Trade Effects of Exchange Rate Fluctuations: Evidence from Sweden

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To my father
ABSTRACT

An overview of the theoretical literature for the last two decades suggests that there is no clear-cut relationship one can pin down between exchange rate volatility and trade flows. Analytical results are based on specific assumptions and only hold in certain cases. Especially, the impact of exchange rate volatility on export and import activity investigated separately leads also to dissimilar conclusions among countries studied. The general presumption is that an increase in exchange rate volatility will have an adverse effect on trade flows and consequently, the overall health of the world economy. However, neither theoretical models nor empirical studies provide us with a definitive answer, leaving obtained results highly ambiguous and inconsistent (Baum and Caglayan, 2006). We purposed to empirically investigate trade effects of exchange rate fluctuations in Sweden from the perspective of export and import in this research. The data comprises period from January 1993 to December 2006, where export and import volumes are considered from the point of their determinants, including exchange rate volatility, which has been measured through EGARCH model. The results for the case of Sweden show that short run dynamics of volatility negatively associated with both export and import, whereas considered from the case of previous period volatility it exhibits positive relationship. These results are consistent with the most findings of prior studies, where the relationship remained ambiguous.

Keywords: Exchange rate volatility, EGARCH, export and import.
## LIST OF CONTENTS

1. INTRODUCTION .......................................................... 1

2. THEORETICAL AND METHODOLOGICAL FRAMEWORK ........ 4
   2.1 Literature review ................................................. 4
   2.2 Real exchange rate and trade performance in Sweden ....... 10
   2.3 Data .................................................................. 12
   2.4 Data description .................................................. 13
   2.5 Model ................................................................ 18

3. EMPIRICAL RESULTS ..................................................... 19
   3.1 Descriptive statistics .............................................. 19
   3.2 Unit root test ....................................................... 20
   3.3 Multiple regressions .............................................. 23
   3.4 Result analysis ..................................................... 26

4. CONCLUSIONS ............................................................. 28

BIBLIOGRAPHY ............................................................. 31
LIST OF TABLES, FIGURES AND APPENDICES

Table 3.1a Descriptive statistics for export related variables, period from 1993 to 2006 19
Table 3.1b Descriptive statistics for import related variables, period from 1993 to 2006 19
Table 3.2.1 Regression results for unit root test (level) 21
Table 3.2.2 Regression results for unit root test (first difference) 22
Table 3.3.1 Regression results for export at time $t$ 23
Table 3.3.2 Regression results for export including lag of export and volatility 24
Table 3.3.3 Regression results for import at time $t$ 24
Table 3.3.4 Regression results for import including lag of import and volatility 25

Figure 2.2.1 The chronicle of real exchange rate between US dollar and SEK during the period from 1993 to 2006 11
Figure 2.2.2 Performance of export and import during the period from 1993 to 2006 in Sweden 12

APPENDIX 1

Figure A.1 Economic time series: Real effective exchange rate 35
Figure A.2 Economic time series: Exchange rate volatility 35
Figure A.3 Economic time series: Relative prices 36
Figure A.4 Economic time series: Export and import 36
Figure A.5 Economic time series: Income level and industrial production index 37
1. INTRODUCTION

The issue of exchange rate risk is ubiquitous in international economics, and this is best understood and exemplified by the incessant debates about the level and scope of its damaging effects. The tendency for nominal exchange rates to move so volatilley and unpredictably has been blamed for limiting gains from international trade and lowering welfare (Straub and Tchakarov, 2004, p.5).

Since the breakdown of the Bretton Woods system of fixed exchange rates, a substantial body of theoretical and empirical literature has investigated the link between exchange rate volatility and international trade flows as this information contributes to the understanding of the transmission mechanism of exchange rate fluctuations on the economy. The general presumption is that an increase in exchange rate volatility will have an adverse effect on trade flows and consequently, the overall heath of the world economy. However, neither theoretical models nor empirical studies provide us with a definitive answer (Baum and Caglayan, 2006, p.2).

The exchange rate regime in Sweden has shifted from being fixed to pegged, and to a floating regime. It is an important macro variable that influences the whole economy therefore attracts keen attention of researchers (Backman, 2006). Whether Sweden should join European Monetary Union (EMU) have been discussed over many debates. Persson (2001) argues regarding the economic consequences of a Swedish EMU membership that the most obvious advantage is transaction gains. A single currency will promote competition within the EU and benefit the consumers, who will experience lower prices. It will also be an advantage for the national economy as a whole, since competition facilitates the work on holding down inflation. The arguments against Swedish membership have often touched on the opportunity to pursue an independent stabilization policy. The starting point for this is that the Swedish economy could for one reason or another find itself out of synch with economic developments in the eurozone, what is known as an asymmetrical shock.

Moccero and Winograd (2006, p.2) indicate that the theoretical literature on the impact of exchange rate fluctuations on trade and the resulting demand for stable anchors (exchange rate fixing) have long been a highly debated topic among economists. Traditional models examined the exchange rate volatility effect on trade based on the producer theory of the firm under uncertainty, where firm profitability is related to exchange rate fluctuations. Some theoretical models point to a positive relationship. Baron (1976) shows how an increase in exchange rate volatility may not necessarily lead to an adverse effect on the level of trade when hedging opportunities exist.
Furthermore, some authors have shown that an increase in exchange rate volatility may be beneficial for trade (De Grauwe, 1988; Franke, 1988). The most obvious case is that in which exporters are risk-lovers. However, De Grauwe (1988) shows that, when exporters are sufficiently risk-averse, a positive relationship may still arise. Very risk-averse firms will worry about the worst possible scenario. When risk increases, the way to avoid a drastic decline in export revenues is by increasing the export volume. Franke (1988) highlights that volatility may increase exports if it also associated with an increase in the real exchange rate level.

At the same time advocates of greater exchange rate stability across the major currencies argue that a significant part of exchange rate volatility is created in the exchange rate market itself. If exchange rate fluctuations are due to non-fundamental reasons in the sense that they are primarily driven by investor psychology, there might still exist a good case for exchange rate stability. If the exchange rate breeds its own shock then it may also be a source of welfare reduction (Straub and Tchakarov, 2004, p.5).

One main argument against flexible exchange rates has been that exchange rate volatility could have negative effects on trade and investment. If exchange rate movements are not fully anticipated, an increase in exchange rate volatility, which increases risk, will lead risk-averse agents to reduce their import and/or export activity and to reallocate production toward domestic markets (Dell’ Aricca, 1999, p.315).

An overview of the theoretical literature for the last two decades suggests that there is no clear-cut relationship one can pin down between exchange rate volatility and trade flows. Analytical results are based on specific assumptions and only hold in certain cases. Especially, the impact of exchange rate volatility on export and import activity investigated separately leads also to dissimilar conclusions among countries studied (Baum and Caglayan, 2006). So, how exports associated with exchange rate volatility, and what about the relationship for imports?

The most commonly held belief is that greater exchange rate volatility generates uncertainty thereby increasing the level of riskiness of trading activity and this will eventually depress trade. A vast majority of economic literature, however, contains highly ambiguous and inconsistent theoretical and empirical results on this issue (Todani and Munyama, 2005, p.3).

