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Essays on Exchange Rate Pass-Through: The Role of Asymmetries and Trade Globalisation

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Abstract

This thesis explores the transmission of exchange rate movements into export and import prices at both the aggregate and the disaggregate level for four advanced countries. We use several up-to-date econometric methods in order to provide robust measures of exchange rate pass-through. The main finding of our research is to provide clear support for the presence of asymmetry in the exchange rate pass-through, i.e. the fact that appreciations and depreciations are pass through prices in a different magnitude. Moreover, we find that, in many cases, the pass-through coefficient is higher when we take into account this asymmetry. Therefore not taking into account potential asymmetries may lead to wrong results in the ERPT estimation. This finding has several important implications for monetary policy. Indeed, policy-makers will face a dilemma as they try to pursue price stability and export competitiveness. Moreover, our research also studies whether the degree of trade openness affects the exchange rate pass-through. The results in this case show that there is no significant role for the degree of trade openness for most cases.

Keywords: exchange rate pass-through, import price, export price, asymmetry, globalisation

Résumé

Cette thèse explore la transmission des variations du taux de change sur les prix d'exportation et d'importation à un niveau agrégé et désagrégé pour quatre pays développés. Nous utilisons plusieurs méthodes économétriques récentes afin de fournir des mesures robustes sur la transmission du taux change. Notre recherche soutient la présence d'asymétrie dans la transmission des variations du taux de change sur les prix. En outre, nous constatons que le coefficient de transmission est plus élevé lorsqu'on tient compte de cette asymétrie. Par conséquent, la non prise en compte de ces asymétries, si elles existent, pourrait conduire à des résultats trompeurs. Ce résultat a d'importantes implications sur les politiques monétaires. En effet, les décideurs devront faire face à un dilemme lorsqu'ils doivent choisir entre la stabilité des prix et la compétitivité-prix à l'exportation. De plus, dans cette recherche, nous testons si le degré d'ouverture affecte le degré de report du taux de change. Les résultats montrent, que dans la plupart des cas, il n'y a pas de rôle significatif pour le degré d'ouverture.

Mots-clés : degré du report du taux de change, prix des importations, prix des exportations, asymétrie, globalisation

Summary

INTRODUCTION AND OVERVIEW

I. Introduction

For decades the exchange rate has been at the center of macroeconomic policy debates. The exchange rate is considered as an important element of the transmission of monetary policy and it is supposed to play a crucial role in the transmission of shocks to the economy. Indeed, the exchange rate contributes to the demand channel through the effects of relative price between domestic and foreign goods, affects consumer prices directly via the domestic currency price of imports and affects the price of imported intermediate goods, and thus the pricing decisions of domestic firms (Svensson (2000); Senay (2001)).

More in detail, exchange rate movements have important implications for a wide range of economic variables. The extent to which exchange rate changes are reflected in prices of goods and services represents one of the most discussed subjects in academic and policy circles. For monetary policymakers, understanding and quantifying the impact of exchange rate shocks on domestic prices is particularly important. There has been renewed interest in the extent to which exchange rate movements affect prices and the channels through which this occurs.

This brings us to address the concept of the degree of transmission of nominal exchange rate changes to prices, generally referred to as the exchange rate pass-through. This notion of exchange rate pass-through will be discussed in more detail later.

Exchange rate pass-through is particularly important in the field of international economics since it plays a central role in debates over appropriate monetary policies. Indeed, many, researches show that the degree of exchange rate pass-through has important implications for the conduct of monetary policy (Corsetti and Pesenti (2005); Adolfson (2002); Sutherland (2005)). For instance, if the inflationary effects of exchange rate changes are large, the central bankers will have to implement monetary policies that could offset the inflationary

consequences of exchange rate changes (Edwards (2006)). Therefore, exchange rate pass-through determines whether central banks should devote more efforts to control the nominal pressures that could compromise the stability of prices.

The economic literature distinguishes two channels of exchange rate pass-through: a direct channel and an indirect channel. The direct channel runs via the external sector of a country, i.e. through the price of imported finished goods and imported inputs. For example, when the exchange rate depreciates, the prices of imported finished goods will increase and they become more expensive for domestic consumers. Prices of imported final goods are directly included in the Consumer Price Index (CPI). Therefore, the exchange rate changes are likely to be passed on to consumer prices. Currency depreciation also causes an increase in imported inputs leading to higher prices of domestically produced goods.

The indirect channel of exchange rate pass-through refers to the competitiveness of goods on international markets. An appreciation tends to reduce the external competitiveness of domestic firms. Indeed, domestically produced goods become more expensive compared to foreign goods. A depreciation, on the contrary, will rather induce an increase in aggregate demand since the prices of the domestic products become cheaper compared to foreign goods.

II. Motivation

Exchange rate pass-through literature has been greatly intensified since the 1970s, when most countries began to adopt floating exchange rate regimes. Indeed, the volatility of exchange rates has become one of the main problems for monetary policy regulations. Moreover, the high integration of domestic markets with the global markets and an intense globalization process were also the reasons for increasing interest in exchange rate pass-through (ERPT from now on).

There are several main motives for the analysis of the ERPT. Indeed, a large body of theoretical research shows that the degree of exchange rate pass-through has important implications for the transmission of shocks, the adjustment in trade balances and the optimal monetary policy in open economies. For example, an external shock could exert pressure on the exchange rate, resulting in the depreciation of the domestic currency, and generating an expenditure-switching effect. This is because, on the one hand, people are more likely to switch to domestic products that are relatively cheaper compared to foreign produced goods and, on the other hand, foreign demand will rise for domestic goods. Therefore, domestic production will rise in the country where the depreciation has occurred and will fall abroad, and this partly offsets the initial effect of the shock (Betts and Devereux (2001)).

In addition, the impact of exchange rate movements on prices determines the potential role of exchange rates in the global adjustment of current account imbalances. Certainly, the degree of exchange rate pass-through affects domestic demand for imports and, therefore, contributes to the adjustment or non-adjustment of the domestic trade balance through the expenditure switching effect (Engle (2002); Obstfeld and Rogoff (2004))

Finally, a thorough understanding of pass-through mechanisms is also important for monetary policymakers since the degree of pass-through has an impact on both the transmission mechanism of monetary policy and on inflation forecasts (Corsetti and Pesenti (2005); Adolfson (2002); Sutherland (2005)). The concept of ERPT is particularly important for inflation targeting countries. Therefore, a central bank with an inflation target has to forecast future changes in exchange rates and to estimate what percentages of these changes will pass-through on prices. The literature on the exchange rate pass-through showed that high inflation was indeed conducive to high pass-through and was usually associated with complete pass-through (Choudhri and Hakura (2001); and Ca'Zorzi et al. (2005)). On the other hand, a monetary policy focused on the control of inflation will not allow exchange rate movements

to degenerate into an inflationary spiral. Policymakers must be able to prevent the changes in relative prices.

Since the 1980s, an important empirical literature on ERPT had emerged. Overall, this literature usually finds that the exchange rate pass-through is generally incomplete and declining over time. For example, Campa and Goldberg (2005) find that the average of long run ERPT is 64 percent in their study of import prices for a sample of 23 OECD countries. In turn, Bailliu and Fujii (2004) suggest a significant decline in first stage pass-through since 1990 for 11 industrial countries.

There are several explanations for the declining and incomplete pass-through. Indeed, Krugman (1987) and Dornbusch (1987) justify the decline as arising from firms operating in a market characterized by imperfect competition. Similarly, Campa and Goldberg (2002) argue that a shift in the composition of the typical import basket from goods whose prices are less sensitive to exchange rate movements explains the observed declines in the ERPT.

Regarding the explanation for an incomplete pass-through, we find a number of potentially important factors such as price rigidity, the market and industry characteristics and market power (Krugman (1987); Dornbusch (1987); Devereux and Engel (2002); Bacchetta and van Wincoop (2003); etc...).

Being motivated by this literature and the recent developments regarding the relationship between exchange rates and prices, we aimed in this thesis to understand and quantify the impact of exchange rate shocks to domestic prices. Throughout this thesis, we support and test the idea that the ERPT can be asymmetric. Indeed, although many studies assume that the degree of pass-through is not really affected by the direction of exchange rates changes, there may be several theoretical arguments that could explain asymmetric price adjustment, such as capacity constraints, market share, the presence of menu costs, quantity rigidities, export prices rigidities and even production switching (see, for instance, Ware and Winter (1988);

Marston (1990); Knetter (1994); Webber (2000); Pollard and Coughlin (2003)). This will be discussed in more detail in the following chapters. However, not taking into account potential asymmetries may lead to wrong results in the ERPT estimation and, therefore, erroneous monetary policy decisions.

More in detail, in our exploration of the exchange rate pass-through, we assess the effects of exchange rate changes on three major areas, namely, import prices, export prices and consumer prices for four advanced countries (France, Germany, Japan and the United-States). The magnitude of pass-through will be estimated as well as its dynamics. Moreover, this thesis looks at the response of prices to the direction of exchange rate changes. In fact, our study tests whether prices can respond differently depending on the direction of the exchange rate variation (i.e. appreciation or depreciation) at both the aggregate and the disaggregate level.

III. Overview and main findings of the thesis

This thesis is divided into four chapters and a final section with the overall conclusions. The first chapter provides the literature review on the determinants of the exchange rate pass-through and the main contributions that explain the incomplete and declining ERPT. The second chapter examines the relationship between import and export prices and the exchange rate pass-through at the aggregate level (see El Bejaoui (2013)). The third chapter studies whether the degree of trade openness affects the exchange rate pass-through for import and consumer price indices. Finally, the last chapter investigates the degree and the asymmetry of exchange rate pass-through for prices of imports and exports at the disaggregated level. We present the main conclusions at the end of the thesis.

In what follows, we present a brief summary of each of the articles contained in this thesis:

Chapter 1: Literature Review:

The issue of exchange rate pass-through to prices has emerged as a strand of the exchange rate literature over the past thirty years. The empirical literature on exchange rate pass-through is vast; therefore in this chapter we present the most important researches.

Chapter 2: Asymmetric effects of exchange rate variations: An empirical analysis for four advanced countries (EL Bejaoui (2013))

In this paper, we begin by estimating the exchange rate pass-through and analyze the main properties of the pass-through elasticities in our sample. In a second step, by relying in a novel methodology, we investigate possible asymmetries in the reaction of export and import prices to changes in the exchange rate. The empirical literature has paid little attention to the issue of asymmetries in ERPT despite the importance of this assumption for monetary authorities. Asymmetry of ERPT implies that prices react differently to an exchange rate change (appreciation or depreciation). Asymmetry may occur in the long-run relationship, in the short-run dynamics or both. This is exactly what we prove in this chapter. We use quarterly data ranging from 1985:Q1 to 2011:Q2 for Japan, France and the United-States. For Germany, since data is not available before, the estimation period starts in 1991.

We contribute to the literature by estimating an asymmetric co-integrating autoregressive distributed lag (ARDL) model. This model is implemented to examine the responsiveness of export and import prices to exchange rate movements. This methodology, developed by Pesaran, Shin and Smith (2001) in its symmetric form and extended by Shin, Yu and Greenwood-Nimmo (2009) for the asymmetric case, allows us to test the existence of a short-term and a long-term relationship.

With the exception of Delatte and Lopez-Villavicencio (2012) that focus on consumer price inflation rather than on export and import prices, to the best of our knowledge, the asymmetries of exchange rate pass-through have not been analyzed before using the ARDL model.

The estimation results show that in most cases, exchange rate pass-through is statistically significant, but the degree of sensitivity varies across countries. Moreover, we provide evidence of asymmetric ERPT to appreciations and depreciations. This means that export and import prices respond differently depending on the direction of the exchange rate variation. In particular, the coefficient of the long-run pass-through is found significant only when the nominal exchange rate appreciates. This implies that in the long-run an appreciation is clearly more passed through to export prices than depreciations and finally that export prices increase due to depreciation (in the cases of France and the United-States) and decline following an appreciation (in Germany and Japan). This result can be explained by several manners (as we explain later).

Chapter 3: Does Openness Affect Exchange Rate Pass-Through? An Empirical Analysis for Four Advanced Countries

There is a vast literature presenting the factors that determine the extent of pass-through to prices. Among these, we find the degree of trade openness of a country. The degree of openness of an economy depends on the presence of the tradable goods which, in turn, determine how prices are sensitive to changes in exchange rates. Thereby, the goal of this chapter is to investigate the effect of the degree of trade openness on the exchange rate pass-through. First, we estimate the exchange rate pass-through and analyze the pass-through elasticities into import and consumer prices index (CPI). Then, we analyze whether the degree of openness affects the exchange rate pass-though. In order to address this issue, we use the

state-space models. The advantage of this framework is to allow unobserved variables to be estimated with the observable model.

To our knowledge, the state-space model has not been used to analyze the relationship between exchange rate and openness. A few exceptions are Leon-Ledesma and Nogueira (2010) who use the state-space model to test whether the inflation environment affects the pass-through. Similarly, Lopez-Villavicencio and Saglio (2014) analyze whether trade and financial openness have weakened the inflation–output trade-off and caused a shift in the preferences of monetary authorities.

Finally, we explore whether the exchange rate pass-through to import or consumer price indexes has declined over time, as suggested by some authors (Gagnon and Ihrig (2004) or Gust, Leduc, and Vigfusson (2010)).

Using quarterly data over the period 1970:Q1 to 2013:Q4 except for Germany where the estimation period starts in 1991, we do not find a significant effect for the degree of openness on exchange rate pass-through to import prices and CPI, in the most cases. Thus, according to our results, there is very weak evidence that openness affect directly exchange rate pass-through.

Moreover, our results show that exchange rate pass-through has declined, but this decline occurs in different periods. However, we find no evidence that the exchange rate pass-through has been declining over time for all the countries of our sample.

Chapter 4: Estimating Exchange Rate Pass-Through at the Disaggregated Level: an Empirical Analysis for four Advanced Countries.

The objective of this chapter is twofold: on the one hand, we examine the pass-through of exchange rate into import and export prices on a disaggregated level, at the short and long-run. This allows us to check which sector is more sensitive to exchange rates changes. On the

other hand, we assess the symmetry of the exchange rate pass-through to import and export prices. The goal of this exercise is to study whether there are sectors that can respond differently depending on the direction of the exchange rate variation.

In this paper, we opt for a dynamic specification and apply the Generalized Method of Moments (GMM) for panel data, as proposed by Arellano and Bond (1991); Arellano and Bover (1995) and Blundell and Bond (1998). We rely on this methodology due to the inclusion of the lagged dependent variable as an explanatory variable and to the potential endogeneity of some variables in the model. However, for robustness, we also provide the estimation obtained from a pooled Ordinary Least Squares (OLS).

It is also important to note that, to the best of our knowledge, no research has been done to measure exchange rate pass-through into import and export prices at the disaggregate level for the countries in our sample using this methodology.

Using quarterly data ranging from 1999:Q1 to 2013:Q4, our results show evidence of a significant exchange rate pass-through to import and export prices, both in the short and the long-run for most of the sectors of our sample. We also find that the pass-through is incomplete in the short-run and different across industries. Furthermore, in the long-run, the exchange rate pass-through is higher than in the short-run.

On the other hand, for most of our sectors, mainly for export price, we provide evidence of an asymmetric exchange rate pass-through to appreciations and depreciations. Moreover, our results show that appreciations are more passed through to export and import prices than depreciations.

To summarize, according to our empirical results throughout the thesis, we provide a strong evidence of incomplete exchange rate pass-through to import and export prices. Moreover, we find that exchange rate pass-through declines, but this decline occurs in different periods.

Provide evidence of asymmetric ERPT to appreciations and depreciations at aggregate and disaggregate level is the most important result of this thesis. Specifically, the coefficient of the long-run pass-through is found significant only when the nominal exchange rate appreciates. Not taking into account the asymmetry of pass-through leads to biased results.

The existence of asymmetric pass-through has several important policy implications. Indeed, policymakers will face a dilemma as they try to pursue price stability and export competitiveness.

CHAPTER 1

LITERATURE REVIEW

According to Goldberg and Knetter (1997), exchange rate pass-through is defined as the degree of sensitivity of import prices to a one percent change in exchange rates in the importing nation's currency. Nevertheless, the increase in import prices could also affects other domestic prices such as, the producer and consumer prices. Therefore, ERPT is broadly refers to the degree to which exchange rate variations influence trade prices and, through them, other domestic prices.

Exchange rate pass-through can be either incomplete or complete. Indeed, ERPT is said to be full or complete when the effect of a depreciation (or an appreciation) is fully reflected in import prices. However, if the import price rises less than proportionally to the exchange rate variation, as the exporters absorb a proportion of the exchange rate change, then it is called partial or incomplete pass-through. Whether full or partial, the pass-through is an important factor that determines the extent to which exchange rate adjustments are able to provide or maintain a stable external balance. Indeed, how exchange rate variations are transmitted into local-currency prices is a primary channel through which currency fluctuations can impact trade volumes.

Since 1980's, exchange rate pass-through literature has been fed by a vast amount of research, mainly after the movement from fixed to floating exchange rate regimes. Indeed, a number of studies have been motivated to examine more closely the underlying relationship between the exchange rate and prices. This chapter provides the literature review on the determinants of the exchange rate pass-through and the main contributions that explain the incomplete and declining ERPT.

I. The determinants of the exchange rate pass-through

There is a vast literature presenting the factors that determine the extent of pass-through to prices. In this section, we try to identify factors that influence the exchange rate pass-through to prices (export, import and consumer prices). Following Campa and Goldberg (2002), the exchange rate pass-through can depend on several factors which can be classified into two groups: microeconomic and macroeconomic factors.

From the Macroeconomic point of view, Taylor (2000) argues that the inflation environment is an important macroeconomic determinant of pass-through. Indeed, he argues that lower inflation is associated with lower persistence of inflation and that persistence in cost changes is related to price stability. Therefore, in a stable environment, the inflation persistence will be smaller. Consequently, the cost changes are perceived to be less persistent and will decrease causing a smaller pass-through. More precisely, in a more stable inflationary environment, exchange rate shocks may be perceived as temporary, which encourages firms to absorb exchange rate fluctuations in their profit margins. This finding has been confirmed by Goldfajn and Werlang (2000). According to their study, an inflationary environment, may leads firms to pass-through cost changes and then increase their prices. Gagnon and Ihrig (2001) show that countries which adopt anti-inflationary policies, will have lower exchange rate pass-through.

Schmidt-Hebbel and Tapia (2002) have also argued that exchange rate pass-through depends on the credibility of the monetary policy. Others empirical studies have explored the relation between pass-through and the inflation environment such as Choudhri and Hakura (2001); Devereux and Yetman (2002); and Gagnon and Ihrig (2004).

The exchange rate regime may be another determinant of exchange rate pass-through. In general, the pass-through is lower in countries with flexible exchange rate regimes than in

fixed exchange rate regimes (Krugman (1989); Steel and King (2004)). This can be explained by the fact that in fixed regime, when exchange rate changes occur, they are considered as permanent which leads firms adjust selling prices rapidly. On the other side, in flexible regimes, exchange rate changes will be considered as temporary. Thus, firms do not adjust their selling prices immediately.

Another important macroeconomic determinant of pass-through is the exchange rate volatility. Large movements in exchange rate are associated with a higher exchange rate pass-through. According to Devereux and Engel (2001), country that has stable monetary policy would have their currencies chosen for transaction invoicing. Thus, exporters set their prices in local currency pricing (LCP); this leads to a low exchange rate pass-through. Therefore, the relationship between exchange rate volatility and exchange rate pass-through is expected positive. Ghosh and Rajan (2009) found also this positive relation. However, Froot and Klemperer (1989) consider that the volatility of exchange rate is temporary, then when firms try to maintain local market share, they will adapt their mark-ups and high volatility is associated with a lower pass-through.

To sum, w can conclude that the relationship between exchange rate volatility and exchange rate pass-through is ambiguous.

The output gap may be considered also as macroeconomic determinant of exchange rate pass-through. The output gap is defined as the difference between the actual and potential gross domestic product (GDP). The evidence of past studies shows a positive correlation between pass-through and output gap (Goldfajn and Werlang (1999); Beckmann, Belke and Verheyen (2013)).

Goldfajn and Werlang (2000) show that exchange rate pass-through may be affected by another macro determinant variable, specifically the business cycle. Indeed, they found that

exchange rate pass-through would be higher when the economy is booming than in periods of recession. Monteiro and Wu (2002) have found also the same result.

Correa and Minella (2006) found that exchange rate pass-through respond to business cycle in a nonlinear way. Nevertheless, according to the study by Ben Cheikh (2013), there is no clear direction concerning the relationship between exchange rate pass-through and the business cycle. Indeed, in some countries, he found that exchange rate pass-through is higher during expansions than in recessions; however, in other countries, he found the reversed result.

The literature also points to the degree of trade openness of a country. The most expected relation between the ERPT and this variable is positive. In this case, a high degree of openness can imply a high sensitivity of the economy to exchange rates variations. In other words, the higher is the degree of trade openness, the higher is the price responsiveness to exchange movements (McKinnon (1963) and McCarthy (2000, 2007)). However, this result may be challenged once we take into account that inflation could be negatively correlated with openness, as empirically found by Romer (1993). This gives rise to an indirect channel, whereby openness is negatively correlated with inflation and, taking into account Taylor's hypothesis, the degree of pass-through. The direct and indirect channels go in opposite directions and the overall sign of the correlation between pass-through and openness can thus be either positive or negative (Ca' Zorzi et al. (2007)).

Regarding the microeconomic point of view, several factors can affect the exchange rate pass-through. Among the most important factors that determine the extent of exchange rate pass-through we find the degree of competition in which the exporter is faced in market destination. When exporters face strong competitiveness, then their market power diminishes and in order to maintain their market share, producers will accept to reduce their mark-ups and thus they will not fully pass-through exchange rate variations to prices. Therefore there is

a negative relation between competition and exchange rate pass-through. Conversely, if exporters do not face much competition for their products the exchange rate pass-through will be higher (Knetter (1993); Reinert, Rajan and Glass (2010)).

The duration of the exchange rate variations is also an important determinant of the extent of the pass-through. Meurers (2003) found that, in the long-run, tend to be almost complete when the exchange rate shock persist. Conversely, if the exchange rate shock is temporary, then in order to maintain their market share, exporters may be accept to reduce their mark-up and thus they will not fully pass-through exchange rate variations to prices (Froot and Klemperer (1989)).

Some studies assume that the degree of pass-through is affected by the direction of exchange rates changes, i.e. the pass-through varies depending if the currency of the importer (exporter) is appreciating or depreciating (Delatte and Lopez- Villavcencio (2012)). If the currency of the exporter depreciates, then the exporter's good will be relatively cheaper in the destination market. In this situation, exporting firm may engage in complete exchange rate pass-through. However, if the currency of the exporter appreciates, then the exporter's good will be more expensive in the destination market which leads exporters to reduce their export price to maintain their market share. The exchange rate pass-through will be incomplete (Pollard and Coughlin (2003)).

The magnitude of exchange rate changes also affects the pass-through. For instance, Coughlin and Pollard (2004) found that most firms respond asymmetrically to large and small changes in the exchange rate with exchange rate pass-through positively related to the size of the change. In general, when the magnitude of exchange rate change is small, firms may be willing to absorb this exchange rate change to keep domestic prices unchanged due to the costs associated with changing prices.

Further determinants of exchange rate pass-through could be the changes that have occurred in the composition of country imports. Indeed, imported goods are composed of heterogeneous products, and the pass-through may vary considerably across the different types of imports. If a country shifts the content of its trade from industries with high pass-through elasticities (such as energy and raw materials) into industries with lower elasticities (such as manufactured goods), then the pass-through will decline. On the other hand, if a country shifts to the higher pass-through products then pass-through increase (Campa and Goldberg (2002)).

The elasticity price-demand also impact exchange rate degree. The more elastic the demand, the more consumers will respond to price changes, which implies that producers have a limited ability to pass-through costs changes. Therefore, the more inelastic the demand, the more producers will pass-through exchange rate variations into prices. This implies the existence of a negative correlation between pass-through and elasticity price-demand.

Indeed, when elasticity demand is high, then consumers will more respond to the exchange rate changes. Therefore, in this case, have a limited ability to pass-through costs changes. Conversely, with an inelastic demand, producers are able to pass the exchange rate changes into prices. Thus there is a negative correlation between pass-through and elasticity price-demand (Souza, Maciel and Pizzinga (2010)).

