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Trade Effects of Exchange Rates and their Volatility: Chile and New Zealand

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Abstract

Trade Effects of Exchange Rates and their Volatility Chile and New Zealand

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Trade deficits and surpluses are sometimes attributed to intentionally low or high exchange rate levels. The impact of exchange rate levels on trade has been much debated but the large body of existing empirical literature does not suggest an unequivocally clear picture of the trade impacts of changes in exchange rates. In addition, much of the evidence on this subject considers currencies of large economies, and overwhelmingly the United States.

This study examines the impact of exchange rates and their volatility on trade flows in two small, open economies – Chile and New Zealand – with three major trading partners, in two broadly defined sectors – agriculture on the one hand and manufacturing and mining on the other. It finds that exchange volatility impacts trade flows in the small, open economies more than was found for larger economies. Findings do not clearly indicate the direction of the impact, i.e. whether this volatility increases or decreases trade in all countries and sectors. Exchange rate levels, on the other hand, affect trade in both agriculture and manufacturing and mining sectors although their magnitude differs depending on the trading partner and sector. Moreover, this study indicates that a depreciation in the exchange rates in Chile and New Zealand would not lead to a strong change in their trade balances with three main trading partners across the board.

Keywords: Exchange rate, New Zealand, Chile, small open economies, Chilean peso, New Zealand dollar, volatility, trade, trade in agriculture, short-run effects, long-run effects, GARCH volatility, trade deficit, depreciation, currency movements, real exchange rate, exchange rate appreciation, exchange hedging.

JEL classification: F1, F31, O24, Q17

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Table of contents

Tables

Figures

Executive Summary

This paper examines the impact of exchange rates and exchange rate volatility on trade in two small, open economies – Chile and New Zealand. A companion paper examined this question in three large economies, China, the Euro area and the United States using the same methodology (see Huchet-Bourdon and Korinek, 2011). It is postulated that small countries' trade may be impacted differently than that of the three large economies previously analysed since they have smaller domestic markets, and are less cushioned from changes on international markets including exchange rate volatility. This study therefore examines the role of the exchange rate in the evolution of the bilateral trade of Chile and New Zealand with three large economies – China, the Euro area and the United States. In order to ensure strict comparability, the methodology and time period used here are the same as the study on the three large economies.

This study confirms previous findings (Evenett, 2010; Huchet-Bourdon and Korinek, 2011) suggesting that the level of exchange rate is only one factor that influences trade imbalances. Indeed, this study indicates that a depreciation in the exchange rates in Chile and New Zealand would not lead to a strong change in their trade balances with the three main trading partners.

This study finds that the two small economies' trade is impacted relatively more by exchange rate *volatility* than large economies. This finding is consistent with other studies and with the theoretical literature; however, the direction of the impact (i.e. increasing or decreasing trade) can go either way. There may be a number of reasons that trade in Chile and New Zealand is more heavily impacted by volatility in their exchange rates than are trade flows in China, the Euro area and the United States. Small, open economies have less room to adjust their exchange rates in the face of changes *vis-à-vis* large economies' currencies and their traders may therefore have to bear the full adjustment costs. Secondly, small economies, especially those with less diversified export structures find it more difficult to move into exports of products that are more price inelastic when an appreciating exchange rate makes their exports more costly. Thirdly, exporters may not be able to source their needs from the domestic market when their exchange rate depreciates, making imports of foreign intermediate goods more costly.

This study finds, furthermore, that in both countries exports respond less to exchange rate volatility than do their imports. One possible explanation for this finding may be that these countries are, in large part, commodity exporters and that their exchange rates often track the commodity prices of the goods they export.

It is difficult to generalize about the long-term impacts of exchange rate *levels* on trade in the two small, open economies. In both countries, not all elasticities are statistically different from zero, i.e. in a number of cases, there is no apparent relationship between changes in the exchange rate and trade flows. In other cases, however, the impacts can be significant.

