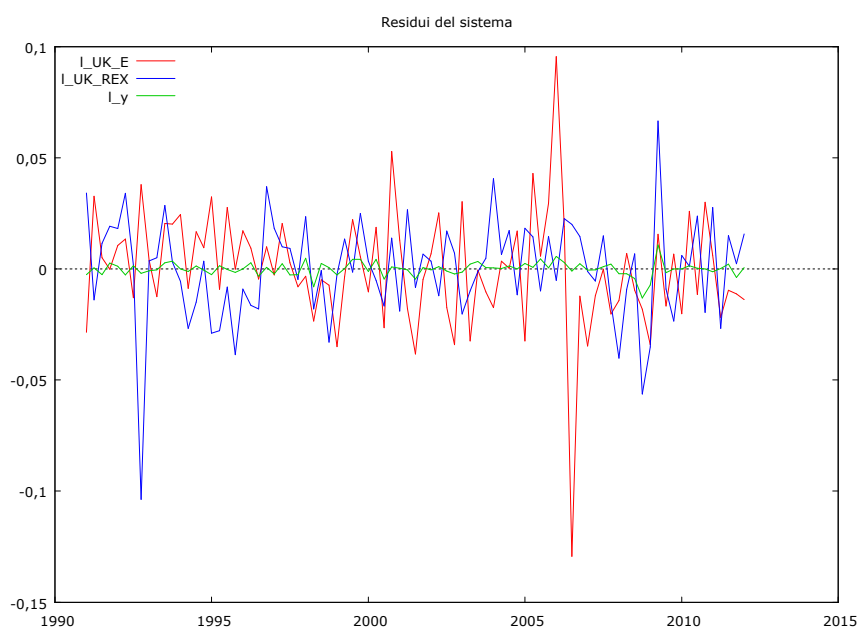


Figure 3.F. UK, residuals. Source: Author's elaboration.

Serial correlation test:

Equation 1:
 Ljung-Box Q' = 0,17032 with p-value = 0,997

Equation 2:

Ljung-Box Q' = 0,269179 with p-value = 0,992

Equation 3:

Ljung-Box Q' = 0,802158 with p-value = 0,938

The null hypothesis of the Q-statistic no serial correlation test cannot be rejected.

Model B with l_UK_REX_ULC:

VECM system, 4 lags

1991:1-2009:3 (T = 75)

Cointegration rank = 1

<i>l_UK_E</i>	1,0000 (0,00000)
<i>l_UK_REX_ULC</i>	-0,26215 (0,099019)
<i>l_y</i>	+1,6438 (0,084836)

These results show that the long-run export price and income elasticities estimates are, respectively: -0,26 and +1,64.

The short-run export price and income elasticities estimates are, respectively: -0,09 and +0,73.

The Error Correction term coefficient is -0,07, it is statistically significant and it exhibits the expected negative sign. The Durbin-Watson test is 1,99.

The following graphs plot the residuals of the system for each variable:

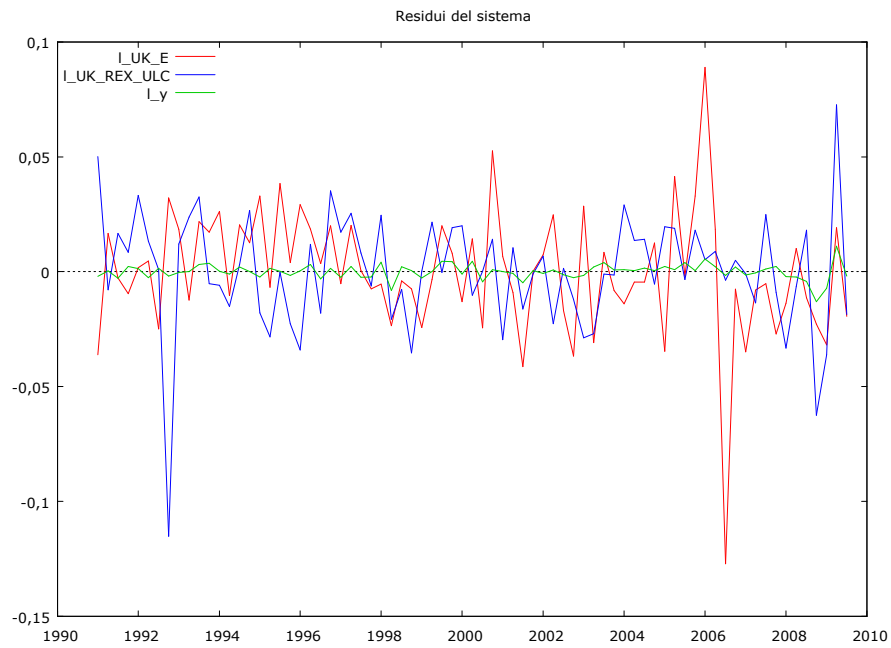


Figure 3.F(1). UK, residuals. Source: Author's elaboration.