Pollard and Coughlin (2004) suggest also that menu costs may affect the exchange rate pass-through. They find that menu costs play an important role in determining pass-through in most industries. Their results provide evidence that menu costs are the key determinant in a few industries.

The literature also points to the mark-up. Indeed, when the mark-up is fixed, the degree of pass-through is complete. However, when the mark-up changes by the same proportion as the

change in the exchange rate, the degree of pass-through is zero. Therefore, mark-up may be a determinant to exchange rate pass-through (Hooper and Mann (1989)).

The high costs of changing prices are also important. Indeed, if the costs associated with changing a price are high, then exporters may leave their price in importer's currency unchanged if exchange rate changes are small.

II. Incomplete and declining exchange rate pass-through

Since the 1980s, an important empirical literature on exchange rate pass-through had emerged, with a focusing on the relationship between the exchange rate and import prices. Measuring the pass-through is the first step to perform. The literature on exchange rate pass-through had reached at least two consensuses. First, the ERPT is in the most cases, incomplete. Second, the ERPT had declined in recent years. Afterwards, it has been measured over the short-run and long-run. Indeed, the extent of pass-through both in short and long-run is therefore important to understand the impact of exchange rate movements on prices. The short-run estimate is based on how quarterly prices change owing to the average exchange rate of that quarter. Whereas the long-run estimate includes pass-through due to the quarter-of exchange rate as well as quarterly lags of the exchange rate. For instance, Campa and Goldberg (2005) measured both short and long-run pass-through. They found that the degree of pass-through is lower in the long-run than in the short-run.

Regarding the theoretical propositions for an incomplete pass-through, Krugman (1987) and Dornbusch (1987) justify it as arising from firms operating in a market characterized by imperfect competition. The argument is that firms adjust their mark-ups in response to exchange rate shocks. In particular, if the firm's mark-up decreases as the price of the good it sells increases, the pass-through is incomplete.

According to the literature, there are at least three explanations for oligopolistic firms acting in this way. First, this action might be a defensive response to perceived temporary currency movements (Marston (1990)). Second, it might result from market share considerations (e.g., Hooper and Mann (1989); Kasa (1992) or Froot and Klemper (1989)). Finally, Ihrig et al. (2006) suggest that a firm can only dampen the impact of exchange rate movements on its price while its mark-up is positive. In another vein, incomplete pass-through can also arise from local currency pricing (i.e. when the exporting firm set prices in the currency of the country to which it exports). Indeed, Devereux and Engel (2001) and Bacchetta and VanWincoop (2003) endogenize a firm's choice of invoicing currency and argue that countries with low relative exchange rate variability or stable monetary policies are more likely to have their currencies chosen for transaction invoicing, and hence more likely to have low import-price pass-through[1]. Bodnar, Dumas, and Marston (2002) show that the pass-through can be less than one if part of the costs of production is incurred in a different currency, if goods are highly substitutable, or if the market share of the exporting firm in the foreign market is large.

Ihrig et al. (2006) list also cross-border production and exchange rate hedges as alternative explanations for incomplete pass-through. In the first case, if production takes place in several stages across many countries, then the costs of producing the final good is incurred in several currencies (e.g. Aksoy and Riyanto (2000); Bodnar, Dumas, and Marston (2002); Hegji (2003); etc..).

In the second case, Mann (1986), among others, suggests that the increased usage of exchange rate hedges may shield a firm from exchange rate shocks by allowing them to avoid passing

[1] As noticed by Ihrig et al. (2006) a problem with the local currency pricing hypothesis is that while in the medium-term a firm may choose to invoice in the currency of the destination market to shield the price paid by its clients from exchange-rate movements, in the long run, and in the face of a protracted appreciation of the exporter's currency, it will have to adjust its local currency price to keep its margins from turning negative.

such shocks to consumers. She explains that hedging can allow firms to postpone passing through an exchange rate shocks. However, in the long run a sufficiently large and permanent exchange rate shock will have to be passed through to importers.

Finally, a common explanation for the declining and incomplete pass-through is that it is a by-product of the low inflation environment of the 1990s. Indeed, as we mentioned above, Taylor (2000) argues that low inflation environment, backed by a credible inflation-targeting monetary policy, allows firms to reduce the extent to which they pass on exchange rate-related cost shocks.

A similar argument is developed in Devereux and Yetman (2010), where the degree of pass-through is a function of the stance of monetary policy as it affects the degree of price stickiness. When firms can adjust their frequency of price changes, loose monetary policy (high inflation) leads to higher ERPT. Gagnon and Ihrig (2004), Campa and Goldberg (2005), Choudhri and Hakura (2006), among others, have analyzed this relationship, finding a positive correlation between ERPT and inflation indicators. More recently, based on state-space models, Leon-Ledesma and Nogueira (2010) provide empirical evidence of a smooth decline in the impact of exchange rates on domestic inflation, but do not support the hypothesis that a lower inflation environment precedes this declining ERPT.

Empirically, several studies report evidence of a declining exchange rate pass-through in industrial countries. For instance, Campa and Goldberg (2002) argue that a shift in the composition of the typical import basket from goods whose prices are less sensitive to exchange rate movements explains the observed declines in the ERPT. Bailliu and Fujii (2004), using a panel of 11 industrial countries, find a significant decline of pass-through since 1990. Olivei (2002) examines US import prices for 34 product categories and explains that the larger presence of multilateral corporations has led to a decline in exchange rate pass-

through, owing to the prevalence of intra-company transfer pricing, which is less responsive to exchange rate movements than prices based on arm's length trade.

The issue of whether exchange rate pass-through has declined is an important one for central banks because a decline in pass-through would imply that movements in the exchange rate have less important effects on consumer prices and, hence, on short-run inflation, than previously thought.

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CHAPTER 2

Asymmetric Effects of Exchange Rate Variations: An Empirical Analysis for Four Advanced Countries

Asymmetric effects of exchange rate variations: An empirical analysis for four advanced countries[2]

ABSTRACT

This paper investigates possible asymmetries in the reaction of export and import prices to changes in the exchange rate for 4 advanced countries between the 1985q1-2011q2 periods. This exercise is conducted using an asymmetric cointegrating autoregressive distributed lag (ARDL) model, with positive and negative partial sum decompositions of the nominal exchange rates. Our results show evidence of asymmetric ERPT to appreciations and depreciations, meaning that export and import prices respond differently depending on the direction of the exchange rate variation. In particular, we find that appreciations are more passed through to export and import prices than depreciations. This result has important implications in terms of monetary policy.

J.E.L Classification: C33; E31; F31

Keywords: Exchange rate pass-through; Asymmetry; ARDL; Export price; Import price.

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I. Introduction

In open economies, studying the responses of prices due to exchange rate changes is of primary importance. Indeed, exchange rate variations could significantly affect the level of inflation, especially for countries with floating exchange rates regimes.

The degree of exchange rate pass-through (ERPT from now on) , which is defined as degree of sensitivity of import prices to a one percent change in the exchange rate of the importing nation's currency, is usually considered as one of the key determinants of monetary policy design. Indeed, ERPT determines whether central banks should devote more efforts to control the nominal pressures that could compromise the stability of prices. Both the theoretical and the empirical literature (e.g. Flamini (2007) and Adolfson (2007)) suggest that the characteristics of the pass-through may even affect the choice of the measure of inflation targeted by the central bank: either the monetary authorities target the inflation rate that involves exclusively locally produced goods or it focuses on total inflation that includes imports prices.

The choice of an exchange rate regime for developing and emerging countries is an ongoing debate in international finance. The type and the credibility of the policy regime can be a vital factor for ERPT. For example, pass-through should be lower in countries with flexible exchange rate regimes than in fixed exchange rate regimes. Indeed, in fixed regimes, the firms consider that a change in the exchange rate is permanent and will have a permanent impact on their production costs. Therefore, they adjust selling prices rapidly. In contrast, in flexible regimes, economic agents seem to consider changes in the exchange rate as partially temporary. Hence, they do not adjust their selling prices immediately.

Over the past years, an extensive literature has been developed on exchange rate pass-through. For instance, several empirical studies which evaluate the degree of the ERPT assume that the exchange rate changes on export and import prices are symmetric (Froot and Klemperer (1989); Dornbusch (1987); Taylor (2000); Devereux and Yetman (2002); etc...). This assumption implies that an appreciation of the exchange rate leads to a price change of the same magnitude than a depreciation. However, several reasons may suggest that this is not the case. Indeed, firms can react differently to exchange rates changes depending on the direction and the magnitude of these changes. For instance, exporters in monopolistic situations may have more interest to pass through appreciations (i.e. to increase their prices) than depreciations (i.e. to decrease prices), leading to an asymmetric ERPT. Moreover, in the presence of menu cost or switching costs, exporters or importers may leave their price unchanged if exchange rate changes are small, and change their prices only when the exchange rate change is above a given threshold. With switching costs, exporters can keep their prices unchanged in their currency as long as the price of their goods in local currency does not vary beyond a given limit. This implies that the exchange rate pass-through can be symmetric but nonlinear.

The empirical literature has paid little attention to the issue of asymmetries in ERPT, despite the importance of this assumption for monetary authorities. The number of studies that considers the possibility of nonlinear or asymmetric responses is relatively scarce[3]. However, there are some studies that indicate that this is an important extension to be studied (Marston (1990); Goldberg and Knetter (1997); Pollard and Coughlin (2004); Yang (2007); Bussière (2007); Delatte and Lopez-Villavicencio (2012)).

[3] We make the distinction between nonlinear and asymmetric ERPT. Nonlinear ERPT implies that small exchange rate variations do not affect prices. However, once the variation is high enough, prices indeed respond to exchange rate movements. Our study focuses on the asymmetric ERPT.

Asymmetry of ERPT implies that prices react differently to an exchange rate change (appreciation or depreciation). Asymmetry may occur in the long-run relationship, in the short-run dynamics or both. This asymmetry is often explained by price rigidities (especially downward rigidities). In particular, the presence of price rigidities allows to differentiate short-run from long-run effects of marginal-cost shocks on prices. When the degree of price rigidity is high, the pass-through in the short-run is smaller. On the contrary, in the long-run the pass-through is supposed to be complete. The objective of this paper is to analyze if exchange rate pass-through to export and import prices is symmetric, as commonly assumed in the empirical literature or if, on the contrary, prices react differently to a positive or a negative exchange rate variation. Our analysis is conducted for four advanced countries, namely Japan, Germany, France and the United-States for the 1985q1 – 2011q2 period.

To this end, we rely on asymmetric cointegration techniques which are based on autoregressive distributed lag (ARDL) models. This methodology, developed by Pesaran, Shin and Smith (2001), allows us to test the existence of a long-term or levels relationship. Moreover, it has two major advantages over the approach of Johansen and Juselius (1990). The first one is that this approach is applicable even if the variables are stationary or integrated or mutually cointegrated. It does not require that the series are integrated in the same order to find a possible long-run relationship between these variables. The second advantage is that this method has better statistical properties in small samples. Moreover, its asymmetric extension, proposed by Shin, Yu and Greenwood-Nimmo (2009), enables to test whether there is an asymmetry in the short-run, in the long-run or both.

To our knowledge, only the study of Delatte and Lopez-Villavicencio (2012) found an asymmetric ERPT using autoregressive distributed lag (ARDL) models, but they focused on inflation rather than export and import prices.

The findings of this study can be summarised into three elements. First, the exchange rate pass-through can be asymmetric. We provide evidence that export and import prices respond differently depending on the direction of the exchange rate variation. Secondly, we find that the appreciation of the exporter's currency would decrease export prices. Finally, in the long-run, an appreciation is more passed through to export and import prices than depreciations.

This paper is structured as follows: Section 2 provides some arguments that justify why the ERPT can be asymmetric. Section 3 describes the methodology. Section 4 is devoted to describe the data and the results. Finally, Section 5 contains our main conclusions.

II. The asymmetry of pass-through

Although many studies assume that the degree of pass-through is not really affected by the direction of exchange rates changes, there may be cases where the pass-through varies depending, first, if the currency of the importer (exporter) is appreciating or depreciating (Delatte and Lopez-Villavicencio (2012)) or, second, on the magnitude of changes in the exchange rate (Knetter (1994); Pollard and Coughlin (2003); Wickremasinghe and Silvapulle (2004)).

For instance, by using the model of pricing to market, Marston (1990) tests for asymmetries in the elasticity of Japanese transportation and electrical machinery exports. Using a sample of monthly data between 1980 and 1987, he finds that appreciations have a larger effect for five sectors.

Goldberg (1995)[4] and Kadiyali (1997)[5] investigate the exchange rate pass-through in a single U.S. automobile and photographic film industry respectively. They find significant

[4] Using a discrete choice model.
[5] Using a structural econometric model.

asymmetry. In particular, they provide evidence that the exchange rate pass-through is higher when the dollar depreciates.

Pollard and Coughlin (2004) used the profit maximization model to analyze the symmetry response of import prices for 30 industries. They test whether the direction and the size of exchange rate changes affect the pass-through. Their results indicate that more than half of the industries respond asymmetrically to appreciations and depreciations. However, they do not find a clear direction of the asymmetry across industries. They also conclude that the size effect is more important than the direction effect.

Bussière (2007) analyzes if export and import prices of G7 countries respond symmetrically and linearly to exchange rate changes. To this end, he used a standard linear model with polynomial functions of the exchange rate. He finds that a non-linear effect cannot be neglected, although the direction of the asymmetries and the magnitude of the non-linearity vary across countries.

Similarly, Yang (2007) had tested the asymmetry in pass-through to U.S. import prices at a disaggregated level, through an adapted Dixit–Stiglitz model of product differentiation. He found that for a few industries, the exchange rate pass-through increases when the dollar depreciates. Yet other industries exhibit decreasing exchange rate pass-through when the dollar depreciated. This result confirms that the direction of asymmetry cannot be predicted or assumed and it rather needs to be formally tested.

Several theoretical arguments, such as capacity constraints, market share, the presence of menu costs, quantity rigidities, export prices rigidities and even production switching, have been proposed to explain asymmetric price adjustment, (see, for instance, Ware and Winter (1988); Marston (1990); Knetter (1994); Webber (2000); Pollard and Coughlin (2003)). In this section, we briefly mention the major explanations of a possible ERPT asymmetry.

Capacity constraints imply that, if exporters are subject to quantity constraints, exchange rate pass-through will be higher when the exporting country's currency is appreciating than when it is depreciating. Indeed, when the exporter country's currency depreciates, sales expressed in importer's currencies will decline. Then, in order to increase prices, exporters could increase their sales. However, if firms have already reached full capacity, the capacity of increasing sales is limited. In this case, they may be tempted to increase their mark-up instead of lowering prices in the importer's currency. Inversely, in the case of an appreciation the profits expressed in the importer's currencies will increase. Then, exporters can decide to keep their price level stable. Thus, the exchange rate pass-through is higher in the case of appreciation than in the case of depreciation of the exchange rate (Pollard and Coughlin (2004) and Knetter (1994)).

Similarly, if export quantities are rigid, for example because firms are already at full capacity, then exporters may prefer to keep their price constant in the case of a depreciation of their currency instead of deceasing it. In fact, the depreciation of the exporter's currency reducing the export prices which may increase importer's demand (Bussière (2007); Knetter (1993)).

Another argument is the market share. According to Pollard and Coughlin (2004), if firms attempt to maintain their market share, then when exporter's currencies depreciates firms have the opportunity to lower the import prices and thus to rise their market share, while keeping their mark-ups constant. Inversely, during an appreciation, in order to maintain their market share, firms will have to absorb a part of the inflationary impact that will determine a decline in their mark-ups. Consequently, the exchange rate pass-through would be higher for depreciation than for appreciation.

The presence of menu costs can also explain the asymmetric pass-through. Indeed, exporters can keep their price in importer's currency unchanged if exchange rate changes are small, and change their prices when exchange rate changes are above some threshold defined as large. In

consequence, Firms may respond asymmetrically with respect to the size of the exchange rate changes (Pollard and Coughlin (2004)).

Several empirical studies argue that (export) prices are rigid in the short-run, particularly they are downward rigid. According to Peltzman (2000) prices rise faster than they fall. This implies that when the exchange rate depreciates, exporters increase their export prices by a larger extent than they decrease them when the exchange rate appreciates. In addition, exporters are more likely to increase their mark-up than to decrease it (Bussière (2007)).

Finally, production switching is also advanced as an argument. In this sense, a firm may be exporting the final product but, at the same time, importing the corresponding inputs. Thus, when the exporter country's currency depreciates, firms will tend to switch towards inputs produced in their own country. On the contrary, during an appreciation, firms will use imported inputs, implying no pass-through (Pollard and Coughlin (2004)).

III. Methodology

In this paper, an asymmetric cointegrating autoregressive distributed lag (ARDL) model is implemented to examine the responsiveness of export and import prices to exchange rate movements. This methodology, developed by Pesaran, Shin and Smith (2001) in its symmetric form and extended by Shin, Yu and Greenwood-Nimmo (2009) for the asymmetric case, allows us to test the existence of a short and a long-term relationship.

The ARDL model and the "bounds test" for long-run relationship have two major advantages over the approach of Johansen and Juselius (1990). The first advantage is that this approach is applicable even if the variables are stationary, integrated or mutually cointegrated. It does not require that the series are integrated in the same order to find a possible cointegrating relationship between these variables. The second advantage is that this methodology has

better statistical properties in small samples[6]. Delatte and Lopez- Villavicencio (2012) used a similar methodology but, as previously mentioned, they focused on inflation rather than export and import prices which is our case.

We denote p_X and p_M as the export and import prices denominated in the export's currency, respectively, as the dependents variables. The explanatory variables are e, the nominal effective exchange rate, ppi, the producer price index of the exporting country, which serves as a proxy for the marginal costs borne by exporting firms, cpi, which is consumer price index of the importing country and measures changes in the price level of consumer goods and services purchased by households. The last explanatory variable, gdp, is the real gross domestic product. All variables are expressed in logarithms.

The choice of these variables is explained by their relationship with the exports and imports prices.

In the literature, exchange rate pass-through is usually captured by the following symmetric relationships:

For export price[7]:

$$p_{Xt} = \beta_0 + \beta_1 e_t + \beta_2 ppi_t + \beta_3 gdp_t + \varepsilon_t \qquad (1)$$

where all the variables are in logarithms and ε_t is an i.i.d process. In (1), β_1 represents the elasticity of the exchange rate pass-through to export prices (i.e. the pass-through), β_2 is the coefficient of exporters' production costs and β_3 refers to the direct effect of gross domestic product on the export price.

For import price[8]:

$$p_{Mt} = \delta_0 + \delta_1 e_t + \delta_2 cpi_t + \delta_3 gdp_t + \Phi_t \qquad (1')$$

[6] The cointegration test derived from the Johansen and Juselius approach are not robust to small samples.

[7] A positive relationship between both the exchange rate and the producer price index with the export prices is expected.

[8] We expect a negative relationship with exchange rate and a positive relationship with consumer price index.

where Φ_t is an i.i.d process. In the previous equation δ_1 refers to the direct effect of the exchange rate on the import price, δ_2 represents the elasticity of import prices to consumer price index and δ_3 refers to the direct effect of gross domestic product on the import prices.

As mentioned before, in order to test a linear long-run relationship, we use an ARDL model. Other that the previously mentioned advantages, an interesting feature of the ARDL is that it takes into account the error correction term. Hence, we can consider the following linear error correction models:

For export prices:

$$\Delta p_{Xt} = \beta_0 + \beta_1 p_{Xt-1} + \beta_2 e_{t-1} + \beta_3 ppi_{t-1} + \beta_4 gdp_{t-1} + \sum_{i=1}^{4} \alpha_i \Delta p_{Xt-i} + \sum_{i=1}^{4} \Omega_i \Delta e_{t-i} + \sum_{i=1}^{4} \theta_i ppi_{t-i} + \sum_{i=1}^{4} \Phi_i gdp_{t-i} + \upsilon_t \qquad (2)$$

For import prices:

$$\Delta p_{Mt} = \delta_0 + \delta_1 p_{Mt-1} + \delta_2 e_{t-1} + \delta_3 cpi_{t-1} + \delta_4 gdp_{t-1} + \sum_{i=1}^{4} \gamma_i \Delta p_{Mt-i} + \sum_{i=1}^{4} \eta_i \Delta e_{t-i} + \sum_{i=1}^{4} \omega_i \Delta cpi_{t-i} + \sum_{i=1}^{4} \rho_i \Delta gdp_{t-i} + \sigma_t \qquad (2')$$

where Δ is a difference operator, $\alpha_i, \Omega_i, \theta_I, \Phi_i$ in (2) and $\gamma_I, \eta_I, \omega_I, \rho_I$ in (2') are the short-run adjustment terms.

The exchange rate pass-through represented in Equations (2) and (2') correspond to the long run and short run symmetric pass-through.

We can test for the null hypothesis of no symmetric long-run relationship. Two statistics are proposed for testing the null hypothesis of no long-run relationship. The first one, named the tBDM, test for the null of no significance of the error correction term. The second one, the F-test is formulated as follows (for the case of the export prices):

$H_0: \beta_1 = 0, H_0: \beta_2 = 0, H_0: \beta_3 = 0$ and $H_0: \beta_4 = 0$

against

$H_1: \beta_1 \neq 0, H_1: \beta_2 \neq 0, H_1: \beta_3 \neq 0$ and $H_1: \beta_4 \neq 0$

A similar procedure applies for import prices. Pesaran, Shin and Smith (2001) have established two critical thresholds for interpreting the test results. When the computed statistic is below its respective lower critical values, then it is not possible to reject the null hypothesis of no long-run relationship. On the contrary, if the computed statistic is higher than the upper critical value, there is evidence of a long-run relationship. However, no clear conclusion can be drawn when the statistic is between the two critical values.

Though interesting, the previous models do not take into account the direction of exchange rate changes. In other words, the short or long-run pass-through is of the same magnitude (but with different sign) independently if the exchange rate appreciates or if it depreciates. As we mentioned before, there is no reason to believe that this is an accurate assumption.

In order to allow for asymmetric exchange rate pass-through, we follow the approach used in Schorderet (2004) and Shin et al. (2009). This procedure requires constructing new variables that capture episodes of appreciation and depreciation. The idea is to decompose a time series, St, into two series (e_t^+) and (e_t^-) as follows:

$$e_t^+ = \sum_{j=1}^{t} \Delta e_t^+ = \sum_{j=1}^{t} \max(\Delta e_t, 0), \qquad e_t^- = \sum_{j=1}^{t} \Delta e_t^- = \sum_{j=1}^{t} \min(\Delta e_t, 0) \tag{3}$$

Where Δe_t^+ and Δe_t^- are the partial sum processes of appreciations and depreciations, respectively. Following shin et al. (2009), equations (2) and (2') can be expressed to allow for asymmetric relationship. In the case of export prices, we consider the following asymmetric ARDL model:

$$\Delta p_{Xt} = \beta_0 + \beta_1 p_{Xt-1} + \beta^+_2 e^+_{t-1} + \beta^-_3 e^-_{t-1} + \beta_4 ppi_{t-1} + \beta_5 gdp_{t-1} + \sum_{i=1}^{4} \alpha_i \Delta p_{Xt-i} + \sum_{i=1}^{4} \Omega^+_i \Delta e^+_{t-i} + \sum_{i=1}^{4} \Omega^-_i \Delta e^-_{t-i} + \sum_{i=1}^{4} \theta_i ppi_{t-i} + \sum_{i=1}^{4} \Phi_i gdp_{t-i} + \upsilon_t \tag{4}$$

And for import prices we estimate the following equation:

$$\Delta p_{Mt} = \delta_0 + \delta_1 p_{Mt-1} + \delta^+_2 e^+_{t-1} + \delta_3 e^-_{t-1} + \delta_4 cpi_{t-1} + \delta_5 gdp_{t-1}$$

$$+ \sum_{i=1}^{4} \gamma_i \Delta p_{Mt-i} + \sum_{i=1}^{4} \eta^+_i \Delta e^+_{t-i} + \sum_{i=1}^{4} \eta^-_i \Delta e^-_{t-i} + \sum_{i=1}^{4} \omega_i \Delta cpi_{t-i} + \sum_{i=1}^{4} \rho_i \Delta gdp_{t-i} + \sigma_t \qquad (4')$$

Where $-\beta^+_2 / \beta_1$, $-\beta^-_3 /\beta_1$, $-\beta_4 /\beta_1$, $-\beta_5 /\beta_1$ and $-\delta^+_2 /\delta_1$, $-\delta^-_3 /\delta_1$, $-\delta_4 /\delta_1$, $-\delta_5 /\delta_1$ are the coefficients of long-run relationship for export and import prices respectively.