At a theoretical level, there are models that demonstrate that increased risk associated with volatility is likely to induce risk averse agents to direct their resources to less risky economic activities. Cote (1994) cited Hooper and Kohlhagen (1978), Clark (1973) among others as theoretical studies that concluded that volatility depresses trade. On the contrary, other theoretical
models show that higher risk presents greater opportunity for profits and, thus exchange rate volatility, to the extent that it increases risk, should increase trade. The ambiguity of theoretical predictions has made the debate to become a fundamentally empirical one. Unfortunately, much of the results from empirical literature are also fraught with the same ambiguity and inconsistencies (Todani and Munyama, 2005, p.3). So, how exchange rate fluctuations exercise influence over particularly Swedish export and import?

This paper presents an empirical investigation of trade effects of exchange rate fluctuations in Sweden from the perspective of export and import. In the presence of conflicting and ambiguous findings of prior studies, scrutinizing the relationship between exchange rate volatility and export/import volumes is purposed in this research. The contribution of this work is that the study of dubious relationship between exchange rate fluctuations and trade from the perspective of both export and import simultaneously has not been performed for the case of Sweden yet. To accomplish above stated purpose, we will integrate the findings of past works with empirical analysis made on different world markets so as to perform empirical work for a Swedish market, where employing aggregate monthly data for 14 years period and running multiple regressions are intended.

Furthermore, analyzing methodological problems that compromise the findings of previous empirical studies is also aimed in the proposed topic. This allows us to provide comprehensive and robust results regarding exposure the impact of exchange rate volatility on trade.

The rest of the paper is constructed as follows. Section 2 introduces theoretical and methodological framework, where literature review provides theoretical basis for the empirical analysis; data sources and description as well as employed export and import models are presented in this section. Section 3 documents our empirical findings, which combines descriptive statistics, unit root test and multiple regression subsections. Section 4 presents conclusion. Finally, bibliography and appendices complete the paper.
2. THEORETICAL AND METHODOLOGICAL FRAMEWORK

2.1 Literature review

Since the breakdown of the Bretton Woods system of fixed exchange rates, both real and nominal exchange rates have fluctuated widely. This volatility has often been cited by the proponents of managed or fixed exchange rates as detrimental, since in their view exchange rate uncertainty will inevitably depress the volume of international trade by increasing the riskiness of trading activity and negatively affecting the optimal allocation of resources. Several theoretical studies (Ethier (1973), Clark (1973), Baron (1976), Cushman (1986), Peree and Steinherr (1989) etc.) have shown that an increase in exchange rate volatility will have adverse effects on the volume of international trade (Baum et al. 2000, p.3).

A vast amount of empirical studies has been conducted within and across the countries to reveal whether exchange rate fluctuation causes movements in trade volumes, particularly, these studies investigated this issue from the point of total trade as well as from the perspective of export and import discretely.

Moccero and Winograd (2006) has employed Markov Switching autoregressive conditional heteroskedastic model (SWARCH) to investigate the link between real exchange rate volatility and exports in the case of Argentina. The empirics of this topic have been discussed in view of the twofold dimension of trade relations: the impact of intra-regional (with Brazil) and extra-regional (with the rest of the world) real exchange rate volatility on intra and extra-regional exports. They found that volatility matters for exports in Argentina, viz. reducing real exchange rate volatility (intra-region or extra-region) has a positive impact on exports to Brazil but a negative impact on sales to the rest of the world. This trade-off increases when the reduction in volatility falls on the intra-regional real exchange rate volatility. It is also emphasized, that if Argentina is committed to deepen commercial integration with Brazil the coordination of exchange rate policies should not be excluded.

Dell’ Ariccia (1999) uses the gravity model in the study and provides a systematic analysis of exchange rate volatility on the bilateral trade of the 15 EU members and Switzerland over a period of 20 years from 1975 to 1994. Revealed effects indicate that exchange rate volatility has a small but significantly negative impact on trade. Bayoumi and Eichengreen (1998) and Tenreyro (2004) have also employed gravity model in their works (Todani and Munyama, 2005, p.3).
Vergil (2002) investigates the impact of real exchange rate volatility on the export flows of Turkey to the United States and its three major trading partners in the European Union for the period from 1990 to 2000. The standard deviation of the percentage change in the real exchange rate is employed to measure the exchange rate volatility while cointegration and error-correction models are used to obtain the estimates of the cointegrating relations and the short-run dynamics, respectively. The results provide evidence of significant negative effect of real exchange volatility on real exports.

Exchange rate sensitivity of Swedish regions has been discussed by Molinder and Westlund (2000, p.2), where they study how Swedish manufacturing export to six trade areas (EMU-countries, West European non-EMU countries, rest of Europe, North America, South East Asia, Japan) was affected by the exchange rates during the 90’s. The exchange rates of the trade areas are weighted, based on the shares of the individual countries’ trade with Sweden. The Swedish regions’ share of manufacturing industry and branch composition determines their sensitivity to exchange rates. The share of export to each of the trade areas governs the sensitivity to changes in the exchange rates to that particular area. They conclude that changes in international demand influence Swedish exports to a higher degree rather than changes in exchange rates.

Qian and Varangis (1992) apply ARCH-in-mean model to six countries in estimating bilateral and aggregate exports. They find exchange rate volatility to have a negative, statistically significant impact in two cases: Canadian and Japanese exports to the United States. In terms of aggregate exports, the relationship is negative but statistically insignificant for Japan and Australia while positive and statistically significant for Sweden and to some extent UK, but statistically insignificant for the Netherlands. The magnitude of the impact of exchange rate volatility varies greatly – from a reduction in exports of 7.4% for Canada to an increase of 5% for Sweden, following a 10% increase in volatility.

Clark et al. (2004, p.15) argues that one reason why trade may be adversely affected by exchange rate volatility stems from the assumption that the firm cannot alter factor inputs in order to adjust optimality to take into account of fluctuations in exchange rates. When this assumption is relaxed and firms can adjust one or more factors of production in response to fluctuations in exchange rates, increased volatility can in fact create profit opportunities. This situation has been analyzed by Canzoneri et al. (1984), De Grauwe (1992) and Gros (1987).

While earlier literature focused on the negative effect of exchange rate on trade, recent studies provide explanations on why a positive effect could also possible. Bailey et al. (1987) argue that in
order to reduce volatility the authorities have to rely on measures that can be more costly than the exchange rate volatility they replace. De Grauwe (1987) argue that if exporters are sufficiently risk averse, an increase in the exchange rate volatility raises the expected marginal utility of export revenue and therefore induces them to increase exports. Cabalero and Corbo (1989) show that under perfect competition, convexity in profit functions, symmetric costs of capital adjustment and risk neutrality, increases in exchange rate volatility will increase exports. Their argument goes as follows: when exchange rate movements are unfavorable, firms will reduce production and thus they will have more capital than optimal. When exchange rate movements are favorable, firms will produce more and have less capital than they need. Assuming a convex profit function, the potential profits foregone due to insufficient capital are higher than the losses due to underutilized capital. So profit maximizing firms, will tend to overinvest, and thus export more in the face of uncertainty. The authors argue, however, that if the hypothesis about risk neutrality and symmetric costs (e.g., sunk costs) are relaxed then exports will decline with increasing exchange rate uncertainty (Qian and Visangis, 1992, p.2).

Others, including Franke (1991), Sercu and Vanhulle (1992) have shown that exchange rate volatility may have a positive or ambiguous impact on the volume of international trade flows depending on aggregate exposure to currency risk (Viaene and de Vries (1992)) and the types of shocks to which the firms are exposed (Barkoulas et al. 2002). There are also models that study the impact of exchange rate uncertainty on trade and its welfare costs within a general equilibrium framework including Obstfeld and Rogoff (2003), Bacchetta and van Wincoop (2000) (cited Baum and Caglayan, 2006, p.2).