Model results suggest that the level of exchange rate has a strong effect on New Zealand's exports with all three major trading partners in both broad sectors (agriculture and mining/manufacturing). A hypothetical 10% depreciation in the NZ dollar is estimated to lead to a 13.4% increase in agricultural exports of New Zealand to the Euro Area and a 16.6% increase in their non agricultural exports to the Euro Area. Similarly, it leads to an increase in exports to China in both sectors (7.3 % in agriculture and 11.6% in manufacturing and mining). Exports to the United States increase by 10.4% in agriculture, and 0% in the manufacturing and mining sectors (or 10.9% according to the alternative model specification).

Regarding the impact of the exchange rate on imports to New Zealand, a 10% depreciation in its currency does not produce robust results across its trading partners and broad sectors. A 10% depreciation of the NZ dollar is associated with no observed change in imports from China. Imports into New Zealand from the United States are also unaffected by a 10% depreciation in the NZ dollar in the manufacturing/mining sector, although imports in the agriculture sector are negatively and very strongly impacted. In the case of New Zealand – Euro area trade, long-term imports of New Zealand show an unexpected positive change regardless of the measure of volatility used.

The impact of the exchange rate on Chilean imports is highly dependent on the trading partner, the broad sector, and other elements such as the measure of volatility used. Imports from China and the Euro area are relatively unaffected by a 10% depreciation of the Chilean peso. Imports from the United States, however, are significantly affected by a depreciation in the peso. A 10% depreciation in the Chilean peso results in a potentially strong decrease in agricultural imports from the United States, and a 18-23% decrease in non-agricultural imports.

Perhaps the most surprising result, however, is the impact of a 10% depreciation in the peso on Chile's exports of mining/manufacturing products to China. A 10% depreciation in the peso induces a 9-12% *decrease* in exports to China in mining and manufacturing. China, a large importer of products of the extractive industries, has had a strong demand for certain raw materials during the period studied. Chile is the world's largest copper exporter, and among the largest exporters of molybdenum, lithium and some other raw materials. Copper accounts for 56% of its exports overall. A change in the price of copper may therefore impact the value of the Chilean peso. All else equal, the rising price of copper over the past few years, due in part to strong Asian demand, would have had an appreciative effect on the peso. Chinese demand for copper, however, continued to grow despite the increase in the price of copper, and as a result the value of its imports from Chile increased overall. An appreciation in the peso can thus be associated with an increase in the value of China's imports from Chile in the mining/manufacturing sector.

Many market fundamentals affect the relationship between the exchange rate and trade such as: the product composition of exports/imports; the price elasticity of each of the traded products; the country's market share of the product globally; the share of the good in the basket of exported/imported products; the import content of exports ; price transmission mechanisms in the product/country markets such as, for example, the degree to which traders can reduce their prices in order to absorb some of the price effects created by changes in the exchange rate; trade costs and their share in the traded price of the good; and the terms of the contract such as its duration and the currency in which it is denominated. All these factors are found to have a bearing on the aggregate results that are reported here. Many have opposite impacts on the relationship between the exchange rate and trade flows.

Trade Effects of Exchange Rates and their Volatility

Chile and New Zealand

I. Introduction

The Working Party of the Trade Committee has discussed a paper that examines the impact of exchange rate changes on bilateral trade in three large economies: China, the Euro zone and the United States (see OECD paper *To What Extent do Exchange Rates and their Volatility Affect Trade?* [TAD/TC/WP(2010)21/FINAL] or Huchet-Bourdon and Korinek, 2011). Delegates responded favourably to the methodology used and agreed with the approach taken. There was a consensus during that meeting that the work should be extended to two small, open economies. Indeed, much of the analytical work in the public domain on the impact of exchange rates and exchange rate volatility on trade has been done on large economies, with a significant portion of the work examining the United States.

The objective here is to examine the impact of exchange rates and exchange rate volatility on trade in the small, open economies selected. It is postulated that their trade will be impacted differently than the three large economies previously analysed since they have smaller domestic markets, and are perhaps less cushioned from changes on international markets including exchange rate volatility. This study therefore examines the role of the exchange rate in the evolution of the bilateral trade of Chile and New Zealand with the three large economies – China, the Euro area and the United States. In order to ensure strict comparability, the methodology and time period used here are the same as the study on the three large economies. Bilateral sectoral imports and exports are estimated separately for each country pair over the period 1999-2009 using an autoregressive distributed lag model with cointegration.[1] The impact on bilateral trade with each of the three partners of the exchange rate, exchange rate volatility and income is ascertained.