Equations (4) and (4') provide a relationship that may exhibit only short-run asymmetry, only long-run asymmetry or combined long- and short-run asymmetries. As such, we are able to test whether export and import prices react in the same way to an appreciation that a depreciation. In particular, we test the following hypothesis (for export prices):

$$H_0: \beta^+_2 = \beta_3$$

against

$$H_1: \beta^+_2 \neq \beta_3$$

Having estimated the model defined in (4) and (4'), and provided that the long-run relationship is asymmetric (either in the short-run, in the long-run or in both), we can derive the asymmetric dynamic multipliers of unit changes in e^+_t and e^-_t, respectively:

$$M_h^+ = \sum_{j=0}^{h} \frac{\partial px_{t+j}}{\partial e_t^+}, \qquad M_h^- = \sum_{j=0}^{h} \frac{\partial px_{t+j}}{\partial e_t^-}, \qquad h=0,1,2.... \qquad (5)$$

Note that, by construction, as $h\rightarrow\infty$, $m^+_h \rightarrow \theta^+$ and $m^-_h \rightarrow \theta^-$, where $\theta^+ = -\beta^+_2 / \beta_1$ and $\theta^- = -\beta^-_3 /\beta_1$ for (export price) and $-\delta^+_2 /\delta_1$, $-\delta^-_3 /\delta_1$ (for import price) are the asymmetric long-run coefficients, as defined before. The multipliers, as defined by Shin et al. (2009), allow us to observe asymmetric adjustment paths and/or duration of the disequilibrium, adding valuable information to the long- and short-run forms of asymmetry (see Shin et al. (2009) for more details). As such, the multipliers capture patterns of adjustment from the initial equilibrium to the new equilibrium following an economic perturbation (i.e., a depreciation or appreciation).

To test the long-run symmetry, we use the Wald test, and if the symmetry is not rejected, then Eq. (4) and (4') simplifies to:

$$\Delta p_{Xt} = \beta_0 + \beta_1 p_{Xt-1} + \beta_2 e_{t-1} + \beta_3 ppi_{t-1} + \beta_4 gdp_{t-1} + \sum_{i=1}^{4} \alpha_i \Delta p_{Xt-i} + \sum_{i=1}^{4} \Omega^{+}_{i} \Delta e^{+}_{t-i} + \sum_{i=1}^{4} \Omega^{-}_{i} \Delta e^{-}_{t-i} + \sum_{i=1}^{4} \theta_i ppi_{t-i} + \sum_{i=1}^{4} \Phi_i gdp_{t-i} + \upsilon_t \quad (6)$$

$$\Delta p_{Mt} = \delta_0 + \delta_1 p_{Mt-1} + \delta_2 e_{t-1} + \delta_3 cpi_{t-1} + \delta_4 gdp_{t-1} + \sum_{i=1}^{4} \gamma_i \Delta p_{Mt-i} + \sum_{i=1}^{4} \eta^{+}_{i} \Delta e^{+}_{t-i} + \sum_{i=1}^{4} \eta^{-}_{i} \Delta e^{-}_{t-i} + \sum_{i=1}^{4} \omega_i \Delta cpi_{t-i} + \sum_{i=1}^{4} \rho_i \Delta gdp_{t-i} + \sigma_t \quad (6')$$

For the symmetry in the short-run, it can be tested by a two ways: (i) Ω+I = Ω-i for all i=0,…, p or (ii) $\sum_{i=1}^{q-1} \Omega^{+}_{t-i} = \sum_{i=1}^{q-1} \Omega^{-}_{t-i}$ (for export price for example).

If short-run symmetry is not rejected, then Eq. (4) and (4') simplifies to:

$$\Delta p_{Xt} = \beta_0 + \beta_1 p_{Xt-1} + \beta^{+}_{2} e^{+}_{t-1} + \beta^{-}_{3} e^{-}_{t-1} + \beta_4 ppi_{t-1} + \beta_5 gdp_{t-1} + \sum_{i=1}^{4} \alpha_i \Delta p_{Xt-i} + \sum_{i=1}^{4} \Omega_i \Delta e_{t-i} + \sum_{i=1}^{4} \theta_i ppi_{t-i} + \sum_{i=1}^{4} \Phi_i gdp_{t-i} + \upsilon_t \quad (7)$$

$$\Delta p_{Mt} = \delta_0 + \delta_1 p_{Mt-1} + \delta^{+}_{2} e^{+}_{t-1} + \delta_3 e^{-}_{t-1} + \delta_4 cpi_{t-1} + \delta_5 gdp_{t-1} + \sum_{i=1}^{4} \gamma_i \Delta p_{Mt-i} + \sum_{i=1}^{4} \eta_i \Delta e_{t-i} + \sum_{i=1}^{4} \omega_i \Delta cpi_{t-i} + \sum_{i=1}^{4} \rho_i \Delta gdp_{t-i} + \sigma_t \quad (7')$$

IV. Data and results

1. Data description

We use quarterly data ranging from 1985q1 to 2011q2 for Japan, France and the United States. For Germany, since data are not available before, the estimation period starts in 1991.

Export and import prices, the dependent variables, are obtained from the OCDE. In particular, they correspond to the price of non-commodity exports of goods and services and to the price of non-commodity imports of goods and services respectively.

Nominal effective exchange rates are provided from the Bank of International Settlements (BIS) and they are defined such that an increase (decrease) indicates an appreciation (depreciation). In the case of the partial sum processes, $\beta^{+}_{2,}$ δ^{+}_{2} correspond then to an appreciation and β^{-}_{2}, δ^{-}_{2} to a depreciation for export and import prices, respectively.

The rest of the variables (cpi, ppi and gdp) are obtained from the International Financial Statistics (IFS). All the variables are seasonally adjusted and we work with its logarithms.

2. Results

In this section, we show the main results of the symmetric and asymmetric exchange rate pass-through for export and import prices (Eqs. (2), (2') and (4), (4')). We first report the results for testing the long -run relationship for both the symmetric and asymmetric models. The t and F tests results are presented in table (1).

Table1: Bounds cointegration test

Export Price	*Symmetric*				*Asymmetric*			
	β_1		F_{pss}		β_1		F_{pss}	
	Coeff.	***tBDM***	***Coeff.***	***Prob***	***Coeff.***	***tBDM***	***Coeff.***	***Prob***
Germany	-0.264	-3.96*	5.82*	0.000	-0.194	-3.47*	3.71*	0.005
France	-0.122	-3.03+/-	2.72+/-	0.034	-0.121	-3.017+/-	2.72+/-	0.030
Japan	No cointegration				-0.328	-3.71**	5.81*	0.000
United-States	-0.166	-3.28**	3.55*	0.0010	-0.192	-3.85*	4.51*	0.002
Import Price	***Symmetric***				***Asymmetric***			
	δ_1		F_{pss}		δ_1		F_{pss}	
	Coeff.	***t*BDM**	***Coeff.***	***Prob***	***Coeff.***	***tBDM***	***Coeff.***	***Prob***
Germany	-0.359	-6.04*	11.99*	0.000	-0.359	-6.04*	11.99*	0.000
France	-0.124	-3.13+/-	7.39*	0.000	-0.360	-6.00*	9.12*	0.000
japan	-0.126	-2.92+/-	10.79*	0.000	-0.169	-4.17*	11.49*	0.000
United-States	-0.151	-2.80+/-	4.59*	0.002	-0.233	-5.07*	8.50*	0.000

Notes: (1) β1 is the error correction parameter in Eq (2) and (4) ;(2) δ1 is the error correction parameter in Eq (2') and (4'); (3) Fpss denotes the PSS F-statistic testing the null hypothesis no cointegration; (4) tBDM is the BDM t-statistic testing the null hypothesis β =0 and δ =0

*Indicates statistical significance at the 5% level.

** Indicates statistical significance at the 10% level.

+/- indicate no conclusion.

According to the results in Table 1, there is a long-run relationship between export and import prices and their explanatory variables except for Japan and France in the export price model. Indeed, for Japan, the *tBDM* test statistic is below the lower critical values so we do not reject the null hypothesis of no long-run relationship between export price and the explanatory variables. Regarding the results for France, the Fpss test statistic is between the critical values.

In this case, no conclusion can be considered regarding the existence of a long-run relationship between the variables.

The estimated long-run coefficients of the symmetric and asymmetric exchange rate pass-through are summarized in Table 2 below[9].

Table 2: Long-run estimates of the symmetric and asymmetric exchange rate pass-through

		Export Price			***Import Price***	
		Symmetric	***Asymmetric***		***Symmetric***	***Asymmetric***
Germany [6]	β_2	-0.139 (-2.45)	β^-_2 **:** -0.064 (-1.044) β^+_2 **:** -0.147 (-2.76)	δ_2	-0.473 (-6.14)	-0.473 (-6.14)
France [6]	β_2	-0.534 (-2.06)	-0.534 (-2.06)	δ_2	0.125 (0.43)	δ^-_2**:** 0.115 (1.043) δ^+_2**:**-1.12 (-5.95)
Japan[7]	β_2		β^-_2: -0.07 (-1.2) β^+_2 : –0.36 (-7.36)	δ_2	-0.41 (-1.64)	-0.57 (-3.29)
United-States[7]	β_2	-0.170 (-3.5)	-0.16 (-3.09)	δ_2	-0.46 (-4.14)	-0.38 (-6.52)

Notes: (1) β_2 is the pass-through to the export prices; (2) β^+_2 is the appreciation of exchange rate; (3) β^-_2 is the depreciation of exchange rate;(4) δ_2 is the pass-through to the import prices ;(5) δ^-_2 is the depreciation of exchange rate;(6) δ^+_2 is the appreciation of exchange rate; (6) when the estimated coefficients are the same, it means that there are short and long run symmetry. This is the case for Germany and France; (7) when there is only one coefficient in the asymmetric estimation (different from the symmetric estimation's coefficient); it means that there is long-run symmetry and a short-run asymmetry. This is the case for the United-states and Japan.

The results presented in Table 2 show that there is a negative relation between both export and import prices and exchange rate changes. In other words, depreciation (appreciation) of exchange rate increase (decrease) export and import prices. Striking though these results are

[9] More complete estimation results can be found in Tables 4;5;6 and 7 in the Appendix.

for the case of exports, they remain entirely consistent with some theoretical propositions. We will come back to this point later.

As seen, the response of export prices to movements in the exchange rate is statistically significant, but the degree of sensitivity varies across countries. In particular, the estimated coefficients for Germany and the United States are both significant but under 0.2, while the coefficient for France exceeds 0.5. These results suggest that a 1 % nominal effective depreciation of German currency or the US dollar would raise the price of their exports about 0.2% in terms of their own currencies. A similar decline in the French exchange rate would increase their export prices more than 0.5%.

With respect to import prices, the results show that the long-run pass-through coefficient is statistically significant for Germany, Japan and United-states. These results indicate that a 1% depreciation of the nominal exchange rate increases import prices by around 0.5% in the three countries. For France, the pass-through coefficient is not significantly different from zero, maybe indicating that import prices are not sensitive to exchange rate or that the equation is wrongly specified.

Note also that the average elasticity to exchange rate changes appears to be larger for import price than for export prices, except in the case of France.

Let us now pay attention to the asymmetric pass-through, the primary objective of this study. According to the results in Table 2, we note that the null hypothesis of symmetry in the response of export and import prices due to the exchange rate changes can be rejected at the 5% critical level, except in the case of France for the export prices and Germany for import prices. In these two countries, the null hypothesis of symmetry is not rejected, implying that prices respond in the same way to an appreciation that a depreciation of the exchange rate.

For the United States, note that symmetry is accepted only in the long-run. This means that prices react symmetrically to an appreciation that depreciation for exports and imports prices in the long-run, but a short-run asymmetry is allowed. Indeed, in the short-run it is admitted that the reaction of export and import prices differs according to whether the exchange rate variation is an appreciation or a depreciation.

Similarly, for Japan the symmetry is accepted only in the long-term. Thus, in the long-run, prices respond symmetrically to exchange rates changes. In the short-run, however, the null hypothesis is rejected. This result is valid only for the import price equation. In fact, for export prices, the symmetry is rejected for both the short and the long-run.

One important finding in this study is that export prices increase due to depreciation (in the cases of France and the United-States) and decline following an appreciation (in Germany and Japan). Indeed, as shown in Table 2, a 1% nominal effective appreciation of the German and the Japanese currencies would produce a decline of export prices - in term of their own currencies - of about 0.1% and 0.4% respectively. A similar depreciation would increase the export prices about 0.5% and 0.2% for France and the United States, respectively.

The previous result can be explained by the fact that, following a depreciation, the exporters can gain in price competitiveness if they maintain their prices in domestic currency unchanged. In this case, they can increase the quantity of the exported goods. However, if they reach their maximum capacity or if the adjustment costs are very high, it becomes difficult for them to adjust their production upwards and in this case they are pushed to increase their prices (Bussière (2007)).

Also, a country may be exporting the final good but, at the same time, importing the corresponding inputs from another country. A depreciation of the exporting country's currency makes the imported inputs more expensive. As such, an exchange rate change affects

the exporter's costs, which leads the exporting firm to raise its prices and subsequently, pass-through less of the exchange rate changes (Ghosh and Rajan (2006)).

Conversely, following an appreciation, exporters can lose competitiveness and market share if they keep their prices unchanged in domestic currency. This explains why exporters generally use pricing to market in order to partially reduce the loss caused by the exchange rate appreciation. Indeed, according to Goldberg and Knetter (1997), the export firms try to reduce partially the impact of this appreciation by accepting to reduce their margin, therefore by lowering their prices in order to keep their market share.

For instance, Bussière, (2007) illustrated this result in the euro area. Indeed, between the end of 1998 to the last quarter of 2001 the euro depreciated by nearly 20% in nominal effective terms. Afterwards, beginning in the second quarter of 2002, the euro started to appreciate again, and regained about 20% of its value by the end of 2004. However, neither export nor import prices reacted symmetrically to these two broadly similar exchange rate changes: during the initial depreciation, export and import prices of goods increased by around 12% and 20%, respectively. On the contrary, during the subsequent appreciation, they decreased by only 4% and 5%, respectively. This example would suggest that appreciations and depreciations do not have symmetric effects on prices.

On the import's price side, the null hypothesis of symmetry is accepted only for Germany. Indeed, for France the result presented in Table 2 shows that import prices respond asymmetrically to exchange rate variation. On the other hand, for Japan and United-states, the import price respond asymmetrically only in the short-run.

Another important finding of our study is that appreciations have a larger effect than depreciations on both export and import prices. Indeed, according to the results in Table 2, depreciations are not significant for Germany and Japan (for export prices) and for France (for

import prices). One potential explanation for this is related to the strategies adopted by firms. Froot and Klemperer (1989) put forward a strategic choice of firms between gaining market shares and increasing their profit margins when an exchange rate variation occurs. In other words, if we accept this hypothesis, this means that these countries react more to an appreciation than to depreciation by fear of losing market share. Thus, when the exchange rate of the exporting country appreciates, exporters prefer to reduce their margins and thus their prices to keep their market share.

To summarize, we can conclude that Germany (only for export prices), France (only for import prices), Japan and the United states adopt an asymmetric strategy depending on the direction of exchange rate change. We also document that export and import prices are more sensitive to an appreciation than to depreciation. Comparing now the estimates from the four countries, we can note some differences. For instance, the estimated long-run elasticity of export prices to exchange rate changes appears to be rather low for Germany (13%) and the US (17%). For France, the elasticity of export prices is found to be substantially higher (53%). This is an important result that brings to the discussion, once more, the important asymmetries among countries belonging to the European Monetary Union (EMU). This finding can be explained by differences in specialization of both countries. Germany is specialized in exclusive and luxury product; where high know-how is required. France instead is specialized mainly in food-processing industry. These different specializations between these two countries make that German exports are less sensitive to an appreciation than French exports.

Moreover, it has been suggested that French exporters have less market power than German exporters and French exporters are ready to compress much more their mark-up than German to preserve their market shares (Gaulier et al. (2006)).

For Japan, the estimated long-run pass-through is around 36%. Note that it is also higher than the corresponding coefficient for Germany and United-states. This can be explained by the fact that Japan has an economy strongly dependent on the external sectors, which makes it more vulnerable during an appreciation. Thereby, it might be the case that Japan tends to lower its export prices more than Germany and the United-States in order not to lose its market share.

Regarding import prices, a 1% appreciation of the nominal exchange rate lowers French import prices by about 1.1%. On the other hand, in the long-run, depreciations do not have effects on prices. On the contrary, for Germany, Japan and the United States, a 1% appreciation lowers their import prices between 0.4% and 0.5%.

Regarding short-run dynamics, a relationship between both export and import prices and exchange rate changes varies across countries (Table 3 in Appendix). Indeed, for Germany there is a positive relation between export prices and the exchange rate changes. This implies that, a depreciation of the exchange rate decrease export prices in the short-run, as expected by the theory.

Figure 1 below shows the short and long-run multipliers. These multipliers are very informative to analyze the dynamics as they allow us to trace out the symmetric and asymmetric adjustment patterns following positive and negative shocks to the exchange rate. As seen, after about ten periods (i.e. about 2 years and half), the initial positive effect in Germany turns to its long-run value. In the long run depreciations are no longer significant.

For Japan, the United-States and France, according to the result in Table 3, there is evidence of a negative relationship between export and import prices and exchange rate changes. These results are consistent with our findings in the long-term analysis. The response of export prices to movements in the exchange rate is statistically significant for all the countries,

except for France. In this country this result may indicate that export prices are not sensitive to exchange rate in the short-term.

As it is the case in the long-run, in the short-run the degree of sensitivity of exchange rate on export prices varies across countries. For instance, the estimated coefficients for Germany and the United-States are both significant but relatively weak, indicating that a 1 % nominal depreciation of the German currency decreases exports prices by only about 0.1% in terms of its own currencies. For Japan, on the contrary, the effect is considerably higher (around 0.4%).

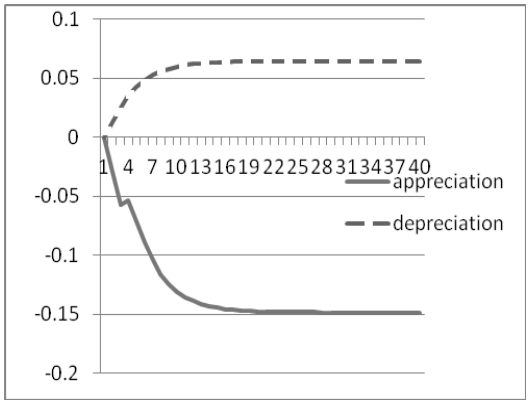
Regarding import prices, the results in Table 3 show that there is pass-through in the short-run in all the countries. For instance, a 1% depreciation of the nominal exchange rate increases import prices by around 0.2% in France and Japan. For the United-States, exchange rate variations have less impact on import prices. Indeed, a 1% depreciation of the nominal exchange rate increases import prices by only about 0.10%.

Turning now to the asymmetric pass-through, the results imply that the short-run pass-through coefficient is statistically significant only for Japan and the United-States in the case of export prices. Note that the null hypothesis of symmetry can be rejected at the 5% critical level only in the United-States -for the export prices- and in the case of France, United-States and Japan -for import prices-. In other words, prices respond differently to an appreciation than to a depreciation of the exchange rate. On the contrary, in the case of Germany, the null hypothesis of symmetry is not rejected, implying that prices respond in the same way to an appreciation than to a depreciation of the exchange rate.

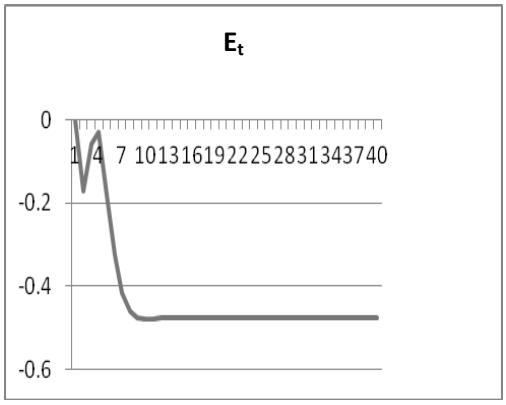
In the case of France, the results indicate that a 1 % nominal effective depreciation of French currency would fall the import prices about 0.3%. With respect to the multipliers and the convergence to the long-run equilibrium, Figure 1 shows that this convergence is relatively

quick (the correction occurs with 5 periods). For the rest of the countries, the depreciation does not have any noticeable effect on export and import prices. This implies that prices react only in the case of an appreciation of the exchange rate. For example, a 1 % nominal effective appreciation in Japan results in a fall of import prices around 0.3%. For the United - States, an appreciation of the same magnitude decreases import prices about 0.2%.