Ambiguous and inconclusive results of exchange rate volatility impact on trade have been found across many studies. De Vita and Abbott (2004) use the autoregressive distributed lag (ARDL) econometrics technique to analyze the impact of exchange rate volatility on UK exports to the European Union (EU). The study estimates an export demand equation using disaggregated monthly data for the period 1993 to 2001 and concludes that UK export to the EU are largely unaffected by exchange rate volatility. Morgenroth (2000) obtains similar results while examining the case of Irish exports to Britain. Estimated error correction models by Doyle (2001), also for Irish export to Britain, reveal that both real and nominal volatility are significant determinants of changes in total exports and in a number of sectors. Both positive and negative short-run elasticities for exchange rate volatility have been estimated, although positive elasticities predominate. Wang and Barrett (2002) analyze the effect of exchange rate volatility on international trade flows by studying
the case of Taiwan’s exports to the United States from 1989-1999. They found that real exchange rate risk has insignificant effects in most sectors, although agricultural trade volumes appear highly responsive to real exchange rate volatility (Todani and Munyama, 2005, p.2).

Hondoyiannis et al. (2005) study exchange rate volatility issue for 12 industrial economies examining a model that includes real export earnings of oil-producing economies as a determinant of industrial-country export volumes. Five estimation techniques, including a generalized method of moments (GMM) and random coefficient (RC) estimation, are employed on panel data covering the estimation period from 1977 to 2003 using three measures of volatility whereas they have not found a single instance in which volatility has a negative and significant impact on trade.

Baum and Fagereng (2007) examine the causal link between export performance and exchange rate volatility across different monetary policy regimes within the cointegrated VAR framework using the implied conditional variance from a GARCH model as a measure of volatility. While treating the volatility measure as either a stationary or a non-stationary variable in the VAR, they were not able to find any evidence suggesting that export performance has been significantly affected by exchange rate uncertainty.

Influence of exchange rate volatility on exports between Sweden and Euro zone has been examined by Backman (2006), where the conclusion was that industrial production, the real effective exchange rate index, time and lagged values of the export influence the export, while no evidence of exchange rate volatility impact on exports was found.

There are only few studies which investigate the impact of exchange rate volatility on import, as most studies in this area focus on exports. Gotur (1985) uses aggregate data for the US, Germany, France, Japan and the UK and finds mixed evidence regarding the impact of exchange rate volatility on US import demand using bilateral time series for the major trading partners of the US. Caporale and Doroodian (1994) use a GARCH technique to measure the volatility of exchange rates. Using monthly data for the period 1974-92, they find that exchange rate volatility has a significant negative impact on US imports. McKenzie and Brooks (1997 and 1998) introduce an exchange rate volatility term into an import demand function for both Australian and German-US trade flows. For the Australian estimates, they find evidence of a significant, but weak, impact of volatility on trade (Anderton and Skudelny, 2001, p.6).

Cheong (2004) investigates the effect of exchange rate volatility on the UK’s import trade. Author considers an ARCH type auxiliary model to measure volatility in the exchange rate, and discusses a procedure for the correct inference of the OLS estimates of a primary equation in the
second stage, which includes the generated variable. By applying this two-step approach, statistically significant, negative impact of exchange rate volatility on Britain’s imports has been explored.

The paper by Anderton and Skudelny (2001) estimates an import demand function for the euro area vis-à-vis its main extra area trading partners which takes into account the possible impact of both intra- and extra-euro area exchange rate volatility. They derive a theoretical model which captures various mechanisms by which exchange rate volatility may influence the demand for extra-euro area imports. If importers are risk averse, the model predicts not only a negative effect of exchange rate volatility, but also substitution possibilities between extra- and intra-area imports due to differences in the degree of extra- and intra-area exchange rate volatility.

Arize (1998) studies the long-run relationship between imports and exchange-rate volatility in eight European countries within the period 1973 and 1995. Applying cointegration analyses, the major results show that exchange-rate volatility has a significant negative effect on the volume of imports of six countries whereas for Greece and Sweden, it is positive and significant. These findings are reasonably robust in terms of measures of exchange-rate volatility, different estimation methods and membership in the European Exchange-rate Mechanism (ERM).

More recently, studies have used panel data in order to analyze the effect of exchange rate volatility on import demand. For example, Pugh et al. (1999) estimate an import demand equation for sixteen Organization for Economic Co-operation and Development (OECD) countries over the period 1980-92 and find significant and negative effect of exchange rate volatility (Anderton and Skudelny, 2001).

Campa and Goldberg (2002) perform import and exchange rate related study from different feature, viz. they argue that exchange rate regime optimality, as well as monetary policy effectiveness, depend on the tightness of the link between exchange rate movements and import prices. Recent debates hinge on the issue of the prevalence of producer-currency-pricing (PCP) versus local currency price (LCP) stability of imports, and on whether exchange rate pass-through rates are endogenous to a country’s macroeconomic conditions. They provide cross-country and time series evidence on both of these issues for the imports of 25 OECD countries. Across the OECD and especially within manufacturing industries, there is compelling evidence of partial pass-through – rejecting both PCP and LCP as short-run phenomenon. Over the long run, PCP is more prevalent for many types of imported goods. Higher inflation and exchange rate volatility are weakly associated with higher pass-through of exchange rates into import prices. However, for
OECD countries the most important determinants of changes in pass-through over time are microeconomic and relate to the industry composition of a country’s import bundle.

A number of diversity studies have been implemented regarding exchange rate fluctuations vis-à-vis different macroeconomic indicators. Jones and Kenen (1990) state that exchange rate volatility is directly influenced by several macro variables, such as demand and supply for goods, services and investments, different growth and inflation rates in different countries, changes in relative rates of return and so forth. The present floating rate has been affected by previous real and monetary disturbances. Expectations about current events and future events are also important factors due to the large influence it has on exchange rate volatility. The volatility can also arise from “overshooting” behavior which occurs when the current spot rate does not equal a measure of the long-run equilibrium calculated from a long-run model. If this behavior arises because the financial market is not working correctly, high exchange rate volatility does not have to imply high transaction costs (Backman 2006, p.3).

Most economists would probably assume, for a start, that exchange rate volatility cannot have a significant impact on labor markets, given that the link between exchange rate volatility and the volume of trade is known to be weak. Belke et al. (2005, p.3) investigate in how far high exchange rate volatility can be made responsible for the negative developments in Central and Eastern European Countries (CEEC) labor markets. In earlier studies they have shown that intra-European exchange rate volatility has increased unemployment and reduced employment, a finding that had an importing bearing on the evaluation of costs and benefits of European Monetary Union (Belke and Gros 2001). More recently, they have showed in the context of a project for the European Commission that exchange rate volatility might also have significant negative effects on the global level. Results indicate that transatlantic exchange rate volatility does have a significant negative impact on labor markets in the EU, and possibly also in the US. Moreover, volatility matters because employment and investment decisions are characterized by some degree of irreversibility in the presence of structural rigidities. Such decisions tend to be discouraged by exchange rate volatility, as can be shown in a variety of economic models (Belke and Goecke 2001).