Serial correlation test:

Equation 1:

Ljung-Box $Q' = 0,143582$ with p-value = 0,998

Equation 2:

Ljung-Box $Q' = 0,97994$ with p-value = 0,913

Equation 3:

Ljung-Box $Q' = 0,86938$ with p-value = 0,929

According to the Q-statistic serial correlation test, the null hypothesis of no serial correlation can be accepted.

3.G) Estimates for China:

Model with l_CH_REX:

VECM system, 4 lags

1991:1-2012:1 (T = 85)

Cointegration rank = 1

l_{CH_E} 1,0000

	(0,00000)
l_CH_REX	-1,9483
	(0,30752)
l_y	+5,5794
	(0,14078)

These results show that the long-run export price and income elasticities estimates are, respectively: -1,95 and +5,58.

The short-run export price and income elasticities estimates are, respectively: +0,27 and +1,87.

The Error Correction term coefficient is -0,27; it is statistically significant and exhibits the expected negative sign. The Durbin-Watson test is: 1,03 and the R^2 is 0,82.

Serial correlation test:

Equation 1:

Ljung-Box $Q' = 20,8791$ with p-value = 0,000335

Equation 2:

Ljung-Box $Q' = 0,940484$ with p-value = 0,919

Equation 3:

Ljung-Box $Q' = 0,4779$ with p-value = 0,976.

The following graph plots the residuals of the for each variable:



Figure 3.G. China, residuals. Source: Author's elaboration.

APPENDIX 4

The Marshall-Lerner condition and the J-curve effect

The Marshall-Lerner condition also known as the MLR condition (Marshall-Lerner-Robinson) is at the heart of the elasticities approach to the balance of payments. The condition seeks to answer the following question:

- (when) does a real depreciation (or a real devaluation)⁶⁹ of the currency improve the current account-balance of a country?

The MLR condition states that a real devaluation or a real depreciation of the currency will improve the trade balance if the sum of the absolute values of elasticities of the demand for imports and the demand for exports with respect to the real exchange rate is greater than 1:

$$|EM| + |EX| > 1$$

where EM is the demand for imports elasticity and EX is the demand for export elasticity.

This condition rests on two fundamental assumptions: the first is that we start from a situation of balanced trade; the second is that the supply elasticities are infinite. This implies that, if the initial situation is a trade deficit, then the MLR condition is a necessary but not sufficient stability condition.

Even when the MLR condition is met, and improvement ultimately occurs, it may be that at the beginning trade balance deteriorates before it subsequently improves. There is some support in theory for this pattern, known as the *J-curve effect*.

In theory, the impact of a real exchange rate depreciation on the trade balance is commonly believed to follow a J-curve. According to this view, a currency depreciation improves the trade balance in the long run but worsens it in the short run. The initial deterioration in the trade balance occurs because (i) currency depreciation increases import prices, while export prices are *sticky* in the sellers' currency and (ii) trade volume tends to respond slowly to a change in relative prices.

To better explain the J-curve phenomenon, it can be said that, at the moment of depreciation, there is a *price effect* due to higher prices of imported goods: since there can be some delays

⁶⁹ We talk about real devaluation in fixed exchange rates and of real depreciation in floating exchange rates.

in transactions which have been ordered several months before, the value of imports increases in the short-run.

Later, when traders have had some time to change their strategy, they integrate their loss in competitiveness face to face to goods produced abroad. This produces a *quantity effect*: the volume of imports decreases while local production is probably increased to satisfy demand. In this way, adjustment of quantities traded are slower to adjust than are changes in relative prices. It is expected that the final effect in the long-run is a net improvement in the trade balance.

The phenomenon is named the J-curve effect because when a country's net trade balance is plotted on the vertical axis and time is plotted on the horizontal axis, the response of the trade balance to a devaluation or depreciation looks like the curve of the letter J.

There are numerous empirical studies exploring both whether currency depreciation leads in the long run to trade balance improvement, and if so, whether a J-curve pattern occurs. These studies investigate different kind of economies such as developed countries, emerging East-European and Asian economies, as well as few developing African countries. Their findings are mixed and, as always, it is up to empirical evidence to support or reject the occurring of the J-curve effect (Petrović and Gligorić, 2009).

According to the above mentioned theories, one of the policy options to improve the current account is depreciation, which involves the deliberate reduction in the value of a country's currency. This type of policy encourages consumers to alter the distribution of their spending: that is, it is based on an *expenditure switching* process. Expenditure switching, indeed, encourages consumers to switch *away from* imports to domestically produced products and this will lead to a fall in import demand. Contemporaneously, a fall in the exchange rate will, *ceteris paribus*, reduce export prices encouraging export demand.

It is easy to see that the main viewpoints of the debate on the results of an appropriate policy end up to two: those who believe in the positive effects of a currency depreciation on the trade balance and those who don't. If the exchange rate of an economy affects aggregate demand through its effect on export and import prices, policy makers may exploit this connection by deliberately altering exchange rates to influence the macro-economic environment.

Price elasticity estimates are therefore clearly fundamental not only for forecasting purposes and hence, for the implementation of a correct policy, but also for the *a posteriori* evaluation of its effectiveness.