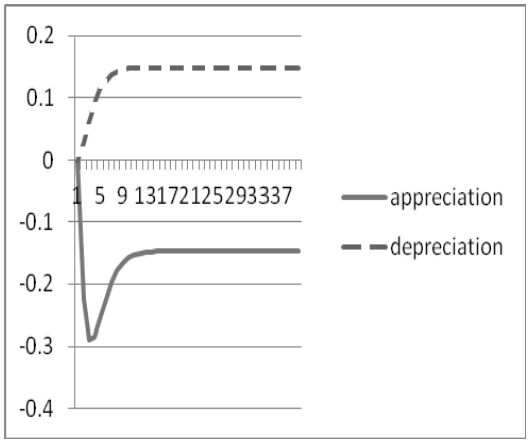
Figure 1: Short- and long-run multipliers



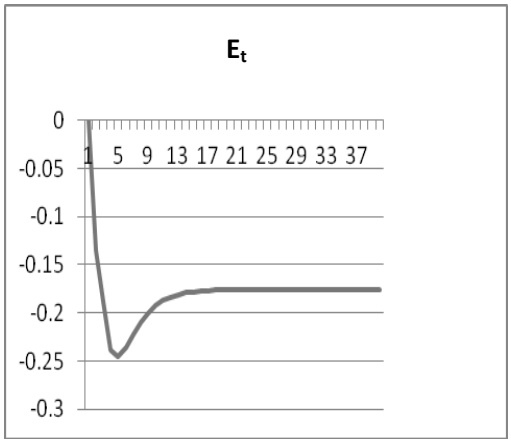
Germany asymmetric (export prices)



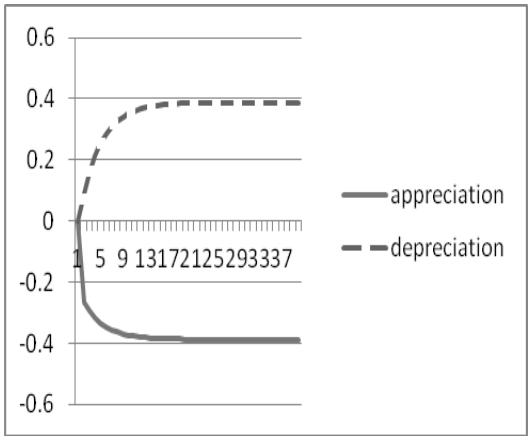
Germany symmetric (import prices)



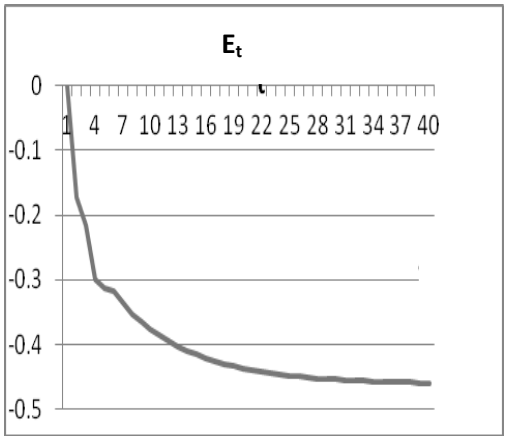
United-States asymmetric (export prices)



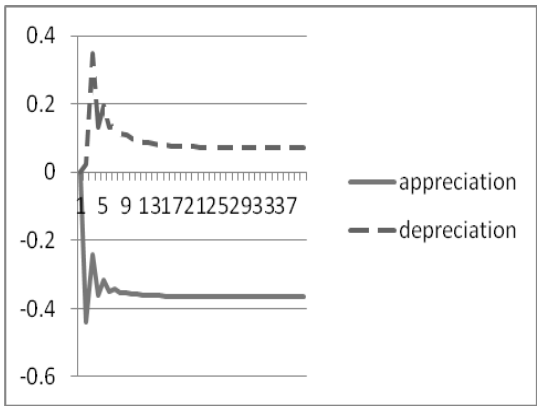
United-States symmetric (export prices)



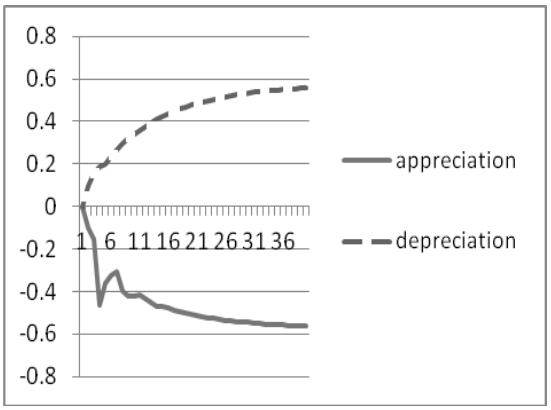
United-States asymmetric (import prices)



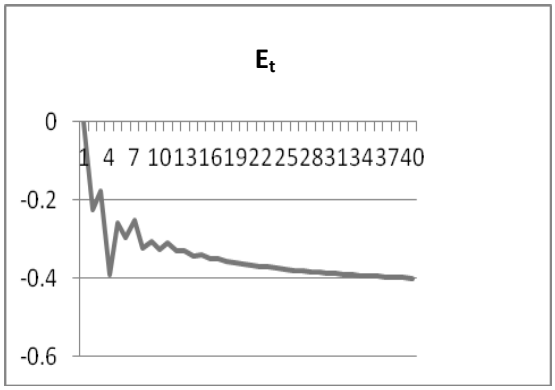
United-States symmetric (import prices)



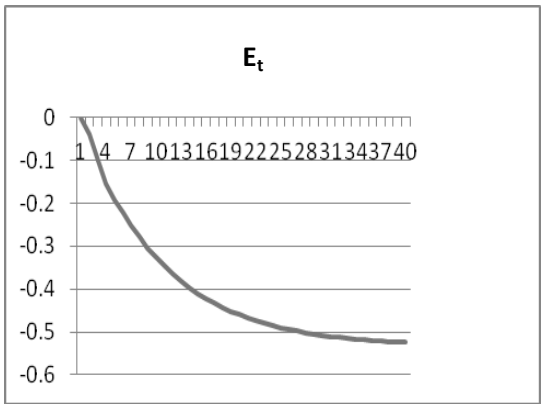
Japan asymmetric (export prices)



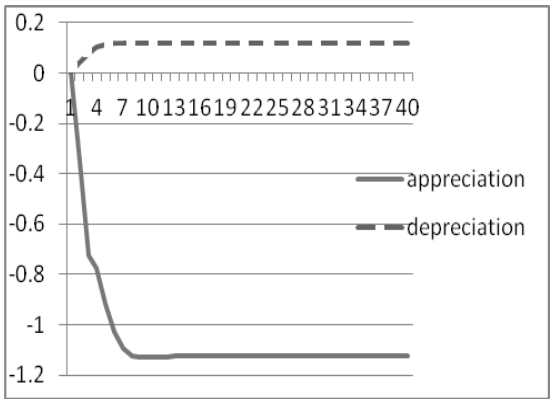
Japan asymmetric (import prices)



Japan symmetric (import prices)



France symmetric (export prices)



France asymmetric (import prices)

V. Conclusions

Using quarterly data from 1985 to 2011, we investigate possible asymmetries in the reaction of export and import prices to changes in the exchange rate for 4 major advanced countries. This exercise is conducted using an asymmetric cointegrating autoregressive distributed lag (ARDL) model.

Our main results can be summarized as follow. First, we provide evidence of asymmetric ERPT to appreciations and depreciations. This means that export and import prices respond differently depending on the direction of the exchange rate variation.

In particular, the coefficient of the long-run pass-through is found significant only when the nominal exchange rate appreciates. This implies that, in the long-run, an appreciation is clearly more passed through to export prices than depreciations. This finding is consistent with the quantity constraint theory.

However, we want to remark that this result cannot be generalized since the direction of the asymmetry may vary by sectors or industrial activities. Indeed, the direction of the asymmetry in these cases is not obvious ex ante and should be tested (Yang (2007)).

Second, we find that exporter's currency appreciation would decrease export prices. This result might be explained by the fact that firms are willing to lower their prices during an appreciation in order not to risk losing market share, even by having lower profit margins.

On the import side, the results show that German import prices respond symmetrically to an appreciation or depreciation. On the contrary the French, Japanese and American import prices react asymmetrically depending on the direction of changes in exchange rates. Moreover, in the long-run, appreciation is clearly more passed through to import prices than depreciations. This result is in line with the market share explanation.

This mixed result was pointed out by a number of empirical studies (Coughlin and Pollard (2004)).

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Appendix

Table A: The unit root test

Variables	Augmented Dickey Fuller test			
	France	**Germany**	**Japan**	**United-States**
import price	-2.661629 (-2.900137)	-2.872405 (-2.900137)	-3.011578 (-2.888932)	-2.746706 (-2.889200)
export price	-1.073801 (-2.889200)	-2.320088 (-2.898145)	-2.018480 (-2.888932)	0.195932 (-2.889474)
neer	-2.579929 (-2.889474)	-2.391576 (-2.898145)	-2.602069 (-2.888932)	-3.173825 (-2.888932)
ppi	-0.356433 (-2.889474)	-1.164969 (-2.898623)	-2.588160 (-2.889200)	0.766531 (-2.889200)
cpi	-0.789288 (-2.899619)	-4.134561 (-2.899619)	-3.212051 (-2.888932)	-2.505904 (-2.888932)
gdp	-1.699047 (-2.889753)	-6.986633 (-2.897678)	-3.968265 (-2.581453)	-1.296449 (-2.889474)

Note: The values in the bracket are the critical value at the 5% level

Table 3: Short-run estimates of the symmetric and asymmetric exchange rate pass-through

	Export Price		***Import Price***	
	Symmetric	***Asymmetric***	***Symmetric***	***Asymmetric***
Germany	ΔS_{t-1} N.S ΔS_{t-2} 0.08** (1.91) ΔS_{t-3} N.S ΔS_{t-4} N.S	ΔS_{t-1} N.S ΔS_{t-} N.S ΔS_{t-3} N.S ΔS_{t-4} N.S	ΔS_{t-1} N.S ΔS_{t-2} 0.26* (3.34) ΔS_{t-3} 0.15** (1.92) ΔS_{t-4} N.S	ΔS_{t-1} N.S ΔS_{t-2} 0.26* (3.34) ΔS_{t-3} 0.15** (1.92) ΔS_{t-4} N.S
France	ΔS_{t-1} N.S ΔS_{t-2} N.S ΔS_{t-3} N.S ΔS_{t-4} N.S	ΔS_{t-1} N.S ΔS_{t-} N.S ΔS_{t-3} N.S ΔS_{t-4} N.S	ΔS_{t-1} -0.18* (-2.04) ΔS_{t-2} N.S ΔS_{t-3} N.S ΔS_{t-4} N.S	ΔS^{-}_{t-1} N.S ΔS^{+}_{t-1} 0.05* (2.37) ΔS^{-}_{t-2} N.S ΔS^{+}_{t-2} N.S ΔS^{-}_{t-3} 0.28* (2.70) ΔS^{+}_{t-3} 0.19* (2.75) ΔS^{-}_{t-4} N.S ΔS^{+}_{t-4} N.S
Japan	ΔS_{t-1} -0.42* (-7.03) ΔS_{t-2} N.S ΔS_{t-3} N.S ΔS_{t-4} N.S	ΔS_{t-1} -0.31* (-5.51) ΔS_{t-2} N.S ΔS_{t-3} N.S ΔS_{t-4} N.S	ΔS_{t-1} -0.17* (-2.24) ΔS_{t-2} -0.20* (-2.84) ΔS_{t-3} N.S ΔS_{t-4} N.S	ΔS^{-}_{t-1} N.S ΔS^{+}_{t-1} N.S ΔS^{-}_{t-2} N.S ΔS^{+}_{t-2} N.S ΔS^{-}_{t-3} N.S ΔS^{+}_{t-3} -0.27* (-2.64) ΔS^{-}_{t-4} N.S ΔS^{+}_{t-4} N.S
United-States	ΔS_{t-1} -0.10* (5.32) ΔS_{t-2} N.S ΔS_{t-3} -0.03** (-1.80) ΔS_{t-4} N.S	ΔS^{-}_{t-1} N.S ΔS^{+}_{t-1} -0.195* (-5.25) ΔS^{-}_{t-2} N.S ΔS^{+}_{t-2} N.S ΔS^{-}_{t-3} N.S ΔS^{+}_{t-3} N.S ΔS^{-}_{t-4} N.S ΔS^{+}_{t-4} N.S	ΔS_{t-1} -0.10 (-2.72) ΔS_{t-2} N.S ΔS_{t-3} -0.08* (-2.20) ΔS_{t-4} N.S	ΔS^{-}_{t-1} N.S ΔS^{+}_{t-1} -0.17* (2.67) ΔS^{-}_{t-2} N.S ΔS^{+}_{t-2} N.S ΔS^{-}_{t-3} N.S ΔS^{+}_{t-3} N.S ΔS^{-}_{t-4} N.S ΔS^{+}_{t-4} N.S

Note: (1)*Indicates statistical significance at the 5% level; (2)** Indicates statistical significance at the 10% level.

Table 4: Estimates of the symmetric model: Export Price

Germany		
	coeff	***t-stat***
s_{t-1}	-0.139	-2.45**
ppi_{t-1}	-0.003	-1.020
gdp_{t-1}	-0.231	-3.24***
dp_{xt-1}	0.154	1.456
dp_{xt-3}	-0.144	-2.111**
ds_{t-2}	0.087	1.917*
$dppi_{t-1}$	0.491263	2.487**
$dgdp_{t-1}$	-0.325	-1.897*
$dgdp_{t-2}$	-0.472	-2.75***

Note: (1) *, **, *** Indicate statistical significance at the10%,5% and 1% level respectively.

	France	
	coeff	***t-stat***
s_{t-1}	-0.534	-2.06**
ppi_{t-1}	0.408	2.01**
gdp_{t-1}	-0.304	-2.16**
dp_{xt-2}	-0.186	-1.951*
ds_{t-1}	0.024	0.345
$dppi_{t-3}$	0.260	2.238**
$dgdp_{t-2}$	0.777	2.072**
$dgdp_{t-3}$	-0.656	-1.8*

Note: (1) *, **, *** Indicate statistical significance at the10%,5% and 1% level respectively.

	United-States	
	coeff	***t-stat***
s_{t-1}	-0.17	-3.5***
ppi_{t-1}	0.413	3.72***
gdp_{t-1}	-0.131	- 1.79*
dp_{xt-1}	0.344	4.296***
ds_{t-1}	-0.105	-5.323***
ds_{t-3}	-0.033	-1.8*
$dgdp_{t-4}$	0.2	2.073**

Note: (1) *, **, *** Indicate statistical significance at the10%,5% and 1% level respectively.

Table 5: Estimates of the symmetric model: Import Price

	Germany	
	coeff	***t-stat***
s_{t-1}	-0.473	-6.14***
cpi_{t-1}	-0.623	-13.75***
gdp_{t-1}	-0.477	-6.17***
dp_{Mt-1}	0.256	2.643***
ds_{t-2}	0.264	3.349***
ds_{t-3}	0.15	1.927*
$dcpi_{t-1}$	0.873	3.509***
$dcpi_{t-2}$	1.233	4.772***
$dcpi_{t-3}$	0.834	3.023***
$dgdp_{t-1}$	-0.716	-2.242**
$dgdp_{t-2}$	-0.826	-2.543**
$dgdp_{t-3}$	-0.637	-1.987**
$dgdp_{t-4}$	-0.561	-1.992**

Note: (1) *, **, *** Indicate statistical significance at the10%,5% and 1% level respectively.

	France	
	coeff	***t-stat***
s_{t-1}	0.125	0.43
cpi_{t-1}	-0.292	-1.39
gdp_{t-1}	-0.135	-0.45
dp_{Mt-4}	0.177	2.059**
ds_{t-1}	-0.183	-2.042**
$dcpi_{t-2}$	1.325	3.823***
$dcpi_{t-3}$	0.871	2.54**

Note: (1) *, **, *** Indicate statistical significance at the10%,5% and 1% level respectively.

	United-States	
	coeff	***t-stat***
s_{t-1}	-0.46	-4.14***
cpi_{t-1}	-0.428	-1.12
gdp_{t-1}	0.349	0.98
dp_{Mt-1}	-0.001	-0.022
dp_{Mt-2}	-0.229	-2.195**
ds_{t-1}	-0.102	-2.723***
ds_{t-3}	-0.086	-2.2**
$dcpi_{t-1}$	0.495	2.304**
$dcpi_{t-2}$	0.582	2.712***

Note: (1) *, **, *** Indicate statistical significance at the10%,5% and 1% level respectively.

	Japan	
	coeff	***t-stat***
s_{t-1}	-0.411	-1.64
cpi_{t-1}	1.293	1.84*
gdp_{t-1}	0.106	0.16
dp_{Mt-1}	-0.313	-3.166***
dp_{Mt-2}	-0.177	-1.831*
dp_{Mt-3}	-0.34	-3.54***
ds_{t-1}	-0.172	-2.249**
ds_{t-3}	-0.207	-2.843***
$dcpi_{t-1}$	2.43	3.2***
$dcpi_{t-3}$	1.656	2.119**
$dgdp_{t-3}$	0.745	2.72***

Note: (1) *, **, *** Indicate statistical significance at the10%,5% and 1% level respectively.

Table6: Estimates of the asymmetric model: Export Price

	Germany	
	coeff	***t-stat***
Dep_{t-1}	-0.064	-1.044
App_{t-1}	-0.147	-2.76***
gdp_{t-1}	0.097	0.48
ppi_{t-1}	-0.09	-0.45
dp_{xt-1}	0.195	1.863*
ds_{t-3}	0.027	0.635
$dgdp_{t-1}$	-0.347	-2.024**
$dppi_{t-1}$	0.561	2.501**

Note: (1) *, **, *** Indicate statistical significance at the10%,5% and 1% level respectively.

	United-States	
	coeff	***t-stat***
s_{t-1}	-0.16	-3.09***
gdp_{t-1}	-0.172	-2.86***
ppi_{t-1}	0.473	4.73***
dp_{xt-1}	0.354	4.496***
App_{t-1}	-0.195	-5.25***
App_{t-3}	-0.054	-1.53
$dgdp_{t-4}$	0.167	1.741*

Note: (1) *, **, *** Indicate statistical significance at the10%,5% and 1% level respectively

	Japan	
	coeff	***t-stat***
Dep_{t-1}	-0.072	-1.2
App_{t-1}	-0.365	-7.36***
gdp_{t-1}	0.345	2.78***
ppi_{t-1}	-0.163	-0.81
dp_{xt-1}	-0.390	-3.329***
ds_{t-1}	-0.319	-5.511***

Note: (1) *, **, *** Indicate statistical significance at the10%,5% and 1% level respectively.

Table7: Estimates of the asymmetric model: Import Price

	France	
	coeff	***t-stat***
Dep_{t-1}	0.115	1.043
App_{t-1}	-1.121	-5.95***
gdp_{t-1}	0.137	8.19***
cpi_{t-1}	1.079	5.42***
dp_{Mt-1}	0.268	3.191***
$dApp_{t-1}$	0.055	2.375**
$dDep_{t-3}$	0.283	2.700***
$DApp_{t-3}$	0.192	2.757***
$dcpi_{t-2}$	0.825	2.431**

Note: (1) *, **, *** Indicate statistical significance at the10%,5% and 1% level respectively.

	United-States	
	coeff	***t-stat***
s_{t-1}	-0.386	-6.52***
gdp_{t-1}	0.029	0.188
cpi_{t-1}	-0.091	-0.52
App_{t-1}	-0.175	-2.677***
$dcpi_{t-1}$	0.639	3.130***
$dcpi_{t-2}$	0.543	2.655***

Note: (1) *, **, *** Indicate statistical significance at the10%,5% and 1% level respectively.

	Japan	
	coeff	***t-stat***
s_{t-1}	-0.571	-3.29***
gdp_{t-1}	-0.211	-0.53
cpi_{t-1}	1.771	4.32***
dp_{Mt-1}	-0.24	-2.571***
dp_{Mt-2}	-0.258	-2.738***
dp_{Mt-3}	-0.315	-3.309***
App_{t-3}	-0.278	-2.640***
$dgdp_{t-3}$	0.782	2.816***
$dcpi_{t-1}$	2.137	2.816***
$dcpi_{t-3}$	1.652	2.094***

Note: (1) *, **, *** Indicate statistical significance at the10%,5% and 1% level respectively.

CHAPTER 3

Does Openness Affect Exchange Rate Pass-Through? An Empirical Analysis For Four Advanced Countries

Does Openness Affect Exchange Rate Pass-Through? An Empirical Analysis for Four Advanced Countries

ABTRACT

In this paper, we study whether the degree of trade openness affects the exchange rate pass-through. Using state space models, our results for France, the United-States, Japan and Germany for the 1970q1-2013q4 period do not provide evidence of a relationship between openness and exchange rate pass-through for the most countries of our sample.

Moreover, we find that exchange rate pass-through has been declining for some countries of our sample. However, we find that this decline occurs in different periods.

JEL classification: E31 ; F31; F41.

Keyswords: Exchange Rate Pass-Through; Import Price; Consumer Price Index; State Space Models.

I. Introduction

The degree to which exchange rate movements are passed-through to prices is a central issue in international finance and a much-debated question among policy-makers. Indeed, a low exchange rate pass-through is thought to provide greater freedom for pursuing an independent monetary policy and to facilitate the implementation of inflation targeting (see for instance Smets and Wouters (2002); Adolfson (2002); Corsetti and Pesenti (2005); Sutherland (2005); and Monacelli (2005)). However, there is no consensus on the conditions that lead to a low exchange rate pass-through (ERPT).

As we mentioned before, the pass-through process consists of two stages. In the first stage, exchange rate movements are transmitted to import prices, while in the second stage, changes in import prices are reflected in the consumer price index (CPI) (see Figure2 in the Appendix). While the response of import prices to exchange rate movements is important, it is the behaviour of the CPI that matters most for monetary policy in inflation-targeting countries. The distinction between first- and second-stage pass-through reflects different developments in the literature. In international economics or industrial organization, the pass-through has often been calculated based on import prices or the prices set by domestic exporters, while the pass-through to consumer prices has recently come to the attention of researchers and policy makers, especially at central banks.

The distinction between the stages of ERPT is important because it allows for different pricing behaviour along a distribution chain. Indeed, the pricing behaviour of foreign exporters or domestic importers is thought to affect the first-stage pass-through. That of the domestic distributors is thought to be relevant for second-stage pass-through. The difference

in these pricing behaviours may lead to different development in each stage of the pass-through (Sekine (2006)).

It is important to remark that the literature on exchange rate pass-through, either that focusing in the first or in the second stage, has reached at least two consensuses. First, the ERPT is, in the most cases, incomplete (Krugman (1987); Dornbusch (1987); Mann (1986); Bodnar, Dumas, and Marston (2002); etc...). Second, the ERPT had declined in recent years.

The degree of exchange rate pass-through has an important role in monetary policy. In fact, an optimal monetary policy may change depending on whether the pass-through is complete or incomplete. Indeed, when exchange rate pass-through is complete, then optimal monetary policy completely stabilises the price of home produced goods. However, when exchange rate pass-through is incomplete, then optimal monetary policy should take account of exchange rate volatility (Sutherland (2002)).

As we mentioned in chapter 1, there is now a growing interest in examining the relationship of exchange rate pass-through and macroeconomic factors to explain incomplete and declining ERPT. Among these factors we find the degree of competition of each exporter. As discussed in Froot and Klemperer (1989), exchange rate pass-through may be lower when nominal exchange rate variability is high and exporters to a country try to maintain local market share. In a highly competitive environment, the exchange rate pass-through will be limited and the producers will absorb cost increases, accepting less mark-up, and will not fully pass-through exchange rate variations to prices, with intention of protecting market-share.

The variance of exchange rate is also another determinant of exchange rate pass-through. Indeed, if the variance of exchange rate is large, then the cost of changing prices decreases and price-makers have more incentive to pass-through cost changes to prices. The idea is that

if the cost variation is large, then it is easier for the price maker to pass through these cost changes to prices (Souza et al. (2010)).

Several studies have tested the relevance of the degree of openness of the country as determinant of the ERPT. The openness degree of an economy depends on the presence of tradable goods, which determine how prices are sensitive to changes in exchange rates. This degree can be defined as the sum of imports and exports as a proportion of GDP. It is used to quantify the exposure to globalization. . Globalization is not a new phenomenon, but it has accelerated since the early 1990s. The relationship between globalization and exchange rate pass-through has gained significant attention in theoretical and empirical research over the last decade (Soto and Selaive (2003); Benigno and Faia (2010); Daniels and VanHoose(2010)).

There is no clear consensus in the economic literature regarding the relation between exchange rate pass-through and openness. The most immediate connection between the two variables is positive: the more a country is open to trade, the more movements in exchange rates are transmitted via import prices into CPI changes. In fact, the larger presence of imports and exports in an economy, the larger the pass-through coefficient. Thus, a high degree of openness can imply a high sensitivity of the economy to exchange rates variations (McKinnon (1963) and McCarthy (2000, 2007)). In other words, the higher is the degree of trade openness, the higher is the price responsiveness to exchange movements.

However, this result may be challenged once we take into account that inflation could be negatively correlated with openness, as empirically found by Romer (1993). This gives rise to an indirect channel, whereby openness is negatively correlated with inflation, taking into

account Taylor's hypothesis[10], the degree of pass-through. The direct and indirect channels go in opposite directions and the overall sign of the correlation between pass-through and openness can thus be either positive or negative (Ca' Zorzi et al. (2007)).

Indeed, using a Barro-Gordon framework, Romer (1993) suggests that greater trade openness enhances negative terms of trade effects resulting from domestic output expansions, thereby reducing the incentive for a central bank to engage in inflationary policymaking. Thus, the relationship between openness and exchange rate pass-through could be negative since the countries with higher average inflation tend to have higher pass-through.

We contribute to the literature by exploring this latter macroeconomic determinant. More precisely, base on a state space model, we investigate the effect of the degree of openness on the exchange rate pass-through. We focus on the exchange rate pass-through to import prices and to CPI. Our results show that, for all countries in our sample, namely France, Germany, Japan and United-States, the degree of openness does not affect the exchange rate pass-through. Indeed, according to our results, there is no evidence that openness can affect exchange rate pass-through.

This paper is organized as follows. Section 2 provides an overview of the literature on the relationship between openness and the degree of pass-through. Section 3 introduces the methodology and describes the data. Section 4 presents the results and the discussion. Finally, section 5 concludes.

[10] Taylor (2000) argues that low inflation environment, backed by a credible inflation-targeting monetary policy, allows firms to reduce the extent to which they pass on exchange rate-related cost shocks.

II. Overview of the literature

There are no conclusive empirical results in the literature about the relation between exchange rate pass-through and openness. However, the most expected result is a positive relation. The more a country is open to trade, the more the movements in the exchange rate are transmitted through import prices into CPI changes. For instance, Bodnar and Gentry (1993) find that the value of firms in more open economies is more influenced by the exchange rate than in more closed economies. Goldfajn and Werlang (2000) show that openness has a positive impact on the estimated coefficient of the exchange rate, in an inflation regression for a panel of countries. Friberg and Nydahl (1999) find a positive and statistically significant relationship between exchange rate exposure and openness for the OECD countries. Campa and Gonzalez (2002) focus on the differences in exchange rate pass-through to import prices in the Euro area. They conclude that those differences are primarily explained by differences in the degree of openness to non-Euro countries. Barhoumi (2006) find a positive correlation of pass-through-openness in panel co-integration framework. According to this study, countries with lower tariff barriers experience a higher long-run pass-through than countries with higher tariff barriers.