1. Trade flows are assumed to be conducted in the currency of the exporter or the importer, therefore the exchange rate used is the bilateral exchange rate between exporting and importing countries' currencies. This is not always the case, however, as suggested in Sanderson (2009): 80% of New Zealand's exports to China are denominated in US dollars. Since this study is not done at the firm level, however, it was not possible to account for such considerations.

Table 1. Main Economic indicators, 2009

	Population (million)	Area (thousands Km2)	GDP (billion USD)	Exports (% GDP)	Imports (% GDP)
Chile	17	757	163	38	30
China	1331	9596*	4985	27	22
Euro Area	329	2623	12465	17.4	17.9
New Zealand	4.3	269	127	28	27
United States	307	9374	14119	11	13.8

Source: Eurostat, OECD, World Bank. *Area without Hong Kong and Macao.

The remainder of this paper is organized as follows. Section II outlines some of the developments in the exchange rates as well as trade of Chile and New Zealand with the three partners. Section III presents the econometric analysis and the main findings. Finally Section IV concludes.

II. Developments in exchange rates and trade

Exchange rate regimes

Since 1985, the New Zealand dollar was floated as part of a broad-based deregulation of financial markets. The rate was determined by the supply and demand in foreign exchange markets. Since 1989, the Policy Targets Agreements of the Reserve Bank of New Zealand have stated explicitly that in implementing monetary policy through a direct inflation targeting the Bank seeks to avoid unnecessary instability in output, interest rates and the exchange rate (the Reserve Bank of New Zealand, 2007).

In Chile, a managed exchange rate was a common feature of the exchange rate policy during the nineteen nineties and before. With the adoption of an inflation targeting monetary scheme in the early 1990s, it appeared that a conflict could exist between the inflation target and the commitment with respect to the nominal exchange rate outlined in the exchange rate policy, i.e. a crawling band adjusted with respect to past inflation. Although the inflation target always prevailed, the Central Bank allowed the Chilean Peso to float in 1999 (Central Bank of Chile, 2011). This was rendered possible due to Chile's macroeconomic stability (low inflation, sound fiscal policies and a strong financial system).

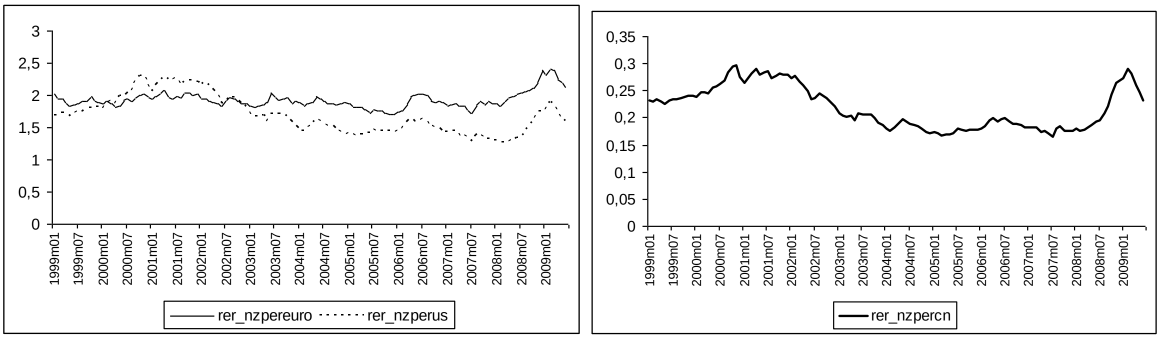
Bilateral exchange rate movements[2]

The real New Zealand dollar exchange rate depreciated at the beginning of the period studied to around NZD 2.20 per USD, NZD 1.95 per euro and NZD 0.26 per Yuan in February 2002 (Figure 1). This was caused partly by monetary control exercised by the Reserve Bank of New Zealand to counter inflationary pressures that could have overvalued the currency. The New Zealand dollar appreciated between 2002 and 2009