Addressing exchange rate fluctuations issue, Andersson (2005) evaluates whether international stock markets are exposed to fluctuation in the exchange rate and if this exposure is related to exports, imports and inflation. Empirical investigation relates to eight countries covering period from 1995 to 2004, and the findings show that all international stock markets are exposed to exchange rate risk, except for Brazil. The amount of exchange rate exposure is found to be sensitive
to a country’s export, import and inflation. The results imply that there are predictable relationship between changes in the return of the national stock index return and fluctuation in the exchange rate. In addition, imports and exports as well as inflation indicated to be useful in predicting exchange rate risks.

Clark et al. (2004, p.11) make quite wide general statement based on the empirical results. They argue that for the world as a whole, there is no obvious association between periods of low exchange rate volatility and periods of fast growth in trade. In other words, at an aggregate level, there is no evidence of a negative effect of exchange rate on world trade. Once one goes to trade and exchange rate volatility at a bilateral level, a negative relationship between the two is borne out by some of the empirical evidence in their study. However, this negative relationship is not robust to a more general specification of the equation linking bilateral trade to its determinants that embodies the recent theoretical advances in a gravity model. Thus, if there is a negative impact of exchange rate volatility on trade, it is not likely to be quantitatively large and the effect is not robust. These findings suggest that, from the perspective of world trade, exchange rate volatility is probably not a major policy concern. Though, this does not imply necessarily that exchange rate fluctuations should be viewed with equanimity. For instance, currency crises – special cases of exchange rate volatility - have required painful adjustments in output and consumption. However, in this case, what is important is not that measures need to be taken to moderate currency fluctuations directly, but that appropriate policies need to be pursued in order to avoid the underlying causes of large, unpredictable and damaging movements in exchange rates.

2.2 Real exchange rate and trade performance in Sweden

In the 1970s the world economy was hit by two major shocks since the oil price was heavily increased in 1973 and in 1979. To handle this, Sweden chooses an expansionary domestic stability politic during 1974 until 1976. The aim was to avoid a depression; the result was, however, that the price and wage level rose by a higher degree in Sweden than in the other countries, which the Swedish krona was bound to. The Swedish krona was devaluated three times in the years 1976 and 1977 and then once in 1981 and in 1982 (Backman, 2006, p.4 cited Jonung, 1991).

In 1991 the Swedish currency was pegged to the European currency unit. The central bank decided to let the Swedish krona float on the 19th of November in 1992. The Swedish central bank was then forced to leave a fixed exchange rate and to let the krona float since almost all the currency reserves was lost in an attempt to keep the fixed exchange rate regime after heavy speculations
against the krona (Sveriges Riksbank, 1992). Since 1992, Sweden has been involved in a floating exchange rate regime even though it has been questioned by the election of whether to join the EMU or not (Backman 2006, p.4). The chronicle of real exchange rate during the period from January 1993 to December 2006 is presented in fig. 2.2.1.

![Graph of real exchange rate between US dollar and SEK](image-url)

**Fig. 2.2.1 The chronicle of real exchange rate between US dollar and SEK during the period from January 1993 to December 2006**

Source: Statistiska Centralbyrå

Sweden is a highly industrialized country and has one of the highest living standards in the world. The country’s economy is mainly driven by exports which account for 45% of GDP. The GDP growth rate was 3.7% in 2004, 2.7% in 2005 and 4.5% in 2006. The share of foreign trade in the country’s trade is approximately 85%. A marked shift in the nature of the exports, where services (like IT and telecommunications) have taken over from traditional industries (steel, paper, and pulp) has made the Swedish export sector less vulnerable to international fluctuations. The country is a member of the EU, but does not currently take part in the single currency. The EU is the country's top trading block constituting more than 50% of Swedish exports and more than 60% of imports. Sweden’s top three export partners are: the USA, Germany and Norway. The commodities mainly exported are machinery, electrical and electronic equipment, vehicles, paper, and pulp, iron and steel. The country’s top three import partners are: Germany, Denmark and Norway. It mainly
imports machinery, vehicles, electrical and electronic equipment, mineral fuels and oils, iron and steel.\(^1\) The graphical depiction of Swedish export and import history during 1993 and 2006 is given in fig. 2.2.2.

![Graph of Swedish export and import history](image)

**Fig. 2.2.2 Performance of export and import during the period from 1993 to 2006 in Sweden**

Source: Statistiska Centralbyråns

### 2.3 Data

Our empirical investigation is carried out with aggregate monthly data over the period between January 1993 and December 2006. The study is performed on the example of Swedish export and import activity for a total of 168 observations. The data are constructed from export and import volumes, exchange rate, industrial production index, real effective exchange rate, relative prices, consumer price index, import price index and income level of Sweden. The sources for the data are: Statistiska Centralbyråns\(^2\), Riksbank’s database\(^3\), International Monetary Fund’s reports\(^4\), Nordisk Statistisk Årsbok\(^5\) and Statistisk Årsbok för Sverige\(^6\).

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\(^{1}\) The Federation of International Trade Associations. [www.fita.org](http://www.fita.org)

\(^{2}\) Statistics Sweden, [www.sbc.se](http://www.sbc.se)

\(^{3}\) Central Bank of Sweden, [www.riksbank.se](http://www.riksbank.se)

\(^{4}\) International Monetary Fund, [www.imf.org](http://www.imf.org)

\(^{5}\) Nordic Statistical Yearbook 2007

\(^{6}\) Statistical Yearbook of Sweden 2007
2.4 Data description

Although the literature on exchange rate volatility impact on trade is abounding it differs from
the features considered in the studies implemented. The cases where not exchange rate volatility
influences trade flows but trade itself creates volatility in exchange rates, have been the special point
in several investigations. Furthermore, exchange rate volatility can also be generated by inflation, interest rate, exchange rate regime and GDP among others.

Up to this point the discussion of the impact of volatility on trade has been within a partial
equilibrium framework, i.e., the only variable that changes is some measure of the volatility of the
exchange rate, and all other factors that may have an influence on the level of trade are assumed to
remain unchanged. However, those developments that are generating the exchange rate movements
are likely to affect other aspects of the economic environment which will in turn have an effect on
trade flows. Thus it is important to take account in a general equilibrium framework the interaction
of all the major macroeconomic variables to get a more complete picture of the relationship between
exchange rate volatility and trade (Clark et al. 2004). Across the studies performed the different type
of trade models have been employed by researchers which depend mainly on the purpose and the
object of the study, i.e. aggregate or disaggregate data, developing and developed country, bilateral
or multilateral trades etc.

In line with many studies, Cheong (2004), Backman (2006), Todani and Munyama (2005) and
others, we consider the exchange rate volatility effect on both export and import volumes, where
real effective exchange rate, industrial production index, relative prices, and income level have been
employed as characteristic variables whereas a peculiar priority is given to study the exchange rate
volatility, since it is the main variable which is supposed to be scrutinized in the given work.

Real effective exchange rate

Real effective exchange rates take account of price level differences between trading partners. Movements in real effective exchange rates provide an indication of the evolution of a country’s aggregate external price competitiveness, consequently, used as an indicator of competitiveness7. We proxied it by TCW-index (Total Competitiveness Weights) which is composed of the value of the Swedish krona against 21 foreign currencies8.

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7 OECD
8 www.riksbank.se
This variable is expected to have a negative impact on exports, i.e. if the real effective exchange rate index is increasing the country experiences appreciation and the commodities in the home country become relatively more expensive and economic agents will change their behavior. The economic agents on the foreign market will choose domestic commodities since they are relatively less expensive, hence, their import will decrease (Backman 2006, p.16).