On the other hand, Choudhri and Hakura (2006) estimate the exchange rate pass-through to consumer price inflation for 71 countries over the period from 1971 to 2000. They found little evidence of a positive relationship between exchange rate pass-through to consumer prices and openness. Similarly, McCarthy (2007) provides weak evidence of a positive relationship between openness and pass-through to import price. On the other side, he finds no evidence of a statistically significant positive relationship with exchange rate pass-through to import prices. Others studies found that there is no statistical link between pass-through to consumer

prices and openness, such as Ca' Zorzi et al. (2007); Choudhri, Faruquee and Hakura (2005) and Gagnon and Ihrig (2004).

Ho and McCauley (2003) compiled several empirical studies over the period 1980-2000. They showed that the degree of pass-through, related to an important degree of openness, is higher in the emerging markets.

However, the picture becomes more complex once we take into account that inflation can be negatively correlated with openness. Indeed, for open economies that adopt inflation targeting, the central bank tries to keep the inflation rate at a low level and to minimize the volatility of the price level, which limits the transmission of exchange rate variations to consumer prices of goods. Romer (1993) finds the existence of an indirect channel moving in the opposite direction, whereby openness is negatively correlated with inflation and, taking into account Taylor's hypothesis, the degree of pass-through. He explains that in the case of absence of a well defined monetary policy, a high degree of openness lead to an important volatility in the inflation rate. Whereas, in the presence of an explicit monetary rule with an objective of inflation, Romer (1993) shows that there exists a negative relation between the degree of openness and the inflation.

The main explanation of the negative effect of openness on import prices exchange rate pass-through is that the greater openness of a country increases competition between foreign and local producers. In this case, in order to maintain their market share, foreign firms are willing to accept adjustments to their mark-up which might reduce the pass-through. Similarly, Burstein et al. (2005) explain that a significant degree of openness is an indicative of increased competitive pressures; in this case firms may have to absorb temporary cost increases that are due to exchange rate movements, and thus the extent of pass-through would be lower. Firms may outsource production to lower-cost countries, including the ones to

which they are exporting, in order to maintain their profit margins, which might further reduce the pass-through.

Gust et al. (2006) also argue that the increase in trade integration, observed over the last decades, has decreased the degree of exchange rate pass-through. Their results are based on a comparison of different set of time samples, namely the 80s versus the 90s.

III. Methodology and data description

1. Methodology

In order to analyze the effects of openness on exchange rate pass-through, we use the state-space models. The State space models have been applied in the econometrics literature to model unobserved variables: expectations, measurement errors, missing observations, permanent income, unobserved components (cycles and trends) and the non-accelerating rate of unemployment. This model is a very powerful and flexible instrument. Extensive surveys of applications of state space models in econometrics can be found in Hamilton (1994a, Chapter 13; 1994b) and Harvey (1989, Chapters 3, 4).

There are three main benefits of representing a dynamic system in state space form. First, the state-space model allows unobserved variables (the state variables) to be estimated with the observable model. Second, state-space models can be analysed using the Kalman Filter recursive algorithm. Named after Kalman (1960), the Kalman filter is a recursive algorithm that computes estimates for the unobserved components at time t, based on the available information at the same date. And third, a very important feature of state equations is it flexibility, as they may contain exogenous variables and unknown coefficients. The state space approach offers attractive features with respect to their generality, flexibility and transparency.

The state space model consists of a state equation and an observation equation. While the state equation formulates the dynamics of the state variables, the observation equation relates the observed variables to the unobserved state vector. The state vector can contain trend, seasonal, cycle and regression components plus an error term. Models that relate the observations over time to different components, which are usually modeled as individual random walks, are referred to as structural time series models. The stochastic behavior of the state variable, its relationship to the data and the covariance structure of the errors depend on parameters that are also generally unknown. The state variable and the parameters have to be estimated from the data[11].

A standard state space formulation can be represented as follows[12].

Let

$$\boldsymbol{Y_t = Z_t A_t + \varepsilon_t} \qquad (1)$$

be the measurement equation, where Y_t is a vector of measured variables of dimension n×1, A_t is the state vector of unobserved variables of dimension p×1, Z_t is a matrix of parameters of dimension n×p and $\varepsilon_t \sim N(0, H_t)$. The state equation is then given as:

$$\boldsymbol{A_t = T_t A_{t-1} + \eta_t} \qquad (2)$$

where T_t is a matrix of parameters and $\eta_t \sim N(0, Q_t)$.

Q_t and H_t are sometimes referred to as the hyper-parameters of the model in order to distinguish them from the other parameters.

The specification of the state space system is completed by two further assumptions: first, that the initial vector A_0 has a mean a_0 and covariance matrix P_0 and second that the disturbances ε_t and η_t are uncorrelated with each other in all time periods, and uncorrelated with the initial state.

[11] See Sascha Mergner (2009)

[12] See Kalman (1960) and Harvey (1989) for exhaustive presentations.

This implies that:

$$\forall (s, t) \qquad E(\varepsilon_t . \eta s') = 0 \tag{3}$$

and

$$\forall_t \qquad E(\varepsilon_t . A'_0) = 0 \tag{4}$$

The equation (1) called measurement equation, describes the relation between the observed time series, Y_t, and the (possibly unobserved) state A_t. Equation (2) is the state equation. It describes the evolution of the state variables as being driven by the stochastic process of innovations η_t.

As mentioned above, state-space models can be analysed using the Kalman Filter recursive algorithm, which is commonly used to estimate time varying coefficient models. The Kalman filtering approach provides optimal estimates for state variables based on the information from the two sources, the measurement and the state equations.

Let a_t be the optimal estimator of A_t based on the observations up to and including Y_t, P_t its covariance matrix, $a_{t|t-1}$ the estimator based on the information available in t-1 and $P_{t|t-1}$ its covariance matrix.

The predicted estimate of A_t is $a_{t|t-1}$, and is defined by[13]:

$$a_{t|t-1} = T_t a_{t-1} \tag{5}$$

With a covariance matrix defined as: $P_{t|t-1} = T_t P_{t-1} T_t' + Q_t$.

The filtered estimate of A_t is at and is updated from $a_{t|t-1}$ when Y_t is:

$$a_t = a_{t|t-1} + P_{t|t-1} Z'_t F^{-1}_t (Y_t - Z_t a_{t|t-1}) \tag{6}$$

where $F_t = Z_t P_{t|t-1} Z'_t + H_t$ and $P_t = P_{t|t-1} - P_{t|t-1} Z'_t F^{-1}_t Z_t P_{t|t-1}$.

The smoothed estimate of A_t is $a_{t|T}$, and is updated from a_t using the whole set of information available:

$$a_{t|T} = a_t P^*_t (a_{t+1|T} + T_{t+1} a_t) \tag{7}$$

[13] See Olivier Basdevant (2003).

The smoothed estimates are calculated working backwards from the last value of the filtered estimate with

$P^*_t = P_t T'_{t+1} P^{-1}_{t+1|t}$.

$P_{t|T} = P_t + P^*_t (P_{t+1|T} + P_{t+1|t}) P'^*_t$, $a_{T/T} = a_T$ and $P_{T/T} = P_T$.

Equations (5) to (7) are the Kalman Filter.

To our knowledge, state space model has not been used to analyze the relationship between exchange rate and openness. A few exceptions are Lopez-Villavicencio and Saglio (2014) who analyze whether trade and financial openness has weakened the inflation–output trade-off and caused a shift in the preferences of monetary authorities. There is also the study of Leon-Ledesma and Nogueira (2010) who use the state-space model to test whether the inflation environment affect the pass-through.

For our purposes, we estimate the following system of equations, where (8) and (10) are the measurement equations and (9) and (11) are the state equations:

For import price equation:

$$\Delta pm_t = \alpha + \Sigma\Phi \Delta pm_{t-i} + \beta \Delta s_t + \eta \Delta gdp_t + \theta \Delta cpi_t + \Omega \Delta oil_t + \varepsilon_t \quad (8)$$

$$\beta_t = \beta_{t-1} + \gamma \Delta open_t + \eta_t \quad (9)$$

For consumer price index equation:

$$\Delta cpi_t = \alpha + \Sigma\Phi \Delta cpi_{t-i} + \beta \Delta s_t + \eta \Delta gdp_t + \theta \Delta pm_t + \Omega \Delta oil_t + \varepsilon_t \quad (10)$$

$$\beta_t = \beta_{t-1} + \gamma \Delta open_t + \eta_t \quad (11)$$

Where Δ is the first difference operator, the import price (pm_t), the nominal effective exchange rate (s_t), the gross domestic product (gdp_t), the consumer price index (cpi_t), the oil price (oil_t) and the degree of openness ($open_t$). The openness variable is measured at the t moment. All variables are expressed in log.

In our model, precisely in Eq(9) and (11), the exchange rate pass-through is modeled as a function of its past value and of the degree of openness. This will allow us to test whether the degree of openness affects the exchange rate pass-through.

We first applied the Kalman Smoothing procedure to obtain time-series for the state variables. This procedure differs from the Kalman Filtering, since the first procedure uses all the information in the sample to provide smoothed estimates of the states and variances, while the second procedure uses only the information available up to the beginning of the estimation period[14].

To test whether the degree of openness affects the exchange rate pass-through, we then use a Wald test for the null hypothesis H_0: $\gamma = 0$ in Equation (9) and (11), implying that the degree of openness does not affect the exchange rate pass-through. The Wald test follows the traditional $\chi 2$ distribution.

2. Data description

Quarterly data were collected for four countries: France, Germany, Japan and the United-States. The data span from 1970:1 to 2013:4. However, for Germany, since data are not available before, the estimation period starts in 1991.

We use the import price of goods and services, the Gross Domestic Product (GDP) and the Consumer Price Index (CPI) from OECD's Main Economic Outlook. The nominal effective exchange rate (domestic currency per unit of foreign currencies) is obtained from the Bank of International Settlements (BIS). Oil prices are obtained from IMF's International Financial Statistics. Finally, our series of the degree of openness, which indicates the importance of international trade linkages for a country, corresponds to the sum of export plus import as percentage of the GDP.

[14] See Leon-Ledesma and Nogueira (2010).

The choice of these variables is explained by their relationship with the imports and consumer prices. We expect a negative relationship with exchange rate and a positive relationship with consumer price index and oil.

IV. Results

We first summarize the results of the exchange rate pass-through on imports and consumer prices in Table1[15]. The results are obtained by applying OLS to Eq. (8) and Eq. (10).

On the import side, the estimation results show that the coefficients of the exchange rate pass-through are statistically significant with expected signs for all cases, except for France. Indeed, for France the pass-through coefficient is not significantly different from zero, maybe indicating that import prices are not sensitive to exchange rate.

The results presented in Table 1 show that there is a negative relation between import prices and exchange rate changes. These results indicate that depreciation (appreciation) of exchange rate increase (decrease) import prices. For instance, according to Table1, we find that a 1 per cent appreciation of nominal effective exchange rate leads to a 0.97 percent decrease in import prices for Germany. Therefore, as expected, the appreciation of the domestic currency reduces the price of import goods.

As seen, the response of import prices to movements in the exchange rate is statistically significant, but the degree of sensitivity varies across countries. In particular, the estimated coefficient for the United-States is significant but under 0.3; while the coefficient for Germany and Japan exceeds 0.7. These results suggest that a 1 % nominal effective depreciation of the US dollar would raise the price of their imports about 0.3% in terms of

[15] More complete estimation results can be found in Table3 in the Appendix.

their own currencies. A similar decline in the German or Japan exchange rate would increase their import prices more than 0.7%.

Hence, the average elasticity to exchange rate changes is considerably higher for Germany and Japan than in the United-States.

Note also that in our study we find that the average of the exchange rate transmission into the aggregate import prices is equal to 0.65%. In other words, a one percent increases in the rate of depreciation of domestic currency raise the import prices by 0.65 percent in average in the countries of our sample. Our estimates of exchange rate pass-through are in line with estimates in the literature of exchange rate pass-through into import prices for industrialized countries; such as Bailliu and Fujii (2004).

Regarding consumer price regressions, the estimation results show that the coefficients of the nominal exchange rate pass-through are statistically insignificant in most cases, except for Japan. Indeed, for this country, we are able to reject the null hypothesis that exchange rate pass-through does not affect the CPI. Moreover, the coefficient has the expected negative sign.

According to Table1, a 1% depreciation of the nominal exchange rate increases consumer prices index by around 0.65% in Japan.

Note also that for the case of Japan, the exchange rate pass-through to import prices is higher compared to exchange rate pass-through to consumer prices. This result is consistent with theory. Indeed, as suggested by some studies, for instance Faruqee (2006) and Sek and Kapsalyamova (2008), it can be expected that exchange rate pass-through to import prices is higher compared to exchange rate pass-through to consumer prices.

Bailliu and Fujii (2004) provide some reasons which may explain why the rate of pass-through to consumer prices is relatively smaller than that to import prices. Indeed, according to Bailliu and Fujii (2004), the degree of pass-through to import price is larger since the

import price is driven entirely by prices of tradable goods, whereas consumer price index is driven by a combination of domestically produced, imported goods and the price of services. Therefore, the extent of pass-through to consumer price will depend on the rate of pass-through to import prices, the share of imports in the consumer price index, and the response of domestically produced goods to movements in the exchange rate.

To sum-up, according to our result, exchange rates have no effect on domestic price inflation for the most cases of our sample, while import prices have a stronger effect. Furthermore, our results are in line with several studies which found that the exchange rate pass-through is low in the United-States, in terms of import and consumer prices (see Gagnon and Ihrig, (2004); Ca' Zorzi, Hahn and Sánchez (2007)). Moreover, we found exchange rate pass-through higher in the euro area than in the United-States, both for consumer and import prices, as has been suggested in literature (Ca' Zorzi, Hahn and Sánchez (2007)).

Table1: Pass-Through Estimation

	Response of Consumer Prices to 1 Percent Exchange Rate Shock (percent)		***Response of Import Prices to 1 Percent Exchange Rate Shock (percent)***	
	coefficient	***p-value***	***coefficient***	***p-value***
France	-0.009	0.207	-2.146	0.513
Germany	-0.011	0.497	-0.976	0.000*
Japan	-0.659	0.000*	-0.738	0.000*
United-States	-0.021	0.162	-0.255	0.001*

Note: (1) * Indicates statistical significance at the5%level; (2*)* the null hypothesis is H_0: $\beta = 0$ in Equation (8) and (10).

In order to analyse whether the degree of openness affects the exchange rate pass-though, we proceed to the estimation of Eq. (9) and Eq. (11) in a state space model.

There is widespread agreement that openness increased for both industrial and emerging market economies since the early 1990s, reflecting the acceleration in globalization. This

observation is verified by looking at Figure 1 in the Appendix. The figures show that the four countries under study have become more open, especially in the last decade. As we mentioned before, the widespread assumption is that there is a positive a connection between openness and pass-through: the more a country is open, the more import prices respond to exchange rate fluctuations. We test this hypothesis by means of a Wald test for the null hypothesis that the degree of trade openness does not affect the ERPT. These results are presented in Table2[16].

Table 2: State space model for the pass-through: p-value associated to the Wald test for causality

	CPI		***Import Price***	
	coefficient	***p-value***	***coefficient***	***p-value***
France	-0.009	0.437	4.743	0.549
Germany	-0.023	0.453	0.226	0.620
Japan	0.068	0.024*	0.070	0.004*
United-States	-0.135	0.279	-0.11	0.901

Note: (1) The null hypothesis in the Wald test is H_0: $\gamma = 0$ in Equation (9) and (11).

Regarding the CPI equation, the results presented in Table 2 show that the association between CPI-pass-through and openness is not statistically significant for all countries in our sample, except for Japan.

Indeed, according to the p-value, we cannot reject the null hypothesis that openness does not affect the exchange rate pass-through for the case of Germany, United-States and France. In other words, the degree of openness does not have an effect on exchange rate pass-through to CPI for these countries. Therefore, contrary to previous studies that suggest that the degree of openness has an effect on the pass-through, our results do not confirm the existence of this

[16] More complete estimation results can be found in Table4 in Appendix.

relationship. Our results are consistent with some studies such as Ca' Zorzi et al. (2007); Choudhri, Faruquee and Hakura (2005) and Gagnon and Ihrig (2004). Indeed, as we mentioned above, these authors found no statistical link between pass-through to consumer prices and openness.

However, this finding is not valid for the case of Japan. Indeed, according to the results in Table 2, we note that the null hypothesis that openness does not affect the exchange rate pass-through can be rejected at the 5% critical level. This result indicates that, for the case of Japan, openness affect the exchange rate pass-through. Moreover, the coefficient is found positive meaning that more openness implies a higher pass-through elasticity.

As we mentioned above, the most expected result about the relation between exchange rate pass-through and openness is a positive relation. The larger the degree of openness, the greater the pass through would be (Soto and Selaive (2003)). Therefore, our result is consistent with this expected result and then with some studies such as Goldfajn and Werlang (2000) and McCarthy (2007). This result can be explained by the fact that Japan has an economy strongly dependent on the external sectors. Therefore, Japan has a large presence of exports in his economy, which makes it more vulnerable during an exchange rate changes.

Looking at the results for import prices, there is an overwhelming lack of evidence that the degree of openness can affect the exchange rate pass-through for the case of Germany, France and United-States. Indeed, according to the p-value, we are not able to reject the null hypothesis that openness does not affect the exchange rate pass-through. To summarize, we find no evidence of strong association between pass-through into import prices and degree of trade openness for these countries. Our results are in line with the study of McCarthy (2007). Indeed, he finds no evidence of a statistically significant positive relationship with exchange rate pass-through to import prices.

Unlike the others countries in our sample, the results for the case of Japan show that the null hypothesis that openness does not affect the exchange rate pass-through can be rejected.

Therefore, for Japan, the results show that the degree of openness affects the exchange rate pass-through.

Moreover, the result shows that the relationship between openness and exchange rate pass-through is positive. This result implies that more openness implies a higher pass-through elasticity. This result is consistent with those obtained for the estimation of consumer prices index. Furthermore, our result is consistent with some studies such as Campa and Gonzalez (2002).

Overall, we can conclude that the evidence of a correlation between pass-through and openness seems to be nonexistent for the most countries of our sample. Therefore, in our study, we had no evidence that the openness was able to cause the pass-through for the case of France, Germany and United-States.

One potential explanation is that a high degree of openness means a large share of imported goods and thus a high pass-through. By cons, it also means that there are many foreign companies in the local market and thus strong competitiveness between local and foreign firms. Thus, in order to maintain their market share, foreign firms could reduce their mark-up, leading therefore to a lower pass-through. In fact, as suggested by Gust, Leduc, and Vigfusson (2010), globalization leading to high share of traded goods and the large share of imported goods would induce a fall in pass-through. Thus according to them, the higher trade integration has reduced the market power producers at home, which require them to reduce their profit margins. Thus, the relationship between openness and the exchange rate pass-through is not clear enough which could explain these results. Moreover, as we mentioned above, there are no conclusive empirical results in the literature about this relationship. For instance, Barhoumi (2006) finds a positive correlation of pass-through-openness, while

McCarthy (2007) shows that association is not particularly strong for exchange rate pass-through to consumer prices, but there is no evidence that countries with larger import share have a greater exchange rate pass-through to import prices.

According to these arguments, it is not surprising to find no evidence of relationship between exchange rate pass-through and the degree of openness.

As suggested by some authors, such as Gust, Leduc, and Vigfusson (2010) and Gagnon and Ihrig (2004), the pass-through to import or consumer price indexes has declined recently. Then, to explore whether the exchange rate pass-through has changed over time, we applied the Kalman Smoothing procedure to obtain time-series for the state variables. Figure 2 and Figure 3 plot the smoothed exchange rate pass-through estimates, together with ± two standard errors.

In Figure 2, the plots show that in accordance with the previously mentioned literature, the exchange rate pass-through has indeed declined over time in the case of United-States and Germany. For Germany, a relatively sharp fall is observed in the early 1990s. Furthermore, the estimated coefficient is statistically insignificant at the beginning of the sample period. However, for Japan, there is a sharp fall in the mid 80s and then the estimated coefficient becomes statistically insignificant. On the other side, in France, the exchange rate pass-through is not significant all along the period.

According to Figure 3, the smoothed plot illustrates a decline of exchange rate pass-through for the case of Germany and United-States. These results are in line with the previous literature (e.g Gagnon and Ihrig (2001); Gagnon and Ihrig (2004)). For Germany, the exchange rate pass-through has indeed declined over time, although the coefficient becomes statistically significant from 2000s. For United-States, the figure shows that the exchange rate

pass-through becomes statistically significant from the end of 2000s. The figure shows also that from this date the exchange rate pass-through has fallen sharply.

While, for Japan, the decline is strongly observed in the mid 80s and thereafter the coefficient estimated becomes statistically insignificant. However, for the case of France, the pass-through is not significant all along the period.

To summarize, our results show the decline in exchange rate pass-through, for some countries in our sample, as has been suggested by the literature (e.g Marazzi et al. (2005) and Gagnon and Ihrig (2004)). However, this decline occurs in different periods.

The issue of whether exchange rate pass-through has declined is an important one for central banks because a decline in pass-through would imply that movements in the exchange rate have smaller effects on consumer prices and, hence, on short-run inflation.

Figure2: State space estimated coefficient in Import Price equation: exchange rate pass-through

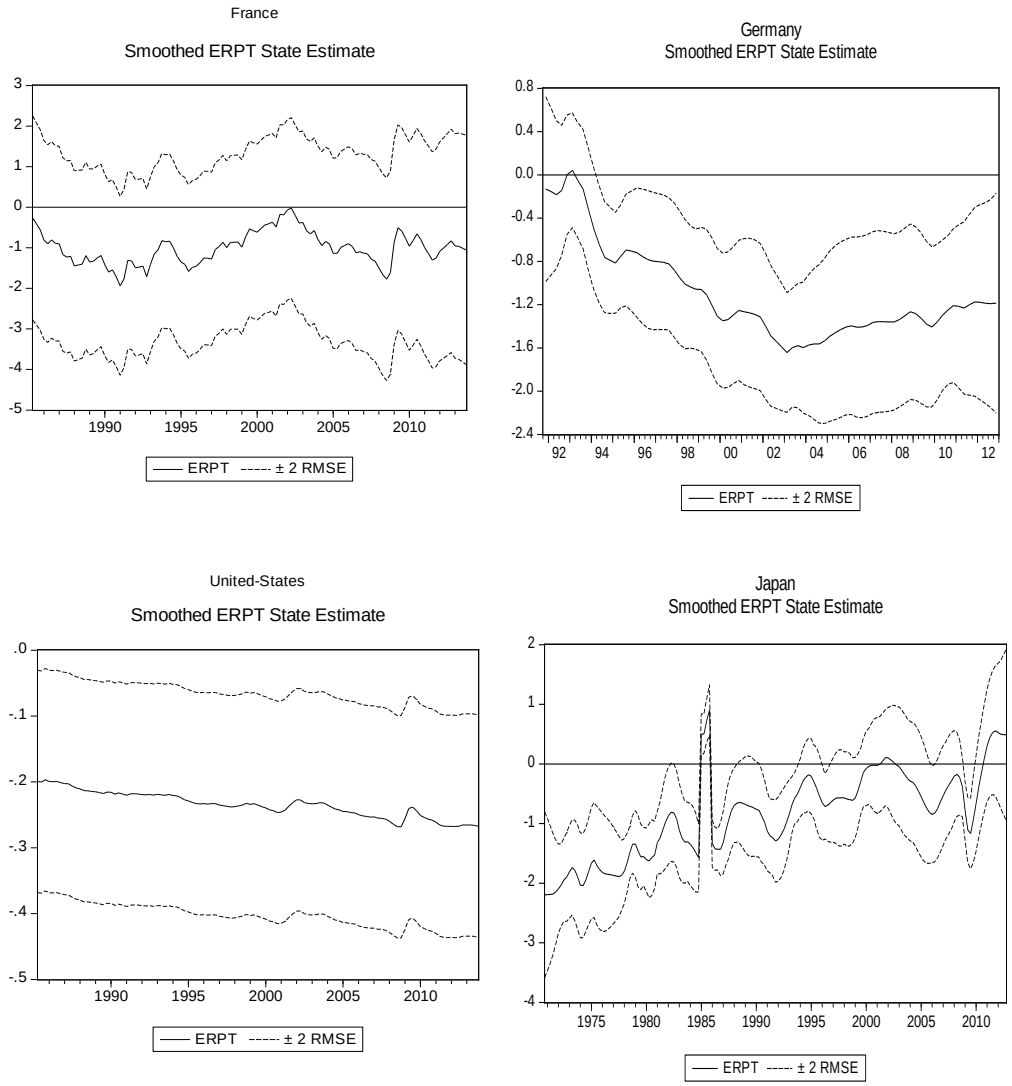
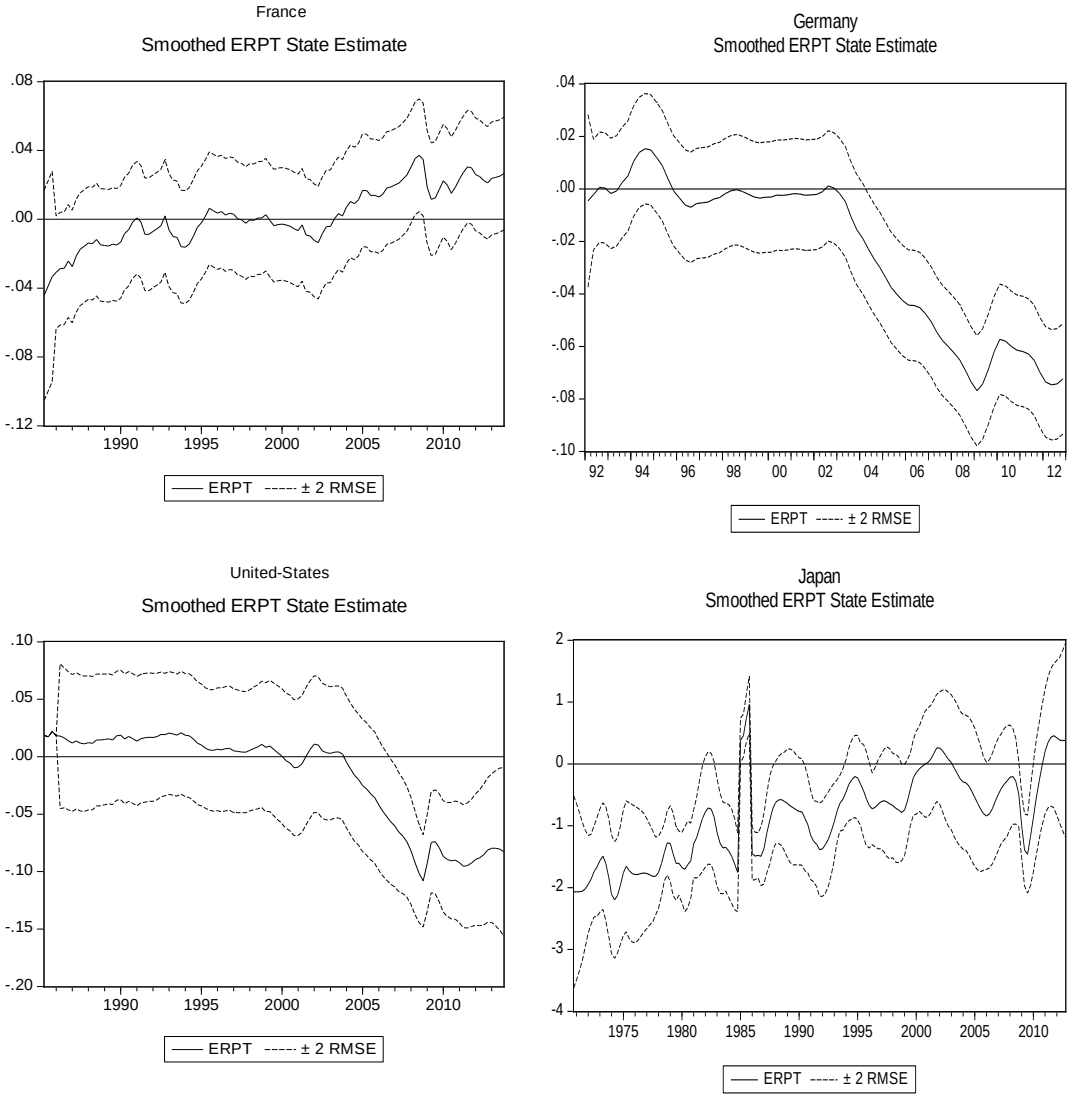


Figure3: State space estimated coefficient in CPI equation: exchange rate pass-through



V. Conclusion

A number of empirical studies have examined the relationship between openness and exchange rate pass-through, but the results are somehow ambiguous. In fact, the most immediate connection between these two variables is positive. This means that the less open the country is, the lower is the pass-through from exchange rate to import prices. However, if we take into account that inflation could be negatively correlated with openness, this could imply the existence of an indirect connection moving in the opposite direction.

This paper examined the relationship between openness and the exchange rate pass-through into import prices and CPI for a sample of 4 advanced countries during the 1970q1-2013q4 period. To this end, we used the state-space model.

Our results show that, for the most countries of our sample, the degree of openness does not affect the exchange rate pass-through. Indeed, according to our results, there is no evidence that openness can affect exchange rate pass-through.

Nevertheless, for the case of Japan, the relation between openness and exchange rate pass-through appears to be existing. Indeed, according to our result, we find that the rate of pass-through is positively correlated with the openness of Japanese economy.

A large economic literature has identified various explanations why exchange rate pass-through to import and consumer prices decline. Among these explanations, we found the degree of openness. Nevertheless, our study found no evidence of a relationship between openness and pass-through to import price and CPI for the most countries of our sample. Thus, according to our results, the decline in pass-through is not necessarily due to the evolution of the degree of openness.

Moreover, according to our results, we find that exchange rate pass-through decline, but this decline occurs in different periods. However, we find no evidence that exchange rate pass-through has been declining over time for all countries of our sample.

It should be noted that the differences in the exchange rate pass-through results in studies may be due to different estimation periods and differences in definitions of pass-through, as well as to different frequency of the data (monthly and quarterly).

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Appendix

Figure1: Openness degree

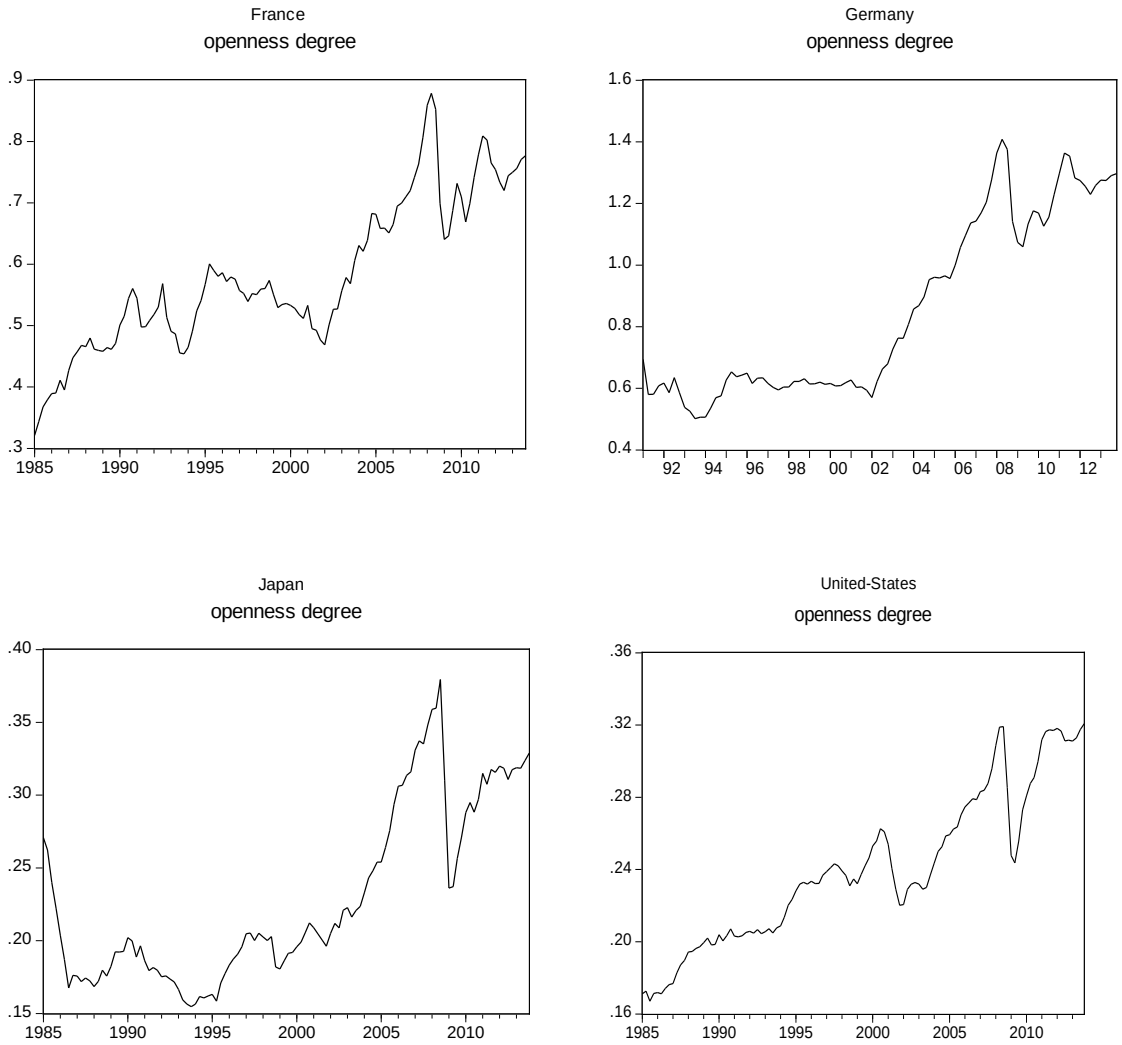


Table A: The unit root test

	Augmented Dickey Fuller test							
	ppi	**gdp**	**neer**	**cpi**	**P_M**	**P_X**	**openness**	**oil**
France	0.341824 (-2.888157)	-2.195244 (-2.888157)	-2.011703 (-2.887909)	-2.306492 (-2.889753)	-1.537299 (-2.888157)	-1.968638 (-2.887909)	-2.023064 (-2.888157)	-0.233420 (-2.888157)
Germany	-0.635653 (-2.895512)	-1.642446 (-2.895512)	-2.147058 (-2.895512)	-2.509284 (-2.895109)	-0.518636 (-2.895512)	-0.649003 (-2.895512)	-0.551613 (-2.895512)	-0.271598 (-2.895924)
United-States	0.695043 (-2.888157)	-2.548546 (-2.887909)	-0.863887 (-2.887665)	-2.021865 (-2.887665)	-1.159144 (-2.888157)	-1.735944 (-2.888157)	-1.565420 (-2.888157)	-0.233420 (-2.888157)
Japan	-2.581528 (-2.887909)	-2.556802 (-2.887665)	-2.210106 (-2.888411)	-2.209750 (-2.888669)	-1.082457 (-2.887909)	-1.408102 (-2.887909)	-0.796528 (-2.888157)	-0.233420 (-2.888157)

Note: The values in the bracket are the critical value at the 5% level

Tables 3: Results for OLS Estimation

	Import Price: France	
	coeff	***p-value***
P_{Mt-4}	-0.490	0.000*
cpi_t	-1.677	0.073**
gdp_t	1.351	0.051*
oil_t	0.043	0.826

Note: (1) *, ** Indicate statistical significance at the5% and 10% level respectively

	Consumer Price Index: France	
	coeff	***p-value***
cpi_{t-1}	1.305662	0.000*
cpi_{t-2}	-0.410102	0.000*
gdp_t	0.072882	0.000*
PM_t	-0.000129	0.427
oil_t	0.000896	0.058*

Note: (1) * Indicates statistical significance at the5%level.

	Import Price: Germany	
	coeff	***p-value***
P_{Mt-1}	0.479	0.000*
cpi_t	-2.465	0.000*
gdp_t	1.895	0.000*
oil_t	0.136	0.000*

Note: (1) * Indicates statistical significance at the5%level.

	Consumer Price Index: Germany	
	coeff	***p-value***
cpi_{t-1}	0.839685	0.0000*
gdp_t	0.104391	0.0006*
PM_t	-0.017044	0.0105*
oil_t	0.007914	0.0003*

Note: (1) * Indicates statistical significance at the5%level.

	Import Price: Japan	
	coeff	***p-value***
P_{Mt-1}	0.004	0.073**
cpi_t	-0.979	0.000*
gdp_t	1.902	0.000*
oil_t	0.040	0.001*

Note: (1) *, ** Indicate statistical significance at the5% and 10% level respectively.

	Consumer Price Index: Japan	
	coeff	***p-value***
cpi_{t-1}	0.002	0.055*
gdp_t	1.870	0.000*
PM_t	-1.014	0.000*
oil_t	0.045	0.000*

Note: (1) * Indicates statistical significance at the5%level.

	Import Price: United-States	
	coeff	***p-value***
P_{Mt-1}	0.401	0.000*
cpi_t	0.508	0.099**
gdp_t	1.169	0.000*
oil_t	0.087	0.000*

Note: (1) *, ** Indicate statistical significance at the5% and 10% level respectively.

	Consumer Price Index: United-States	
	coeff	***p-value***
cpi_{t-1}	0.286	0.000*
cpi_{t-3}	0.281	0.000*
cpi_{t-4}	0.217	0.000*
gdp_t	0.020	0.731
P_{Mt}	0.049	0.003*
oil_t	0.018	0.000*

Note: (1) * Indicates statistical significance at the5%level.

Tables 4: Results for State space model

	Import Price: France	
	coeff	***p-value***
P_{Mt-4}	-0.474	0.000*
cpi_t	-1.656	0.061**
gdp_t	1.357	0.583
oil_t	0.058	0.918

Note: (1) * Indicates statistical significance at the5%level.

	Consumer Price Index: France	
	coeff	***p-value***
cpi_{t-1}	1.289	0.000*
cpi_{t-2}	-0.391	0.000*
gdp_t	0.071	0.000*
PM_t	-0.00001	0.762
oil_t	0.0009	0.027*

Note: (1) * Indicates statistical significance at the5%level.

	Import Price: Germany	
	coeff	***p-value***
P_{Mt-1}	0.425	0.000*
cpi_t	-2.199	0.000*
gdp_t	2.066	0.000*
oil_t	0.135	0.000*

Note: (1) * Indicates statistical significance at the5%level.

	Consumer Price Index: Germany	
	coeff	***p-value***
cpi_{t-1}	0.828	0.000*
gdp_t	0.125	0.000*
P_{Mt}	-0.017	0.008*
oil_t	0.007	0.000*

Note: (1) * Indicates statistical significance at the5%level.

	Import Price: Japan	
	coeff	***p-value***
P_{Mt-1}	-0.001	0.078**
cpi_t	-0.953	0.000*
gdp_t	2.339	0.000*
oil_t	0.024	0.000*

Note: (1) *, ** Indicate statistical significance at the5% and 10% level respectively.

	Consumer Price Index: Japan	
	coeff	***p-value***
cpi_{t-1}	0.003	0.063**
gdp_t	2.519	0.000*
P_{Mt}	-1.052	0.000*
oil_t	0.027	0.000*

Note: (1) *, ** Indicate statistical significance at the5% and 10% level respectively.

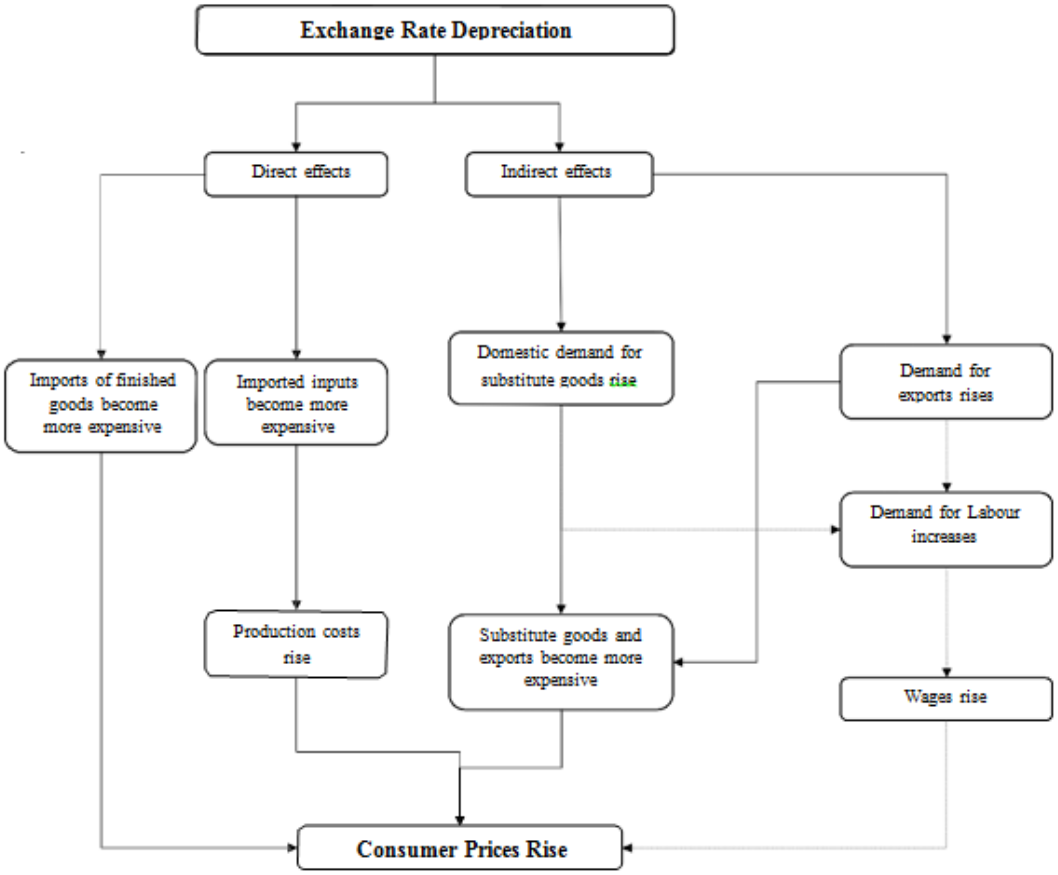
	Import Price: United-States	
	coeff	***p-value***
P_{Mt-1}	0.334	0.000*
cpi_t	0.971	0.038*
gdp_t	1.184	0.000*
oil_t	0.078	0.000*

Note: (1) * Indicates statistical significance at the5%level.

	Consumer Price Index: United-States	
	coeff	***p-value***
cpi_{t-1}	0.395	0.000*
cpi_{t-3}	0.385	0.000*
cpi_{t-4}	0.001	0.037*
gdp_t	0.039	0.525
P_{Mt}	0.029	0.008*
oil_t	0.016	0.000*

Note: (1) * Indicates statistical significance at the5%level.

Figure2: Transmission mechanism of exchange rate depreciation to prices



Source: LAFLÈCHE (1996).

CHAPTER 4

Estimating Exchange Rate Pass-Through at the Disaggregated Level: an Empirical Analysis for Four Advanced Countries

Estimating Exchange Rate Pass-Through at the Disaggregated Level: an Empirical Analysis for four Advanced Countries

ABSTRACT

This paper examines the pass-through of exchange rate into import and export prices on disaggregated data for four advanced countries over the period 1999-2013. We find evidence of a significant exchange rate pass-through to import and export prices, both in the short and the long-run for the most sectors. However, our results confirm that the pass-through is incomplete in the short-run and different across industries. Furthermore, in the long-run, the exchange rate pass-through is high, although the estimated elasticity is still lower than unity, except for food products. In a second step, we assess the symmetry of exchange rate pass-through to import and export prices. In addition, our results show that the pass-through is asymmetric for the most sectors of our sample, with prices responding differently depending on the direction of the exchange rate variation. In particular, we find that appreciations are more passed through to export and import prices than depreciations.

JEL Classification: C32; F31; F40.

Keywords: Exchange Rate Pass-through; Import Price; Export Price; GMM; Disaggregated data.

I. Introduction

Pass-through of exchange rate movements into a country's import prices has been at the center of macroeconomic debate over the past two decades. As we mentioned before, exchange rate pass-through is defined as the percentage change in the local currency price of an imported good resulting from a 1 per cent change in the nominal exchange rate between the exporting and importing countries.[17] A one-to-one response of import prices to exchange rate changes is known as complete exchange rate pass-through, while a less than one-to- one response of import prices to exchange rate changes is known as partial or incomplete exchange rate pass-through.

Whether exchange rate pass-through is incomplete or pervasive, it is expected that an appreciation of the currency reduces import prices and conversely in case of depreciation (Krugman (1987); Varangis and Duncun (1993); Tivig (1996)). In fact, theoretically, depreciation of the home currency leads to an increase in import prices in terms of the home currency. Therefore, price of imports in the home country currency raises leading to a reduction in the domestic demand for imports. This implies that exporters' market share will decline. Yet in order to avoid losses their market share, exporters adjust their mark-ups. This implies an incomplete exchange rate pass-through.

According to the literature, exchange rate fluctuations impact prices through two channels: a direct channel and an indirect channel. The direct channel of pass-through runs via imported goods, which constitute a part of final consumption. The indirect channel, in turn, is via imported inputs and intermediate goods for domestically produced products.

[17] Bailliu and Fujii (2004).

This paper investigates the degree of exchange rate pass-through to prices of imports and exports across some selected sectors. The purpose of this study is twofold. The first objective of this paper is to estimate and analyze the responsiveness of import and export prices to exchange rate movements at disaggregate level for four advanced countries, namely, France, United-States, Japan and Germany. This will allow us to detect the sectors that are more sensitive to exchange rates changes. The second goal of this paper is to answer the question of whether or not foreign exporting firms behave the same way when their exchange rate is appreciated as compared to when it depreciates. The main idea in this case is to analyse whether there are sectors that can respond differently depending on the direction of the exchange rate variation.

As was explained in the first chapter, many theoretical as well as empirical researches on the exchange rate pass-through find that pass-through is incomplete and decline over time. A number of studies investigate why the exchange rate pass-through is incomplete (see Krugman (1987); Dornbusch (1987); Gagnon and Ihrig (2001); Ihrig et al. (2006); etc...). In this literature, there are several explanations for incomplete exchange rate pass-through, such as, the market and industry characteristics, market power and imperfect substitutability between domestic substitute and foreign products, the existence of trade barriers, transaction and transportation costs and the weight of non-traded inputs in the wholesale[18].

Furthermore, several studies report evidence of a declining exchange rate pass-through.

Several explanations have tried to account for the decline in the exchange rate pass-through over time. For instance, Taylor (2000) explains this decline by the fact that firms become increasingly difficult to fully pass exchange rate movements on their export prices in the context of recent economic environment, characterized by intensified worldwide competitive pressure and low and stable inflation.

[18] For more explanations see Krugman (1987), Dornbusch (1987).

Overall we can conclude, from these studies, that the exchange rate pass-through is generally incomplete and decline over time.

As we mentioned above, an extensive literature has been developed on exchange rate pass-through. However, most of them are based on aggregate data. Nevertheless, recent empirical studies estimate the exchange rate pass-through with disaggregated data to incorporate the microeconomic behavior of firms exporting (Yang (1997); Knetter (1993); Campa and Goldberg (2002)).

The remainder of the paper is organized as follows. Section 2 briefly reviews the theoretical and empirical research on exchange rate pass-through to import and export prices at disaggregate data. Section 3 explains the estimation methods. The data and results are described in the section 4. The main empirical findings are summarized in the conclusion.

II. Literature review

It is well known that estimating exchange rate pass-through using aggregate price indices bears the disadvantage of overlooking exchange rate pass-through heterogeneity across products. As a result, the empirical work based on aggregate data may suffer problems from aggregation bias. This heterogeneity can be explained by firm in a different local region producing differentiated products, even within a narrowly defined product category or by the fact that the same company produces differentiated products in different regions[19]. For instance, Mumtaz, Oomen, and Wang (2006) show that not taking into account the sectoral heterogeneity leads to biased estimators. However, it is important to note that working with disaggregate data has a cost in terms of data frequency. Indeed, several studies which estimate

[19] See Yoshida (2008).

the exchange rate pass-through at disaggregates level suffer from limited coverage over time or a low level of disaggregation.

Most of the studies that dealt the exchange rate pass-through with disaggregated data agree that exchange rate pass-through is incomplete and varies across industries. For instance, Knetter (1993) uses a two-way fixed effects model to study the pricing to market behavior of US, UK, German and Japanese exporting firms using unit values of exports for rather disaggregated (seven digits) industries and finds more variation in the degree of exchange rate pass-through across industries than across countries.