**Industrial production index**

The industrial production index is one of the most important short-term business indicators, which aims to measure at a monthly frequency the ups and downs of industrial production during the long period of time. Monthly survey on industrial production index allows identifying the turning points in economic development at an early stage; also the timely industrial production index is one of the most important measures of economic activity\(^9\).

Industrial production index are computed mainly as fisher indexes with the weights based on annual estimates of value added. This index, along with other industrial indexes and construction, accounts for the bulk of the variation in national output over the duration of the business cycle\(^{10}\).

The coefficient estimate is expected to be positive since the exports increase if industrial production becomes stronger. If the Swedish production increases it will have spill-over effects on the export since the Swedish market is filled and a company has to go abroad to find a market for its commodities (Backman 2006, p.16).

**Relative prices**

Relative price is the price of a commodity such as a good or service in terms of another. A relative price may be expressed in terms of a ratio between any two prices or the ratio between the price of one particular good and a weighted average of all other goods available in the market\(^{10}\). According to Cheong (2004) relative prices are examined from the perspective of import demand function and are measured as follows:

\[
RP = \frac{MPI}{CPI}
\]

where, MPI and CPI are import price and consumer price indices respectively. It is expected that an increase of relative prices negatively affects the Sweden’s imports (Cheong 2004).

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\(^9\) [www.nsi.bg](http://www.nsi.bg)

\(^{10}\) [www.wikipedia.org](http://www.wikipedia.org)
**Income level**

The income level of a country is reflected by its GDP, though the issue arises because of the unavailability of this variable on a monthly basis. Therefore, in several studies it is proxied by industrial production, which is not an accurate approximation since it provides a limited measure of overall economic activity (Baum and Caglayan, 2006).

We proxied this variable by activity index, which measures the activity in the total economy and can be seen as a monthly indicator of GDP. It is a combination of different monthly indicators that show strong relation with GDP\(^\text{11}\). It is expected that an increase of income has a positive effect on import volume.

**Exchange rate volatility measure**

Exchange rate volatility is a measure that intends to capture the uncertainty faced by exporters and importers due to unpredictable fluctuations in the exchange rates. Clearly, this is an unobservable variable and thus its measure is a matter of serious contention. Consequently the literature is not unanimous as to which measure is most appropriate (Todani and Munyama, 2005, p.9).

Any attempt to evaluate the effects of exchange risk on trade flows requires specification of a measured risk. The choice of a particular specification may have a considerable impact on the empirical findings; counterintuitive results may be merely reflecting errors of measurement in a proxy for risk. A number of competing specifications may be found in the empirical literature (Baum et al. 2000, p.10).

The most widely used measure of exchange rate volatility is the standard deviation of the first difference of logarithms of the exchange rate\(^\text{12}\) (Clark et al. 2004), moving sample standard deviation\(^\text{13}\) (Todani and Munyama, 2005), moving average standard deviation\(^\text{14}\), the family of autoregressive conditional heteroskedasticity (ARCH) models\(^\text{15}\) (Qian and Varangis, 1992) etc. Recently, it is getting to be more popular to use as a measure of volatility the generalized

---

\(^{11}\) According to the reasoning by Statistiska Centralbyrån


\(^{13}\) De Vita and Abbot (2004), Das (2003), Chowdhury (1993) and Arize (2000) etc.

\(^{14}\) Aristoleous (1999), Bredin et al. (2003), Vita and Abbot (2004) etc.

autoregressive conditional heteroscedasticity (GARCH) model of Bollerslev (1986) and its extensions.\(^\text{16}\)

However, there might be a methodological problem in previous studies in re all above mentioned measures to have been criticized over the studies for the inappropriateness of their application as a measure of volatility. The standard deviation method has been reproached for wrongly assuming that the empirical distribution of the exchange rate is normal and for ignoring the distinction between predictable and unpredictable elements in the exchange rate process (Takaendesa et al. 2005 cited Musonda (2000), Hook and Boon (2000)).

Qian and Varangis (1992) argues that moving standard deviation of past growth rates approach as a measure of volatility may incorrectly specify the stochastic process that generates exchange rate. In addition, as pointed out by Kroner and Lastrapes (1991), the test requires a two step procedure; first calculating the volatility and then using it in the regression, which may lead to inefficient estimators.

Moving average standard deviation measure has been questioned on the ground that they lack a parametric model for the time-varying variance of exchange rates. Moreover, as assessed by Pagan and Ullah (1998), they are likely to suffer from the measurement error problem and as such produce biased estimates of the impact of risk on the decision making of economic agents.

ARCH based measures of volatility according to Pagan (1984) may create a generated regressor problem in that whilst the model produces consistent parameter estimates, they may not necessarily be efficient (Boug and Fagereng, 2007, p.4).

GARCH method has two distinct problems. Firstly, the nonnegativity conditions of the variance may be violated by the estimated model. Secondly, the models cannot account for leverage effects, although they can account for volatility clustering and leptokurtosis in the series\(^\text{17}\) (Takaendesa et al. 2005, p.8).

In measuring exchange rate volatility we follow Takaendesa et al. (2005) and use exponential autoregressive conditional heteroskedasticity (EGARCH) proposed by Nelson (1991). Nelson and Cao (1992) comparing GARCH and EGARCH models argue that the nonnegativity constraints in the linear GARCH model are too restrictive. The GARCH model imposes the nonnegative

---


\(^\text{17}\) See Brooks (2002)
constraints on the parameters, while there are no restrictions on these parameters in the EGARCH model\textsuperscript{18}.

The EGARCH model is given by

\[
\log \sigma_i^2 = \sigma + \eta \log \sigma_{i-1}^2 + \phi \frac{\varepsilon_{i-1}}{\sigma_{i-1}} + \lambda \left| \frac{\varepsilon_{i-1}}{\sigma_{i-1}} \right|
\]

where $\sigma_i^2$ is the conditional variance of the real exchange rate; $\sigma$, $\eta$, $\phi$ and $\lambda$ are parameter estimates; $\varepsilon_{i-1}$ are the residuals\textsuperscript{19} which is a measure of information about volatility in the previous period while $\sigma_{i-1}^2$ is the GARCH term representing last period’s forecast variance. Predicted values of $\log \sigma_i^2$ are applied as an estimate of real exchange rate volatility (Takaendesa et al. 2005, p.10).

The exchange rate volatility based on the above discussions is thus ambiguous, which implies that it can be both positively and negatively associated with trade volume.

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\textsuperscript{18} www.caspur.it

\textsuperscript{19} Residuals derived from the equation $\ln ER_i = \alpha + \ln ER_{i-1} + \varepsilon_i$, where $ER_i$ is the exchange rate at time $i$, while $ER_{i-1}$ is the exchange rate from previous period.
2.5 Model

Investigating the relationship between exchange rate volatility from both export and import perspectives is aimed in this empirical work. We present two models viz. export and import, which is estimated by multiple regression model, that considers exchange rate, industrial production index, real effective exchange rate, relative prices, consumer price index, import price index and income level to explain export and import volume movements affected by exchange rate fluctuations.

Following Backman (2006) the relationship for export side is presented by the following equation:

\[ \text{EXP}_t = \alpha_0 + \alpha_1 \text{REER}_t + \alpha_2 \text{IPI}_t + \alpha_3 \text{V}_t + \epsilon_t \]  (2.5.1)

where, \( \text{EXP} \) represents real export volume, million SEK (converted to its natural logarithm, since the values were large); \( \text{REER} \) - the real effective exchange rate index; \( \text{IPI} \) – industrial production index; \( \text{V} \) – exchange rate volatility.