Yang (1997) looks at exchange rate pass-through from the point of view of the exporter and studies US manufacturers across industrial sectors. He finds that the degree of pass-through is incomplete and varies across industries. The focus of his study is to test the market segmentation and the pricing power of firms.

Campa and Goldberg (2002) show that the exchange rate pass-through varies across industries. They also conclude that the major source of pass-through variations are competition issues in each sector.

Otani, Shiratsuka, and Shirota (2003) analyze six sectors, namely, food, raw materials, fuels, chemicals, textiles, metals and machinery. They provide evidence that the decline they observe in exchange rate pass-through come from a decline of exchange rate pass-through at the product category level.

Campa and Goldberg (2005) follow this trend of disaggregated estimation of pass-through to import prices. Their study covers 23 OECD countries. Manufacturing, energy, raw materials, food and non-manufacturing imports are the sectors considered in their study. They find evidence of incomplete exchange rate pass-through in the short run, mainly in the food and manufacturing sectors.

Most of these papers have been carried out to find the existence, both theoretically and empirically, of incomplete or perverse pass-through. Overall, these researches assume that pass-through rate is symmetric for appreciation and depreciation of a currency. This means, that the direction of the change in the exchange does not matter for the pass-through rate to prices.

Nevertheless, there are some studies that considered that pass-through could be asymmetric. This implies that degree of pass-through is affected by the direction of exchange rates changes, i .e. the pass-through varies depending if the currency of the importer (exporter) is appreciating or depreciating (Delatte and Lopez- Villavcencio (2012)). However, literature in this subject remains limited, especially at disaggregated date.

Using Japanese export data, Marston (1990) provides weak evidence for the asymmetric exchange rate pass through. He finds that appreciations have a larger effect for five out of 17 sectors.

In order to emphasize the role of the exporting firms' price setting behaviors, some studies chooses to focus more on a specific market. For instance, Goldberg (1995) used a discrete choice model to study the exchange rate pass-through in a single U.S. automobile industry. Kadiyali (1997) investigated the exchange rate pass-through in U.S. photographic film industry using a structural econometric framework. Both find significant asymmetry of exchange rate pass-through. They provide evidence that the exchange rate pass-through is higher when the dollar depreciates.

Mahdavi (2002) is interested in the possible asymmetry in pass-through to U.S. export industries. He found evidence of an asymmetric response in 7 of the 12 industries he studied but with no clear direction in the asymmetry. Olivei (2002) who also tests for asymmetries in the elasticity of US industries, found some degree of asymmetry for 9 of the 34 industries studied.

Pollard and Coughlin (2004) investigate the possible asymmetry in the pass-through to US import prices for 30 industries. They found evidence of asymmetric pass-through for more than half of the industries, and show that the direction of the asymmetry varies across industries.

Bussière (2007) contributes to the exchange rate pass-through literature by considering the presence of asymmetries and nonlinearities in the reaction of both import and export prices of G7 countries. He finds that a non-linear effect cannot be neglected, although the direction of the asymmetries and the magnitude of the non-linearity vary across countries.

Similarly, Yang (2007) had tested the asymmetry in pass-through to U.S. import prices at a disaggregated level. The author concludes that for some industries, appreciations are more passed through than depreciations while the contrary holds in other industries.

From the microeconomic point of view, several reasons can explain why export and import prices are not symmetric with the depreciation and appreciation of the home currency. Among the most important factors that could explain the asymmetry of exchange rate pass-through we find the degree of competition in which the exporter is faced in market destination. When exporters face strong competitiveness, then their market power diminishes and in order to maintain their market share, producers will accept to reduce their mark-ups and thus they will not fully pass-through exchange rate variations to prices. Therefore there is a negative relation between competition and exchange rate pass-through and in this case, the exchange rate pass-through is expected to be higher after after depreciation than an appreciation (in the exporter's currency).

Conversely, if exporters do not face much competition for their products the exchange rate pass-through will be higher after an appreciation than depreciation (Knetter (1993); Reinert, Rajan and Glass (2010); Delatte and Lopez- Villavcencio (2012)).

In the same vein, there is also a literature that suggests that the response of exporters to exchange rate variations may be asymmetric. Indeed, if the currency of the exporter depreciates, then the exporter's good will be relatively cheaper in the destination market. In this situation, exporting firm may engage in complete exchange rate pass-through. However, if the currency of the exporter appreciates, then the exporter's good will be more expensive in the destination market which leads exporters to reduce their export price to maintain their market share. The exchange rate pass-through will be incomplete (Pollard and Coughlin (2003)). The fact that exchange rate pass-through is incomplete in case of appreciations but (almost) complete in case of depreciations implies an asymmetric exchange rate pass-through.

The duration of the exchange rate variations is also an important determinant of the extent of the pass-through. Meurers (2003) found that, in the long-run, tend to be almost complete when the exchange rate shock persist. Conversely, if the exchange rate shock is temporary, then in order to maintain their market share, exporters may be accept to reduce their mark-up and thus they will not fully pass-through exchange rate variations to prices (Froot and Klemperer (1989)).

Exporters' capacity constrains is a second source of asymmetric responses. Indeed, if exporting firms face capacity constraints in their distribution networks, then exchange rate pass-through will be higher when the exporting country's currency is appreciating than when it is depreciating. Indeed, when the exporter country's currency depreciates, sales expressed in importer's currencies will decline. Then, in order to increase prices, exporters could increase their sales. However, if firms have already reached full capacity, the capacity of increasing sales is limited. In this case, they may be tempted to increase their mark-up instead of lowering prices in the importer's currency. Inversely, in the case of an appreciation the profits expressed in the importer's currencies will increase. Then, exporters can decide to keep their price level stable. Thus, the exchange rate pass-through is higher in the case of appreciation

than in the case of depreciation of the exchange rate (Pollard and Coughlin (2004) and Knetter (1994)).

In the existing literature we can identify others sources for asymmetric exchange rate pass-through such as mark-ups' importance, monetary policy, business cycle, production Switching ((Lopez and Antonio (2008)); Delatte and Lopez- Villavcencio (2012); Pollard and Coughlin (2003).

III. Empirical framework

As we mentioned above, the purpose of this papers is twofold. Firstly, to study the pass-through of exchange rate changes to import and export prices at disaggregated level. Secondly, to test whether the direction of a change in the exchange rate affects the pass-through. The basic idea is to test whether there are sectors that can respond differently depending on the direction of the exchange rate variation.

To this end, we opt for a dynamic specification and apply the Generalized Method of Moments (GMM), proposed by Arellano and Bond (1991); Arellano and Bover (1995) and Blundell and Bond (1998). The use of this methodology is due to the inclusion of the lagged dependent variable as an explanatory variable and to the potential endogeneity of some variables in the model. Indeed, according to the purchasing power parity (PPP) hypothesis, exchange rate may be considered as an endogenous variable in an equation relating exchange rate and prices. If this is the case, there could be a two-way causality between prices and exchange rate[20]. There are two types of GMM estimators: the difference GMM and the system GMM. The basic idea of difference GMM consists in taking the equation to be estimated in first-differences to remove unobserved time-invariant country-specific effects,

[20] The use of others traditional econometric methods such as OLS, tend give an inconsistent and biased estimators.

and then instrument the right hand side variables in the first-differenced equations using levels of the series lagged two periods or more, under the assumption that the time-varying disturbances in the original levels equations are not serially correlated[21]. Therefore, the Arellano-Bond (1991) estimation transforms all regressors by differencing, in order to eliminate the fixed effects and to correct the bias created by the presence of the lagged dependent variable as a regressor.

The difference GMM estimator is designed for situations with small T, large N panels, meaning few time periods and many individuals. However, some recent studies (Blundell and Bond (1998); Blundell, Bond and Windmeijer (2000)) found that the difference GMM estimator can have very poor finite sample properties in terms of bias and precision when the series are persistent and the number of time series observations is small. The reason is that, the instruments in those cases turn out to be weak instruments.

To improve the performance of the difference GMM estimator, Arellano and Bover (1995) and Blundell and Bond (1998) propose to estimate a system of equations formed by the equation in first-differences and the equation in levels; where the instruments used in the levels equations are lagged first-differences of the series. Under certain conditions of the initial observation (e.g. the first differences of instrument variables are uncorrelated with the fixed-effects) and when these conditions are satisfied, these instruments would be valid. Several authors (e.g. Blundell and Bond (1998) and Blundell, Bond and Windmeijer (2000)) showed that the resulting system GMM estimator performs much better than the difference GMM estimator, in terms of finite sample bias and mean squared error, since the instruments in the level equation are considered as good predictors for the endogenous variables even when the series are very persistent.

[21] See Bond et al. (2001).

Based on the previous considerations and given that our sample consists only of 4 countries (N = 4), we opt for system GMM estimator. However, for robustness, we also provide the estimation obtained from a pooled Ordinary Least Squares.

1. Dynamic panel data analysis

Considering this log-linear equation for import price index:

$$p_{Mt} = \beta_0 + \beta_1 e_t + \beta_2 cpi_t + \beta_3 gdp_t + \mu_t \quad (1)$$

where μ_t is an i.i.d process. β_1 refers to the direct effect of the exchange rate on the import price, β_2 represents the elasticity of import prices to consumer price index and β_3 refers to the direct effect of gross domestic product on the import prices.

The pass-through elasticity β_1 should, theoretically, take values between 0 and -1. Indeed, an increase in the nominal effective exchange rate corresponds to an appreciation in the domestic country currency, which should result in a decrease in import prices. When this parameter is equal to -1, then Exchange rate pass-through is complete. In this case, exporters let the domestic currency import prices affected by exchange rate change. Whereas, when $\beta_1 < -1$, the exchange rate pass-through will be incomplete, since exporters adjust their mark-up to keep their market share.

Regarding the case of export price index estimation the log-linear equation is as follows:

$$P_{xt} = \beta_0 + \beta_1 e_t + \beta_2 ppi_t + \beta_3 gdp_t + \mu_t \quad (1')$$

Where μ_t is an i.i.d process. β_1 refers to the direct effect of the exchange rate on the export price, β_2 represents the elasticity of export prices to producer price index and β_3 refers to the direct effect of gross domestic product on the export prices.

To investigate the exchange rate pass-through at disaggregate level we use the GMM method, as we mentioned above, for this, we modify our benchmarks pass-through equations (1) and (1') taking into account the fact that we have several countries to obtain the following dynamic panel data model:

For the case of Import Price Index:

$$\Delta p_{Mi,t} = \alpha_i + \beta_1 \Delta e_{i,t} + \beta_2 \Delta cpi_{i,t} + \beta_3 \Delta gdp_{i,t} + \sum_{j=1}^{2} \delta_j \Delta p_{Mi,t-j} + \mu_{i,t} \qquad (2)$$

For the case of Export Price Index:

$$\Delta px_{i,t} = \alpha_i + \beta_1 \Delta e_{i,t} + \beta_2 \Delta ppi_{i,t} + \beta_3 \Delta gdp_{i,t} + \sum_{j=1}^{2} \delta_j \Delta px_{i,t-j} + \mu_{i,t} \qquad (2')$$

where Δ is the first-difference operator, $\Delta p_{Mi,t}$ ($\Delta p_{xi,t}$ for the case of Eq.(2')) the rate of change in the relevant disaggregate price index for country *i* in time period *t*, α_i is a country-specific effect, $\Delta e_{i,t}$ is the rate of change in the nominal effective exchange rate for country *i* and time period t and $\mu_{i,t}$ is an independent and identically distributed error term. In our case, we include two lags of the dependent variable as explanatory variables[22].

In our dynamic specifications (2) and (2'), both the short run and the long run exchange rate pass-through are estimated. In fact, the immediate reaction of the exchange rate on import prices in Eq. (2) (and export prices in Eq. (2')) is given by the coefficient β_1. The long run pass-through, in turn, is the overall response of import (export) price to an exchange rate shock and it is defined as $\beta_1 / [1- (\delta_1 + \delta_2)]$.

[22] In our estimation two lags were necessary to remove autocorrelation in the residuals.

2. *Asymmetry of exchange rate pass-through*

The next important question is whether there are significant asymmetries in the exchange rate pass-through in selected sectors. Indeed, asymmetry pass-through implies that prices react differently to an exchange rate change (appreciation or depreciation). Therefore, we examine how changes in the exchange rate are transmitted to import and export prices in the periods of appreciation and depreciation. To address this issue, we follow the approach used in Pollard and Coughlin (2003) and we decompose the time series of nominal effective exchange rate into two series ($e_{i,t}^{+}$) and ($e_{i,t}^{-}$). Thus we set:

$A_{i;t}$ = *1 if* $\Delta ln\ (e_{i,t}) > 0$, *0 otherwise*

$D_{i,t}$ = *1 if* $\Delta ln\ (e_{i,t}) < 0$, *0 otherwise*

Therefore, the variable $A_{i,t}\ \Delta e_{i,t}$ and the variable $D_{i,t}\ \Delta e_{i,t}$ represent the accumulated sum of appreciation and depreciation episodes, respectively.

To test for asymmetry, we introduce into equations (2) and (2') an additional terms that capture the asymmetries. Only the data series relating to one of the episodes has to be included in the export and import price equation. In our case, we choose to include the series for appreciation episodes.

Hence, equation (2) and (2') take the following form:

For the case of Import Price Index:

$$\Delta p_{Mi,t} = \alpha_i + \beta_1 \Delta e_{i,t} + \beta_2 \Delta cpi_{i,t} + \beta_3 \Delta gdp_{i,t} + \sum_{j=1}^{2} \delta_j \Delta p_{Mi,t-j} + \beta_4 A_{i,t} \Delta e_{i,t} + \beta_5 A_t + \mu_{i,t} \qquad (3)$$

For the case of Export Price Index:

$$\Delta px_{i,t} = \alpha_i + \beta'_1 \Delta e_{i,t} + \beta'_2 \Delta ppi_{i,t} + \beta'_3 \Delta gdp_{i,t} + \sum_{j=1}^{2} \delta'_j \Delta px_{i,t-j} + \beta'_4 A_{i,t} \Delta e_{i,t} + \beta'_5 A_t + \mu_{i,t} \qquad (3')$$

Where A_t is a dummy variable equal to 1 for appreciations, 0 otherwise. The coefficients of interest are β_4 and β'_4. If these coefficients are significantly different from zero, then we can

conclude that there is asymmetry, otherwise, we cannot reject the null hypothesis of symmetry and we can conclude that appreciation has the same effect than depreciation on import or export prices.

In the above equations, if the asymmetry hypothesis is accepted, then the exchange rate pass-through coefficient are $(\beta_4 + \beta_1)$ and β_1 corresponding to appreciation and depreciation, respectively, for import price and $(\beta'_4 + \beta'_1)$ and β'_1 for export price.

IV. Estimation Results and Data Description

1. Data description

Our panel data set consists of quarterly observations for France, Germany, Japan and the United-States. The period of estimation corresponds to the interval that spans from 1999:1 to 2013:4. We use the Gross Domestic Product (gdp) and the Consumer Price Index (cpi) from OECD's Main Economic Outlook. The nominal effective exchange rate (e) (domestic currency per unit of foreign currencies) is obtained from the Bank of International Settlements (BIS). The producer price index (ppi) is obtained from the International Financial Statistics (IFS).

As we mentioned above, this study analyzes the exchange rate pass-through into import and export prices using disaggregated data. The disaggregated data for each country corresponds to the 0-digit level of disaggregation in the Standard International Trade Classification (SITC) for five different industry categories (except for textile sector which corresponds to 1-digit level). Sectors selected are namely food products (SITC 0); Mineral fuels (SITC 3); Chemical products (SITC 5), Basic manufactures (SITC 6); Machines and transport equipment (SITC 7); (see Table1). The choice of sectors is restricted by data availability.

The import and export prices indexes of food and chemical products are taken from OECD's Main Economic Outlook for all countries. Regarding import and export prices indexes of textile, mineral fuel and lubricants and machinery and equipments are obtained from Bank of Japan (BOJ), US Bureau of Labor Statistics (BLS), Federal Statistical Office Germany (FSO) and National Institute of Statistic and Economic Studies (INSEE).

All the variables are seasonally adjusted and we work with their logarithms. The choice of these variables is explained by their relationship with the imports and export prices. The choice of these sectors is supported by the availability of data for the four countries in our sample.

Table1: Sectors selected

	Industry category
STIC 0	Food products
STIC 3	Mineral fuel and Lubricants
STIC 5	Chemical Products
STIC 6	Textile
STIC 7	Machinery and Equipments

2. Results estimations

The pass-through estimates, both in the short and the long run, for the import and export price indexes are reported in Table 2 and 3, respectively[23]. As explained before, we use two estimation methods. Indeed, to verify the reliability of our GMM estimates, we provided also estimation results for the pooled OLS which, according to our results, provide close estimates to those obtained by the GMM methodology, confirming the robustness of our results in all cases; the exchange rate pass-through coefficients have the same sign and roughly the same magnitude.

[23] More complete estimation results can be found in Table6 and Table7 in Appendix 1.

To test the validity of instruments, two assumptions must be tested: the first one is that the instruments are exogenous; meaning, that they are not correlated with the errors in the first-differenced equation. This assumption is tested by the Sargan/Hansen test. The null hypothesis of this test is that the instruments are valid as such, (i.e. uncorrelated with the error term). On the other hand, a rejection of this null hypothesis could cast doubt on the validity of the instruments. The second assumption is that there is no second order autocorrelation in the first-differenced errors. To test the validity of this assumption, the *m*2 test for autocorrelation is used[24].

Table 2 and 3 reports the results of the Sargan test (validity of instrument) and the assumption that there is no second order autocorrelation in the first-differenced errors. The results show that these two specification tests support the validity of the instruments for the GMM estimations.

Regarding now the pass-through coefficient, we remind that an increase in the nominal effective exchange rate corresponds to an appreciation in the domestic currency, which should result in a decrease in import prices. This means, that theoretically, exchange rate pass-through coefficient is expected take a value between 0 and -1.

Looking at the estimation results for import price, the table shows that the exchange rate pass-through estimates present the expected negative and statistically significant coefficient both in the short and the long run, except for textile.

Firstly, a distinction between short- and long-run pass-through is necessary. Regarding the short-run estimates, the pass-through coefficients vary from 0.03 for chemical product to 0.11 for mineral fuel. For instance, a 1 per cent appreciation of nominal effective exchange rate leads to a 0. 06 and 0.05 per cent decrease in import prices for the case of food product and machinery and equipments respectively. Then, as we can see, the pass-through is incomplete

[24] The null hypothesis of this test is that there is no autocorrelation.

and relatively low in the short-run for all sectors of our sample. However, the magnitude of the pass-through coefficients varies across sectors.

Nevertheless, for textile sector, the pass-through coefficient is not significantly different from zero, suggesting that import prices are not affected by the exchange rate changes.

Turning now to the long-run estimates, as reported in Table 2, pass-through is incomplete in the long-run for all the sectors except for food products. Indeed, for this case, the pass-through exceeds 1. This implies that a one percentage depreciation in the exchange rate increases import prices by more than one percent, which implies a very strong reaction of import prices to exchange rate movements. The pass-through coefficients vary from 0.46 for machinery and equipments to 1.5 for food product. For example, a 1% change in the rate of depreciation leads to 0.65% increase in the import-prices in the case of mineral fuel. Thus, in the long-run, the transmission of exchange rate changes is relatively high but still incomplete for most cases.

In general, we can conclude that exchange rates changes affect the import prices for all sectors, except for textile, both in the short and the long-run. However, the magnitude varies across the sector. Our results show, likewise, that the sectors that are most sensitive to exchange rates changes are mineral fuel and food product. , The sectors that are less sensitive to exchange rates changes are, in turn, machinery and equipments and chemical product.

These results are in line with previous research. Indeed, we found that the degree of pass-through is much higher for more homogeneous product, such as mineral fuel, than for highly processed goods, such as machinery and transport equipment. According to Campa and Goldberg (2005), who estimate pass-through for five different product categories, the products that are less processed exhibit larger pass-through.

Finally, our results show that exchange rate pass-through is higher in the long-run than in the short-run.

For the export side, according to Table3, the results obtained via both GMM estimation and OLS method yield very similar results. Indeed, the magnitude of the coefficients is quite similar, ensuring the robustness of the results. As regards the Sargan test and the *m*2 test, the results of these two specification tests support the validity of the instruments for the GMM estimation.

As reported in Table3, the short-run pass-through coefficient is found negative and significant for all sectors. However, for all sectors, the coefficients of exchange rate are incomplete. Note that the evolution of the coefficients differs across product groups. Indeed, regarding the magnitude of the coefficient estimates, mineral fuel and food product are the highest at 0.11 and machinery and equipment and textile the lower (0.02 and 0.03, respectively).

As for long-term coefficients, the long-run elasticities are negative and significant for all sectors, except for textile. The elasticities differ also among the sectors; the lowest (and not significant) being for textile. On the other hand, food products, mineral fuel and chemical products show large estimates of 1.85, 0.95 and 0.69 respectively. This means that the export prices react strongly to exchange rate changes in these sectors.

Therefore, we observe clearly that the magnitude of long-run elasticity is larger than that of short-run elasticity, as expected. Nevertheless, it remains incomplete for some sectors.

The difference in magnitude of the pass-through coefficient across sectors can be largely due to sector specific factors such as the degree of (non) homogeneity of products, market concentration and competition.

One important finding in this study is that export prices increase due to depreciation and decline following an appreciation. Indeed, according to our results, in the long-run, a 1% nominal effective appreciation of the domestic currencies of countries in our sample leads to a 0.69 per cent decrease in export prices of chemical products, in term of their own currencies.

This result can be explained by the fact that following an appreciation, exporters can lose competitiveness and market share if they keep their prices unchanged in domestic currency. This explains why exporters generally use pricing to market in order to partially reduce the loss caused by the exchange rate appreciation. Indeed, according to Goldberg and Knetter (1997), the export firms try to reduce partially the impact of this appreciation by accepting to reduce their margin, therefore by lowering their prices in order to keep their market share.

On the contrary, in case of depreciation, exporters can gain in price competitiveness if they maintain their prices in domestic currency unchanged. In this case, they can increase the quantity of the exported goods. Nevertheless, if they reach their maximum capacity or if the adjustment costs are very high, it becomes difficult for them to adjust their production upwards and in this case they are pushed to increase their prices (Bussière (2007)).

Also, a country may be exporting the final good but, at the same time, importing the corresponding inputs from another country. A depreciation of the exporting country's currency makes the imported inputs more expensive. As such, an exchange rate change affects the exporter's costs, which leads the exporting firm to raise its prices (Ghosh and Rajan (2006)).

Estimates of Exchange Rate Pass-Through

Table2: Panel Pass-Through Estimates for Import Price

	GMM				OLS			
Industry category	***Short-run PT***	***Long-run PT***	***Sargan test***	***m2 test for autocorrelation***	***Short-run PT***	***Long-run PT***	***Adj R-squared***	***R-squared***
Food products	-0.061 [-2.10**]	-1.564 (0.000**)	0.323	0.350	-0.061 [-2.03**]	-1.564 (0.021**)	0.9939	0.9941
Mineral fuel and Lubricants	-0.114 [-1.68*]	-0.655 (0.045**)	0.842	0.209	-0.115 [-1.76*]	-0.751 (0.049**)	0.9996	0.9996
Chemical Products	-0.037 [-4.15***]	-0.637 (0.000**)	0.100	0.174	-0.032 [-1.89*]	-0.533 (0.090*)	0.9874	0.9877
Textile	-0.001 [-0.18]	-0.032 (0.989)	0.512	0.426	-0.001 [-0.12]	-0.032 (0.901)	0.9498	0.9509
Machinery and Equipments	-0.05 [-3.29***]	-0.467 (0.093*)	0.822	0.272	-0.043 [-1.97**]	-0.472 (0.038**)	0.9485	0.9496

Notes: 1. Short-run PT corresponds to β 1 and long-run PT refers to β 1 / [1- (δ1 +δ2)]. 2. The m2 test for autocorrelation has a null hypothesis of no autocorrelation, while Sargan test has the null hypothesis that model and over-identifying conditions are correct specified. 3. *,**,*** denotes significance at 10%, 5%, 1%. 4. The estimates are carried out using the Arellano-Bond one-step. 5. The figures in the brackets are the t-statistic testing the null hypothesis β 1=0.6. The figures in the parentheses are p-value which based on the null hypothesis of zero exchange rate pass-through,

Table3: Panel Pass-Through Estimates for Export Price

	GMM				OLS			
Industry category	***Short-run PT***	***Long-run PT***	***Sargan test***	***m2 test for autocorrelation***	***Short-run PT***	***Long-run PT***	***Adj R-squared***	***R-squared***
Food products	-0.115 [-1.86**]	-1.854 (0.000**)	0.200	0.163	-0.115 [-3.03***]	-1.854 (0.002**)	0.9894	0.9853
Mineral fuel and Lubricants	-0.117 [-3.55***]	-0.951 (0.041**)	0.384	0.230	-0.117 [-1.68*]	-0.951 (0.016**)	0.9779	0.9784
Chemical Products	-0.057 [-2.14**]	-0.695 (0.05*)	0.329	0.438	-0.057 [-2.37**]	-0.678 (0.022**)	0.9716	0.9723
Textile	-0.030 [-3.50***]	-0.211 (0.173)	0.654	0.483	-0.028 [-1.43]	-0.321 (0.141)	0.9268	0.9284
Machinery and Equipments	-0.027 [-3.94***]	-0.421 (0.000**)	0.052	0.516	-0.022 [-2.10**]	-0.354 (0.054*)	0.9369	0.9382

Notes: 1. Short-run PT corresponds to β 1 and long-run PT refers to β 1 / [1- (δ1 +δ2)]. 2. The m2 test for autocorrelation has a null hypothesis of no autocorrelation, while Sargan test has the null hypothesis that model and over-identifying conditions are correct specified. 3. *,**,*** denotes significance at 10%, 5%, 1%. 4. The estimates are carried out using the Arellano-Bond one-step. 5. The figures in the brackets are the t-statistic testing the null hypothesis β 1 =0.6. The figures in the parentheses are p-value which based on the null hypothesis of zero exchange rate pass-through, 7. Due to the lack of data the estimates of food products does not take into account the Japan.

Let us now pay attention to the asymmetric pass-through, the second objective of this study. Tables 4 and 5 present the results for asymmetry test and pass-through coefficients, respectively, while the full results are presented in Table 8 in the appendix.

Table 4: Test results for asymmetry

	Import price	***Export price***
	β_4	β'_4
Food products	*0.012*	*0.069****
Mineral fuel and Lubricants	*0.166*	*0.069*
Chemical Products	*-0.024*	*-0.084****
Textile	*-0.001*	*-0.052***
Machinery and Equipments	*-0.074***	*-0.032***

Note: 1. **,*** denotes significance at 5%, 1% level respectively.

Starting with export prices, the results presented in Table 4 show that the null hypothesis of symmetry in the response of export due to the exchange rate changes can be rejected for all sectors, except in the case of mineral fuel and lubricants sector. This means that, for these sectors, prices react asymmetrically to an appreciation that depreciation. However, for mineral fuel and lubricants sector, β'_4 is not significantly different from zero, implying that prices respond in the same way to an appreciation that a depreciation of the exchange rate.

The results also show that the coefficient β'_4 has a negative sign during appreciation episodes for the sectors of chemical products, textile and machinery and equipments.

This result indicates that appreciations may trigger a larger reaction than depreciations.

Conversely, for the sector of food product, β'_4 has a positive sign. This implies that appreciations may trigger a smaller reaction than depreciations. These results are confirmed by the results in Table5. Indeed, taking the example of machinery and equipments, the result show that appreciations have a larger effect than depreciations. Moreover, as seen, depreciations are not significant for the sectors of chemical products and textile.

As seen, the response of export prices to movements in the exchange rate varies across sectors. Regarding the magnitude of the coefficient estimates, mineral fuel is the highest at 0.121 and textile the lowest at 0.03, in the case of appreciation. This result is consistent with the results obtained from the symmetric estimation.

On the import's price side, the null hypothesis of symmetry is rejected only for machinery and equipments sector. Indeed, for this sector the result presented in Table 4 shows that import prices respond asymmetrically to exchange rate variation. Moreover, the coefficient β_4 has a negative sign during appreciation episodes. This implies that appreciation have a larger effect than depreciations on import price. This is confirmed by the result on Table 5; which appreciation has a greater coefficient (-0.036) than depreciation (-0.028).

However, for the others sectors of our sample, the import price respond symmetrically to exchange rate variation. This result would suggest that appreciations and depreciations have symmetric effects on import prices for these three sectors.

To summarize, we can conclude that most of the sectors of our sample, mainly for export price, adopt an asymmetric strategy depending on the direction of exchange rate change. We also document that export and import prices are more sensitive to an appreciation than to depreciation. This finding is consistent with the quantity constraint theory.

Table 5: Results of coefficients pass-through

	Import price	***Export price***
Food products	*-0.053***	*App :-0.045**** *Dep:-0.114***
Mineral fuel and Lubricants	*-0.148*	*-0.121***
Chemical Products	*-0.027***	*App : -0.091*** *Dep:-0.007*
Textile	*0.006*	*App : -0.038*** *Dep:0.014*
Machinery and Equipments	*App : -0.036**** *Dep:-0.028**	*App : 0.097*** *Dep:0.012***

Note: 1. *,**,*** denotes significance at 10%,5%, 1% level respectively.

To conclude, our main results can be summarized as follows. First, the transmission of exchange rate movements to import and export price is incomplete in the short run.

Second, in the long-run, the elasticities of pass-through are larger than in the short-run but for most sectors remains incomplete. The findings also show that the transmission of exchange rate changes to import and export price differs across sectors.

Finally, we provide evidence of asymmetric exchange rate pass-through to appreciations and depreciations, for the most sectors of our sample, mainly for export price. This means that for these sectors, export and import prices respond differently depending on the direction of the exchange rate variation. We also document that export and import prices are more sensitive to an appreciation than to depreciation. This finding is consistent with the quantity constraint theory.

V. Conclusion

This paper examines the pass-through of exchange rate into import and export prices based on disaggregated data for four advanced countries, using quarterly data over the period 1999-2013. To the best of our knowledge, no research has been done to measure exchange rate pass-through into import and export prices at the disaggregate level for the countries in our sample. This paper has estimated the short and long-run pass-through. We find evidence of a significant exchange rate pass-through to import and export prices, both in the short and the long-run for the most sectors.

The results obtained confirm that the pass-through is incomplete in the short-run and different across industries. Furthermore, in the long-run, the exchange rate pass-through is higher, although estimated elasticities are still lower than unity, except for food products.

Another interesting result of this study is the fact that the degree of pass-through has been much higher for more homogeneous product, such as mineral fuel, than for highly processed goods, such as machinery and transport equipment. This result is consistent with the empirical findings of Campa and Goldberg (2005).

The most striking result in this study is that export prices increase due to depreciation and decline following an appreciation. This latter result supports the idea that, in case of appreciation, exporters decide to compress their profit margins to offset the increase in the price of the good in the local currency for not to lose their market share. On the other hand, in case of depreciation exporters can increase their prices to gain more from this depreciation. This finding is consistent with the existing empirical literature, such as Goldberg and Knetter (1997) and Bussière (2007).

On the other hand, this paper has examined the case of possible asymmetries in the reaction of export and import prices to changes in the exchange rate at disaggregated level.

The results indicate first, that for most of our sectors, mainly for export price, we provide evidence of asymmetric exchange rate pass-through to appreciations and depreciations. This means that export and import prices respond differently depending on the direction of the exchange rate variation, although the direction of the asymmetries varies across the sectors.

Second, we find that appreciation is clearly more passed through to export and import prices than depreciations. This finding is consistent with the existing empirical literature, such as Pollard and Coughlin (2004).

References of Chapter 4

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Appendix

Table A: The unit root test

	Augmented Dickey Fuller test			
	France	**Germany**	**United-States**	**Japan**
ppi	-0.899192 (-2.913549)	-0.458496 (-2.913549)	-0.517965 (-2.912631)	-1.886915 (-2.912631)
gdp	-1.932438 (-2.911730)	-0.832918 (-2.911730)	-1.307695 (-2.912631)	-1.827997 (-2.912631)
neer	-1.397984 (-2.912631)	-1.318356 (-2.912631)	-1.639974 (-2.912631)	-1.302804 (-2.911730)
cpi	-2.208584 (-2.919952)	-0.193486 (-2.911730)	-1.421764 (-2.911730)	-2.580014 (-2.912631)
P_{M1}	-1.996199 (-2.912631)	-2.027162 (-2.912631)	-1.202984 (-2.915522)	-1.145582 (-2.911730)
P_{M2}	-1.991025 (-2.912631)	-1.482177 (-2.912631)	-0.722476 (-2.912631)	-1.128645 (-2.913549)
P_{M3}	-1.926627 (-2.911730)	-0.208279 (-2.912631)	-0.437580 (-2.913549)	0.994817 (-2.911730)
P_{M4}	0.277831 (-2.911730)	-0.234915 (-2.912631)	-0.473079 (-2.911730)	-0.580741 (-2.971853)
P_{M5}	-1.735819 (-2.912631)	-2.023027 (-2.917650)	-2.337330 (-2.911730)	-2.004239 (-2.914517)
P_{X1}	-2.404281 (-2.912631)	-2.082579 (-2.912631)	-1.561815 (-2.912631)	-0.890937 (-2.911730)
P_{X2}	-1.845556 (-2.912631)	-0.963448 (-2.912631)	-0.876642 (-2.912631)	-1.555989 (-2.911730)
P_{X3}	-1.787895 (-2.911730)	-0.404499 (-2.911730)	-0.921211 (-2.913549)	-0.527682 (-2.911730)
P_{X4}	-0.465842 (-2.915522)	-1.124420 (-2.912631)	-0.552562 (-2.912631)	-
P_{X5}	-1.907664 (-2.911730)	-1.447293 (-2.911730)	-2.333023 (-2.912631)	-1.306342 (-2.911730)

Note: (1) The values in the bracket are the critical value at the 5% level; (2) P_{M1}, P_{X1} correspond to import and export price for fuel; P_{M2}, P_{X2} correspond to import and export price for chemical product; P_{M3}, P_{X3} correspond to import and export price for textile product; P_{M4}, P_{X4} correspond to import and export price for food product and P_{M5}, P_{X5} correspond to import and export price for machinery and equipments.

Estimation Results for Equations (2) and (2')

Table6: Estimation Results for import price

	GMM				OLS			
Industry category	$\Delta p_{i,t-1}$	$\Delta p_{i,t-2}$	Δgdp	Δcpi	$\Delta p_{i,t-1}$	$\Delta p_{i,t-2}$	Δgdp	Δcpi
Food products	1.171***	-0.210***	0.106**	-0.004	1.171***	-0.210***	0.105**	-0.004
Mineral fuel and Lubricants	1.209***	-0.383***	0.890*	1.63	1.201***	-0.354***	0.109*	0.060**
Chemical Products	1.324***	-0.382***	0.070***	0.024***	1.323***	-0.383***	0.083***	0.026***
Textile	1.323***	-0.354***	0.031***	0.001	1.323***	-0.354***	0.031**	0.001
Machinery and Equipments	1.056***	-0.163	-0.045	-0.029***	1.067***	-0.158**	-0.037	-0.025***

Note: (1) *,**,*** denotes significance at 10%, 5%, 1% level respectively.

Table7: Estimation Results for export price

	GMM				OLS			
Industry category	$\Delta p_{i,t-1}$	$\Delta p_{i,t-2}$	*Δgdp*	*Δppi*	$\Delta p_{i,t-1}$	$\Delta p_{i,t-2}$	*Δgdp*	*Δppi*
Food products	1.219***	-0.281***	0.154**	0.005	1.219***	-0.281***	0.154***	0.005
Mineral fuel and Lubricants	1.225***	-0.102**	0.166	0.051	1.225***	-0.102***	0.167	0.051
Chemical Products	1.087***	-0.169***	0.088	0.038*	1.062***	-0.146**	0.091**	0.039***
Textile	1.246***	-0.388**	0.074*	0.027**	1.280***	-0.367***	0.054**	0.015**
Machinery and Equipments	1.011***	-0.075*	0.007	-0.007	1.017***	-0.079	0.005	-0.007*

Note: *,**,*** denotes significance at 10%, 5%, 1% level respectively.

Tables 8: Estimation results for asymmetric exchange rate pass-through

8.1 Chemical products

	Import price	*Export price*
	coeff	***coeff***
$\Delta p_{i,t-1}$	*1.33****	*1.059****
Δpi,t-2	*-0.384****	*-0.132****
Δgdp	*0.058****	*0.051*
Δcpi/ Δppi	*0.023***	*0.033***
Δneer	*-0.027***	*-0.007*
A_t	*0.11*	*0.376****
A_t ****(Δneer)***	*-0.024*	*-0.084****

Note: (1) **,*** Indicate statistical significance at the5% and 1% level respectively.

8.2 Fuel

	Import price	*Export price*
	coeff	***coeff***
$\Delta p_{i,t-1}$	*1.277****	*1.211****
Δpi,t-2	*-0.334****	*-0.253***
Δgdp	*0.146*	*0.13**
Δcpi/ Δppi	*0.064**	*0.041*
Δneer	*-0.148*	*-0.121***
A_t	*-0.802*	*-0.356*
A_t ****(Δneer)***	*0.166*	*0.069*

Note: (1) *,**,*** Indicate statistical significance at the 10%, 5% and 1% level respectively.

8.3 Food

	Import price	*Export price*
	coeff	***coeff***
$\Delta p_{i,t-1}$	*1.15****	*1.22****
Δpi,t-2	*-0.189****	*-0.281****
Δgdp	*0.10****	*0.172***
Δcpi/ Δppi	*-0.004*	*0.004*
Δneer	*-0.053***	*-0.114****
A_t	*-0.067*	*-0.329****
A_t ****(Δneer)***	*0.012*	*0.069****

Note: (1) **,*** Indicate statistical significance at the5% and 1% level respectively.

8.4 Machinery and equipments

	Import price	*Export price*
	coeff	***coeff***
$\Delta p_{i,t-1}$	*1.086****	*1.02****
Δpi,t-2	*-0.126*	*-0.057****
Δgdp	*0.012*	*0.02****
Δcpi/ Δppi	*-0.009***	*-0.003***
Δneer	*-0.028**	*0.129***
A_t	*0.335****	*0.142***
A_t ****(Δneer)***	*-0.074****	*-0.032***

Note: (1)*, **,*** Indicate statistical significance at the 10%,5% and 1% level respectively.

8.5 Textile

	Import price	*Export price*
	coeff	***coeff***
$\Delta p_{i,t-1}$	*1.308****	*1.28****
Δpi,t-2	*-0.342****	*-0.363****
Δgdp	*0.027***	*0.053****
Δcpi/ Δppi	*0.001*	*0.014****
Δneer	*0.006*	*0.014*
A_t	*-0.001*	*0.231***
A_t ****(Δneer)***	*-0.001*	*-0.052***

Note: (1) **,*** Indicate statistical significance at the5% and 1% level respectively.

CONCLUDING REMARKS

This thesis provides a macroeconomic analysis of the overall effect of exchange rate changes on the aggregate and disaggregated domestic prices over the last three decades, an issue of key importance for the conduct of monetary policy.

In fact, exchange rate fluctuations can have an effect on inflation and economic activity and hence are an important factor for monetary policy decisions. Therefore, a closer look at the degree and characteristic of the pass-through is necessary to evaluate, for instance, a possible inflation threat or, more relevant in recent times, a deflation threat[25].

Several studies have analyzed the degree of exchange rate pass-through from various aspects. Overall, the literature on exchange rate pass-through provides evidences that the exchange rate pass-through has declined in industrialized countries over time. Several potential explanations for this finding are advanced in the literature, including the shift to a low-inflation environment in industrialized countries. Indeed, there have been the changes in the monetary policy regimes which were perceived as being more credible than those carried out in the past. Similarly, the decline of exchange rate pass-through could be also explained by shifts in the composition of imported goods that have lower rates of exchange rate pass-through (Stahn (2009)).

Nevertheless, while there is evidence that pass-through rate has been declining over time in some countries this pattern of pass-through decline has not been a common feature of all OECD countries. For instance, Campa and Goldberg (2004), caution against the assumption that pass-through has been declining over time across all OECD countries. Indeed, they found

[25] Deflation in the importing country typically threatens foreign firms' profits through falling prices, resulting from weak domestic demand. Therefore, foreign firms become more vulnerable to cost fluctuations. Any cost changes, including those due to exchange rate movements, are easily reflected in their products and then in the import price. Thus exchange rate pass-through becomes higher (See Lin and Wu (2012) ,"Exchange rate pass-through in deflation: The case of Taiwan", International Review of Economics and Finance).

that exchange rate pass-through elasticites declined for only 15 of the 21 countries of their sample, and increased for the other 6 countries, such as Hungary and France.

Similarly, Fuentes (2007)[26] studies the ERPT to the price of imported goods for developing countries, among them Chile. The author finds that there is no evidence of decline over time.

Some studies of exchange rate pass-through assume that the decline in exchange rate pass-through to import prices could be associated with the rise of globalization. Intuitively, it is expected that the rate of pass-through is positively correlated with the openness of an economy. However, if we take into account that inflation could be negatively correlated with openness, and taking into account Taylor's hypothesis, then the relation between openness and pass-through becomes negative. Therefore, a high degree of openness implies a lower degree of pass-through. However, the relationship between these two variables is somehow ambiguous.

Furthermore, most of exchange rate pass-through papers have argued that the pass-through is incomplete. The result suggests that exporting firms absorb a part of exchange rate changes into their mark-ups. Incomplete exchange rate pass-through is a well-documented empirical regularity for many economies. The literature has suggested a number of potentially important factors in explaining incomplete pass-through. Dornbusch (1987) and Krugman (1987) justify incomplete pass-through as a result of firms' markup adjustment depending on market destination. Moreover, price rigidity and other dynamic factors have the potential to contribute to incomplete pass-through (Devereux and Engel (2002); Bacchetta and van Wincoop (2003)).

The empirical evidence also suggests that pass-through to imported goods is higher than pass-through to consumer prices. The differences in relative pass-through in import prices and

[26] Fuentes, M. (2007), "Pass-through to import prices: evidence from developing countries", Documentos de Trabajo 320, Instituto de Economia. Pontificia Universidad Católica de Chile.

consumer prices suggest that the roles of the retail sector and local distribution costs are important for price determination (Faruquee (2004)).

Furthermore, most studies assume that the pass-through has symmetric effects on import or export prices with respect to the direction of the change in the exchange rate. However, this finding is challenged by some studies, which considers that prices react differently to an exchange rate change; nevertheless, these studies remain scarce. Thus, the aim of our thesis is to contribute to this debate.

Hence, in our research we examine, inter alia, this possible asymmetry in the ERPT at the aggregated and disaggregated level by using relevant empirical methods. Moreover, assessing the extent of pass-through into domestic prices is important, given potential policy implications. This explains why, in our research, we estimate and examine the exchange rate pass-through to import prices, export prices and consumer prices. Moreover, our study has estimated short and long-run elasticities for four advanced countries.

Throughout the different empirical exercises, the main result of this thesis can be summarized as follows:

For the second chapter:

This paper has examined the case of possible asymmetries in the reaction of export and import prices to changes in the exchange rate, using quarterly data from 1985 to 2011.

In line with the bulk of the previous literature, we provide strong evidence of incomplete exchange rate pass-through to import and export prices in the short-run. However, the extent of pass-through varies across countries. Long-run elasticities are higher, although estimated elasticities are still lower than unity, except for the case of France (import price).

Second, we address the question of possible asymmetry of pass-through in appreciation and depreciation periods. To test for this effect, we divided the time series into appreciation and depreciation periods. The results obtained confirm that the asymmetric effects cannot be

neglected. Moreover, the direction of the asymmetries varies across countries. Nevertheless, in the long-run, the appreciation is clearly more passed through to export prices than depreciations. Therefore, our study provides clear support for the presence of asymmetry in the exchange rate pass-through.

It is important to note that our results provide another interesting finding. In fact, overall, we find that the coefficient of exchange rate pass-through is higher when we consider the asymmetry. Indeed, if we take into account the asymmetry, the long-run pass-through coefficient changes from 41% to 57% for the case of Japan and it becomes statistically significant when exchange rate appreciates for the case of France (import price). Similarly, for the case of Germany, the coefficient of pass-through increases from 13% to 14% (export price).This finding appears to contradict the studies which find that exchange rate pass-through decline, if they didn't consider the asymmetry. In fact, the finding of a declining exchange rate pass-through in previous studies may be due to the fact that the authors consider that prices react in the same way to an appreciation that a depreciation. Therefore, to not obtain misleading results, we should not be restricted to the symmetry assumption.

Likewise, our results indicate that exporter’s currency appreciation would decrease export prices. This result can be explained by the pricing strategy of exporters. In fact, in a situation with imperfect competition, exporters are willing to lower their prices by adjusting their mark-up to not lose market share.

For the third chapter:

In this paper we estimated and examined the exchange rate pass-through to import prices and consumer prices. The second aim of our paper is to study whether the degree of trade openness affects the exchange rate pass-through.

As it is the case in the previous chapter, the main findings show high, but incomplete, exchange rate pass-through into import price. However, the extent of pass-through varies

across countries. For instance, Germany has the highest degree of pass-through and close to one with 0.97%.

Our empirical evidence indicates also, that exchange rates have no effect on domestic price inflation for all cases of our sample, except for Japan.

Nevertheless, for Japan, our findings suggest that the exchange rate pass-through to import prices is higher compared to exchange rate pass-through to consumer prices. This result is in line with most empirical studies of exchange rate pass-through.

Regarding the relationship between openness and exchange rate pass-through, there is no significant role for the degree of openness, measured as the sum of export plus import as percentage of the GDP, expect for Japan. Thus, the evidence of a positive correlation between pass-through and openness appears to be weak.

Finally, our findings also indicate that pass-through from exchange rates to import price and consumer price has declined, although this decline has not been a common feature of all countries of our sample. Moreover, while, there is an apparent decline in pass-through for some countries, this decline occurs in different periods.

For the fourth chapter:

In the last chapter of this thesis, we estimate short and long-run elasticities of pass-through at the disaggregated level. In a second step, we analyze the pass-through in five manufacturing industries to determine if industries behave asymmetrically to exchange rate changes. In line with earlier studies, our results suggest that the degree of pass-through varies across industries.

For all industries, in the short run, exchange rate pass-through coefficients are smaller than one, meaning that exchange rate changes lead to variability in the firms' mark-ups. By contrast, in the long run, the pass-through elasticities are higher than short run and closer to one for mineral fuel and lubricants and exceed one for food products.

In addition, for the case of export price, we find evidence of asymmetric behavior in all industries of our sample except for mineral fuel and lubricants and the direction of the asymmetry varies across industries.

However, regarding import price, we found little evidence of asymmetry. Indeed, the findings suggest that only in the sector of machinery and equipments asymmetry is accepted.

Additional finding is that appreciation has a larger effect than depreciations for the most industries. Thus, export and import prices are more sensitive to an appreciation than to depreciation.

Moreover, we find that the pass-through coefficient is higher when we take into account the asymmetry, in the most cases. These results corroborate those of the Chapter 2. For instance, the pass-through coefficient changes from 0.05 to 0.09 for chemical products and from 0.02 to 0.09 for machinery and equipments (export price). Therefore not taking into account the asymmetry could, if they exist, may lead to misleading results.

Overall, according to our findings, we can say that exchange rate changes continue to lead to significant pressures on prices for our four advanced countries; however this pressure varies across countries and industries.

The main finding in our thesis is the asymmetry of pass-through. This result implies that prices respond differently to exchange rate changes and the direction of the asymmetry varies across industries. This finding has several important policy implications. Indeed, policymakers will face a dilemma as they try to pursue price stability and export competitiveness. They must take into account the direction of exchange rate changes (appreciation or depreciation) in order to determine the rules of appropriate monetary policy.

Moreover, according to our results, we found that exchange rate pass-through has declined but this decline is not common for all countries of our sample and that, for the most countries,

openness seems not to have an effect on the pass-through decline, as suggested in some studies.

We conclude by indicating some possible directions for future research. Future studies should investigate either macroeconomic or microeconomic variables which are more responsible for changes in pass-through. The coming results could help policy makers to adjust and control the price of imports in domestic market more effectively.

Another important subject for future research is to seek to more systematically explore what explains cross-country differences in the convexity of pass-through and quantify the different responses of the coefficients of pass-through according to different magnitude or duration of the appreciation/depreciation of the importer's currency at a more disaggregated level.

Moreover, it is also interesting to extend the analysis to a larger number of countries, mainly emerging countries.