We follow Cheong (2004) in investigating import effects of exchange rate volatility, and the proposed import equation is:

\[ \text{IMP}_t = \beta_0 + \beta_1 \text{RP}_t + \beta_2 \text{Y}_t + \beta_3 \text{V}_t + \epsilon_t \]  (2.5.2)

where, \( \text{IMP} \) denotes the real import volume, million SEK (converted to its natural logarithm, since the values were large); \( \text{RP} \) – relative prices (index); \( \text{Y} \) – income level of Sweden (index).

We used multiple regression model to run a regression, in order to reveal whether volatility has an effect on both export and import. The regression analyses have been done in EViews. Andersson et al (1986) state that a regression can only discover relationship, but never promise for sure the underlying causal mechanism. Yet, a regression is a good mean of assistance for future prognosis and estimates.
3. EMPIRICAL RESULTS

3.1 Descriptive statistics

Descriptive statistics for variables related to exports are presented in Table 3.1.a, whereas for the case of imports are presented in Table 3.1.b.

Table 3.1.a Descriptive statistics for export related variables, period from 1993 to 2006

<table>
<thead>
<tr>
<th></th>
<th>Number of observations</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports*</td>
<td>168</td>
<td>10.21</td>
<td>11.54</td>
<td>10.9745</td>
<td>0.29253</td>
</tr>
<tr>
<td>Real effective exchange rate</td>
<td>168</td>
<td>113.38</td>
<td>142.04</td>
<td>126.1421</td>
<td>5.51670</td>
</tr>
<tr>
<td>Industrial production index</td>
<td>168</td>
<td>65.30</td>
<td>116.40</td>
<td>93.4327</td>
<td>12.14615</td>
</tr>
<tr>
<td>Volatility**</td>
<td>168</td>
<td>51.07</td>
<td>95.19</td>
<td>65.3093</td>
<td>10.24069</td>
</tr>
</tbody>
</table>

Table 3.1.b Descriptive statistics for import related variables, period from 1993 to 2006

<table>
<thead>
<tr>
<th></th>
<th>Number of observations</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imports*</td>
<td>168</td>
<td>9.90</td>
<td>11.40</td>
<td>10.7810</td>
<td>0.29907</td>
</tr>
<tr>
<td>Relative price**</td>
<td>168</td>
<td>0.44</td>
<td>0.57</td>
<td>0.4981</td>
<td>0.03058</td>
</tr>
<tr>
<td>Income level</td>
<td>168</td>
<td>78.14</td>
<td>119.22</td>
<td>96.8802</td>
<td>11.43348</td>
</tr>
<tr>
<td>Volatility**</td>
<td>168</td>
<td>51.07</td>
<td>95.19</td>
<td>65.3093</td>
<td>10.24069</td>
</tr>
</tbody>
</table>

*Converted to its natural logarithm, as the values were large.

**Calculated according to the procedure described in section 2.4.

As per the results on the tables above, except for the real effective exchange rate, industrial production index and income level other variables are relatively normally spread out. Real effective exchange rates take account of price level differences between trading partners, which normally, may increase over the period. Industrial production as well as accompanied income level of Sweden varies significantly, due to the proliferation of state-of-the-art technology, hence growth of the overall economy.
3.2 Unit root test

A type of stochastic process that has received a great deal of attention and scrutiny by time series analysts is the so-called stationary stochastic process. Broadly speaking, a stochastic process is said to be stationary if its mean and variance are constant over time and the value of the covariance between the two time periods depends only on the distance or gap/lag between the two time periods and not the actual time at which the covariance is computed. If time series is not stationary in the sense just defined, it is called a nonstationary time series, which might be the case in our study (Gujarati, 2004). The econometric consequences of nonstationarity can be quite severe, leading to least squares estimators, test statistics and predictors that are unreliable. The stationarity of a time series data can be tested with a unit root test (Hill et al. 2001).

We test for stationarity all variables which are supposed to be employed in our both export and import models before running multiple regressions, since the consequences of using nonstationary time series have been discussed above.

According to the visual inspection (Appendix 1), the patterns of variables follow differently, thus the model for testing unit root will be dissimilar.

Real effective exchange rate and volatility exhibit no definite trend and follows random walk, the model for testing unit root is\(^{20}\) (Fig. A.1 and Fig.A2):

\[
\Delta y_t = \theta y_{t-1} + \nu_t \quad (3.2.1)
\]

where, \(\Delta y_t = y_t - y_{t-1}\) is first difference of time series, \(y_{t-1}\) is lag(first) of variable, \(\nu_t\) is a random disturbance with mean zero and constant variance \(\sigma^2\).

Relative prices show a trend and follows random walk with drift, thus the model will be (Fig.A.3):

\[
\Delta y_t = \alpha_0 + \theta y_{t-1} + \nu_t \quad (3.2.2)
\]

where, \(\alpha_0\) is intercept.

Export, import, income level and industrial production index grow over time exhibiting time trend, where the appropriate testing model will be (Fig.A.4 and Fig.A.5):

\(^{20}\) For more information see Hill et al. (2001), Gujarati (2004)
\[ \Delta y_t = \alpha_0 + \alpha_t + \theta \Delta y_{t-1} + \nu_t \quad (3.2.3) \]

where, \( t \) is time trend.

The stationarity requires the condition where in all above presented equations \(|\theta| < 0\), otherwise time series is said to be nonstationary.

We test \( H_0 : \theta = 0 \) against \( H_1 : \theta < 0 \). At \( \alpha\% \) significance level, the null hypothesis of unit root will be rejected, if \( \frac{\hat{\theta}}{se(\hat{\theta})} < DF_c \), where \( DF_c \) stands for Dickey-Fuller test critical values.

The results of regression are presented in the tables below. According to the results, export and import turn out to be time series integrated of order zero (\( EXP_t \sim I(0), \ \text{IMP}_t \sim I(0) \)), whereas the rest are nonstationary time series (Table 3.2.1). By taking the first differences of nonstationary time series, one can get stationary ones.

### Table 3.2.1 Regression results for unit root test (level)

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>( \tau )-statistic</th>
<th>5% critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Export</td>
<td>-0.644549</td>
<td>0.072748</td>
<td>-8.860079</td>
<td>-3.4369</td>
</tr>
<tr>
<td>Import</td>
<td>-0.475618</td>
<td>0.066573</td>
<td>-7.144296</td>
<td>-3.4369</td>
</tr>
<tr>
<td>Real effective exchange rate</td>
<td>0.000117</td>
<td>0.001028</td>
<td>0.113422</td>
<td>-1.9427</td>
</tr>
<tr>
<td>Industrial production index</td>
<td>-0.089602</td>
<td>0.029748</td>
<td>-3.012057</td>
<td>-3.4369</td>
</tr>
<tr>
<td>Relative prices</td>
<td>-0.011799</td>
<td>0.012514</td>
<td>-0.942915</td>
<td>-2.8787</td>
</tr>
<tr>
<td>Income level</td>
<td>-0.039583</td>
<td>0.026027</td>
<td>-1.520802</td>
<td>-3.4369</td>
</tr>
<tr>
<td>Volatility</td>
<td>-0.001925</td>
<td>0.004622</td>
<td>-0.416542</td>
<td>-1.9427</td>
</tr>
</tbody>
</table>

After taking first differences of real effective exchange rate, industrial production index, relative prices, income level and volatility, we test whether converting made these time series stationary. Although, \( n.b. \) theory suggests that in many cases taking first differences yields stationary time series, nevertheless, we preferred to verify whether this statement holds in our case. The results of regression are presented in Table 3.2.2.
Table 3.2.2 Regression results for unit root test (first difference)

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>5% critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real effective exchange rate</td>
<td>-0.788731</td>
<td>0.075953</td>
<td>-10.38453</td>
<td>-1.9427</td>
</tr>
<tr>
<td>Industrial production index</td>
<td>-1.236340</td>
<td>0.077205</td>
<td>-16.01367</td>
<td>-3.4371</td>
</tr>
<tr>
<td>Relative prices</td>
<td>-0.864785</td>
<td>0.077182</td>
<td>-11.20450</td>
<td>-2.8788</td>
</tr>
<tr>
<td>Income level</td>
<td>-1.242557</td>
<td>0.076331</td>
<td>-16.27860</td>
<td>-3.4371</td>
</tr>
<tr>
<td>Volatility</td>
<td>-1.584478</td>
<td>0.063389</td>
<td>-24.99624</td>
<td>-1.9427</td>
</tr>
</tbody>
</table>

Due to the results in Table 3.2.2, the null hypothesis of a unit root can be rejected and real effective exchange rate, industrial production index, relative prices, income level and volatility are said to be time series integrated of order one \( REER_t \sim I(1), \ IPI_t \sim I(1), \ RP_t \sim I(1), \ Y_t \sim I(1), \ V_t \sim I(1) \) implying stationarity.

Drawing conclusion to the processes performed above, we conclude that \( EXP_t \sim I(0), \ IMP_t \sim I(0), \ REER_t \sim I(1), \ IPI_t \sim I(1), \ RP_t \sim I(1), \ Y_t \sim I(1), \ V_t \sim I(1) \) therefore, in these cases are stationary.
3.3. Multiple regressions

Taking into account the results of unit root test the models for export and import are modified. Two cases for both export and import equations will be considered.

Export.
1. Equation for export at time $t$ is:

$$ EXP_t = \alpha_0 + \alpha_1 \Delta REER_t + \alpha_2 \Delta IPI_t + \alpha_3 \Delta V_t + \epsilon_t \quad (3.3.1) $$

where, $\Delta REER$ - first difference of real effective exchange rate; $\Delta IPI$ - first difference of industrial production index; $\Delta V$ - first difference of exchange rate volatility. According to the results in Table 3.3.1, none of the variables are significant except for constant.

Table 3.3.1 Regression results for export at time $t$

<table>
<thead>
<tr>
<th>Model</th>
<th>Coefficient</th>
<th>Std. error</th>
<th>t-statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>10.981434</td>
<td>0.022965</td>
<td>478.165143</td>
<td>0.000</td>
</tr>
<tr>
<td>Real effective exchange rate</td>
<td>-0.012719</td>
<td>0.013486</td>
<td>-0.943087</td>
<td>0.347032</td>
</tr>
<tr>
<td>Industrial production index</td>
<td>-0.006933</td>
<td>0.017738</td>
<td>-0.390842</td>
<td>0.696424</td>
</tr>
<tr>
<td>Volatility</td>
<td>-0.002948</td>
<td>0.005729</td>
<td>-0.514607</td>
<td>0.607524</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.0089</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-statistic</td>
<td>0.4883</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Equation for export including lag of export and volatility is:

$$ EXP_t = \alpha_0 + \alpha_1 \Delta REER_t + \alpha_2 \Delta IPI_t + \alpha_3 EXP_{t-1} + \alpha_4 \Delta V_{t-1} + \epsilon_t \quad (3.3.2) $$

where, $EXP_{t-1}$ - lag of export; $\Delta V_{t-1}$ - lag of the first difference of exchange rate volatility. The results of regression presented in Table 3.3.2 indicate that constant and export value from previous period are statistically significant at 1%, whereas others not.
Table 3.3.2 Regression results for export including lag of export and volatility

<table>
<thead>
<tr>
<th>Model</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1.014884</td>
<td>0.345385</td>
<td>2.938419</td>
<td>0.003784</td>
</tr>
<tr>
<td>Real effective exchange rate</td>
<td>-0.002491</td>
<td>0.005354</td>
<td>-0.465279</td>
<td>0.642361</td>
</tr>
<tr>
<td>Industrial production index</td>
<td>0.007022</td>
<td>0.007091</td>
<td>0.990236</td>
<td>0.323544</td>
</tr>
<tr>
<td>Lag of export</td>
<td>0.907965</td>
<td>0.031439</td>
<td>28.880597</td>
<td>0.000</td>
</tr>
<tr>
<td>Lag of volatility</td>
<td>0.002233</td>
<td>0.002269</td>
<td>0.984487</td>
<td>0.326353</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.8392</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-statistic</td>
<td>210.0642</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Import.

1. Equation for import at time $t$ is:

$$IMP_t = \beta_0 + \beta_1 \Delta RP_t + \beta_2 \Delta Y_t + \beta_3 \Delta V_t + \epsilon_t \quad (3.3.3)$$

where, $\Delta RP$ - first difference of relative prices; $\Delta Y$ - first difference of income level; $\Delta V$ - first difference of exchange rate volatility. Regression results in Table 3.3.3 show that only constant is significant at 1%, while other variables are insignificant.

Table 3.3.3 Regression results for import at time $t$

<table>
<thead>
<tr>
<th>Model</th>
<th>Coefficient</th>
<th>Std. error</th>
<th>t-statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>10.770833</td>
<td>0.027156</td>
<td>396.626137</td>
<td>0.000</td>
</tr>
<tr>
<td>Relative price</td>
<td>-3.264925</td>
<td>4.767267</td>
<td>-0.684863</td>
<td>0.494403</td>
</tr>
<tr>
<td>Income level</td>
<td>0.068289</td>
<td>0.058553</td>
<td>1.166284</td>
<td>0.245203</td>
</tr>
<tr>
<td>Volatility</td>
<td>-0.002217</td>
<td>0.005893</td>
<td>-0.376238</td>
<td>0.707229</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.0124</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-statistic</td>
<td>0.6849</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. Equation for import including lag of import and volatility is:

\[ IMP_t = \beta_0 + \beta_1 \Delta RP_t + \beta_2 \Delta Y_t + \beta_3 IMP_{t-1} + \beta_4 \Delta V_{t-1} + \epsilon_t \]  

(3.3.4)

where, \( IMP_{t-1} \) - lag of import; \( \Delta V_{t-1} \) - lag of the first difference of exchange rate volatility.

According to the results in Table 3.3.4, constant and import value from previous period are significant at 1%, however, the remaining variables appeared to be insignificant.

**Table 3.3.4 Regression results for import including lag of import and volatility**

<table>
<thead>
<tr>
<th>Model</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.941280</td>
<td>0.328368</td>
<td>2.866544</td>
<td>0.004705</td>
</tr>
<tr>
<td>Relative price</td>
<td>-1.675212</td>
<td>1.847817</td>
<td>-0.906589</td>
<td>0.365979</td>
</tr>
<tr>
<td>Income level</td>
<td>0.016413</td>
<td>0.022728</td>
<td>0.722134</td>
<td>0.471259</td>
</tr>
<tr>
<td>Lag of import</td>
<td>0.913059</td>
<td>0.030474</td>
<td>29.962245</td>
<td>0.000</td>
</tr>
<tr>
<td>Lag of volatility</td>
<td>0.001733</td>
<td>0.002279</td>
<td>0.760145</td>
<td>0.448279</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.8494</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-statistic</td>
<td>226.9464</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.4 Result analysis

In this section, descriptive statistics were presented, followed by unit root test to examine whether the variables which are supposed to be employed in our both export and import models are stationary or not. The accuracy in conducting unit root test is extremely significant, as using nonstationary time series may yield statistically significant relationship, while it is not the case. There are some studies, which performed unit root test for the level cases only and concluded that taking the first differences will inevitably give stationary time series. In some cases, it does not suffice taking first differences to get stationary time series. Arize (1996) stresses this issue and also indicates that most specifications applied in prior studies fail to recognize that the real exports and some of its proposed determinants are potentially nonstationary variables and the correct representation of the nature of nonstationarities is very important. Neglecting of this point implies that inferences made regarding the relationship between trade and volatility are potentially highly misleading.

Therefore, we specified the particular model for each variable taking into account the nature of nonstationarity, in order to prevent the problem of spurious regressions. Results indicate that export and import are stationary time series around time trend, whereas real effective exchange rate, industrial production index, relative prices, income level and volatility became stationary after taking the first differences which have been tested for unit roots accordingly.

Two kinds of model specifications have been considered for export and import. The first model, equations 3.3.1 and 3.3.3, is aimed to reveal whether short run changes in export and import determinants affect the volume of both export and import. According to the results, none of the determinants have a statistically significant impact. Volatility is negatively associated with both export and import, though not significant. This negative relationship implies that increase in volatility depresses Swedish export and import, and can be explained as both exporters and importers cannot adjust to exchange rate fluctuations at the time of occasion, which is consistent with Ethier (1973), Clark (1973), Baron (1976), Cushman (1986), Peree and Steinherr (1989) etc.

The second model, equations 3.3.2 and 3.3.4, disclosures whether both past export and import volumes, as well as, exchange rate volatility from the previous period have an impact on export and import at present. Persuant to the results, previous export and import volumes significantly exert positive influence on the trade at present, while past exchange rate fluctuations do not. However,
comparing to the first model where volatility is negatively related to export and import, in this case it is positive, which resembles with the findings of De Grauwe (1987), Cabalero and Corbo (1989), Qian and Varangis (1992), Arize (1998) etc. This can be explained as, exchange rate volatility does not only represent a risk for a company, it can also be considered as an opportunity to make a profit viz. increase in volatility enhances the opportunities of making large profits (De Grauwe, 1992). Moreover, traders possessing the information from previous period may adequately be responsive in making decision when contracting the future volumes of both exports and imports.
4. CONCLUSIONS

In this paper, an empirical investigation of trade effects of exchange rate fluctuations in Sweden from the perspective of export and import was performed. In the presence of conflicting and ambiguous findings of prior studies, the purpose of this study was to determine the impact of exchange rate volatility on export and import in Sweden.

This research distinguishes itself from the studies implemented before in three respects. First, this study provides an analysis of relationship between exchange rate fluctuations and trade from the perspective of export and import concurrently for the case of Sweden, which has not been performed yet. Most studies, present investigations of the relationship between volatility and export, alternatively import, or in a general way, between volatility and trade, while in our study the relationship has been examined discretely.

Second, compared to the most previous studies we proposed EGARCH model as a measure of volatility, which is more efficient than prior measures. Methodological problems of prior studies have been discussed from the point of employing the various measures of volatility, which have been criticized over the studies for the inappropriateness of their application as a measure of volatility.

Finally, a study prudently deals with representation of the nature of nonstationarity in the variables employed in regressions, and specifies a particular model for each variable to test for unit roots cautiously, so as to avoid the issue of spurious regressions. Several previous studies, fail to recognize that exports and its determinants are potentially nonstationary time series, and limit the test with examining level cases of variables and conclude that taking the first differences will yield stationary time series, while it is not always the case.

The study has been implemented with aggregate monthly data over the period between January 1993 and December 2006, consisting of 168 observations for the case of Sweden. The history of Swedish trade activity and its main partner countries have been presented, moreover, export and import as well as related variables to them have also been discussed.

According to our empirical results, the relationship between exchange rate volatility and both export and import is indeterminate and statistically insignificant in the case of Sweden. Effects in short run changes of volatility are negatively associated with export and import. This relationship might be considered to be natural, as the exporters and importers cannot immediately adjust the volume of their trade in accordance with fluctuations in exchange rate. From another point, the
relationship is appeared to be positive when we admit the fact that traders being aware of the previous period fluctuations made appropriate decisions regarding the volume of their trade.

It would only be efficient for the exchange rate to be highly volatile if the underlying economic variables are equally volatile. If not, there would exist abnormal profit opportunities for speculators that smooth exchange rate movements. The exchange rate cannot contain any pattern or signals about future rates, since it could be used to gain a profit. The volatility is a risk for a company that trade on the international market since it is a variable that cannot be foreseen (Jones and Kenen, 1990 cited Backman, 2006, p.3).

Mirroring the diverse analytical findings and empirical research on different markets, analyzing methodological problems of previous works and choosing a more efficient measure of volatility, nevertheless, do not allow us to reach firm conclusions for the case of Sweden. The empirical results are, in general, sensitive to the choices of sample period, model specification, form of proxies for exchange rate volatility, and countries considered viz. developed versus developing (Baum and Caglayan, 2006).

The proliferation of financial hedging instruments over the last 20 years may reduce firms’ vulnerability to the risks arising from volatile currency movements. Consequently, insignificant impact of exchange rate volatility on export and import for Swedish market might be explained by existing hedging possibilities for exporters and importers via futures and/or forward markets (Clark et al, 2004).

Another reason for obtaining insignificant relationship between exchange rate volatility and trade volumes might be an aggregation issue. Casting light on aggregation problem, Wang and Barrett (2007) argue that trade effects of exchange rate fluctuations may vary across sectors, viz. the level of competition, the nature of contracting- and thus the price-setting mechanism- the currency of contracting, the economic scale of production units, openness to international trade, and the degree of homogeneity and storability of goods vary among sectors. For instance, Bordo (1980) and Maskus (1986) argue that agricultural trade volumes may be far more responsive to exchange rate changes than is manufactured goods trade. Thus, the studies underscored the disaggregate exploration, specifically, intersectoral differences regarded scrupulously may reveal more legible picture of the relationship between exchange rate volatility and trade volumes, which might be a further extension of present analysis.

Furthermore, studies concerning revealing the relationship between exchange rate volatility and trade may also differ from their use of time series, cross sectional or panel data. Most empirical
studies use time series techniques, but only few of them find a significant impact of exchange rate volatility on trade, whereas studies based on panel data estimation have been more fruitful (Anderton and Skudelny, 2001).

Results of this work are in line with other findings in the literature, and our empirical study investigated the linear relationship between exchange rate volatility and both export and import, whereas nonlinear relationship might also be the case, which could serve as a reason for further research.
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APPENDIX 1

For visual detection whether the variables show any patterns of stationarity or nonstationarity we plot them against time.

**Fig.A.1 Economic time series: Real effective exchange rate**

**Fig.A.2 Economic time series: Exchange rate volatility**
Fig.A.3 Economic time series: Relative prices

Fig.A.4 Economic time series: Export and import
Fig. A.5 Economic time series: Income level and industrial production index