2. The exchange rate is defined such that an increase in the exchange rate corresponds to a *depreciation* of the national currency. We focus on the real exchange rate hereafter which is an indicator of price competitiveness. The real exchange rates are derived by multiplying the nominal exchange rate by the ratio of the foreign to local currency consumer price index.

with a record in 2007 (around NZD 1.28 per USD, NZD 1.72 per euro and NZD 0.16 per Yuan). However, the NZD subsequently depreciated considerably against the other currencies during the first quarter of 2009. It was valued at NZD 1.90 per USD, NZD 2.40 per Euro and NZD 0.29 per Yuan in February 2009.

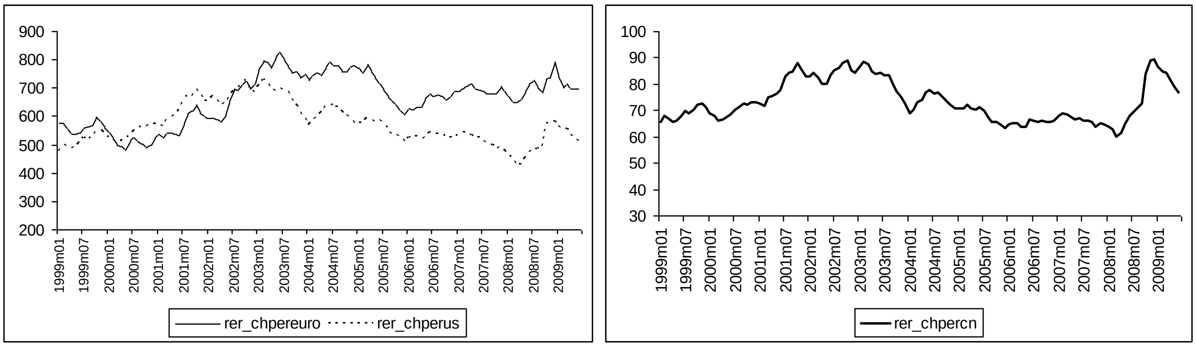
Figure 1. Real exchange rate of the New Zealand dollar relative to euro, US dollar and Yuan[1]



Source: IMF.

In Chile, the first years after the floating exchange rate regime was established were characterised by a depreciation of the Chilean peso relative to the other currencies reaching a record in 2003: CLP 728.1 per USD, CLP 795.8 per Euro and CLP 88.4 per Yuan (Figure 2). Subsequently, it has tended to appreciate against the other currencies before another trough during the financial crisis (the Chilean peso appreciated by 22% relative to the euro from March to December 2008, 36 % relative to the US dollar and 48% against yuan in real terms).

Figure 2. Real exchange rate of the Chilean peso relative to euro, US dollar and Yuan[1]



Source: IMF.

Note that both countries are price takers in terms of exchange rates and prices, compared with the US dollar, Euro and Yuan. Central banks and monetary authorities of large countries may influence their exchange rate through various channels which may not be as easily used by small economies. For instance, large economies may intervene on international currency markets through their foreign exchange reserves by selling or buying currency. Some other drivers of exchange rates are likely to influence capital markets. These include interest rate differentials between the economy in question and other major economies. These interest rate differentials can lead to changes in the amounts of inward/outward capital flows which will contribute to the appreciation/depreciation of the national currency. Larger economies may more easily attract capital investments by raising their interest rates than smaller economies. Smaller economies have less leverage in their exchange and monetary policies by which to influence their exchange rate, having fewer foreign exchange reserves and less opportunity to engage foreign capital. This does not imply however that they do not intervene on foreign exchange markets as did for example the Central Bank of Chile in 2003, 2008 and 2011.

In addition, the domestic markets of the two countries under study here are small (as shown in Table 1), thereby leaving little room for traders that are negatively impacted by the exchange rate to increase their supply to the domestic market. If a negative relationship between exchange rate volatility and trade flows were to be found, such small, open economies might have a strong incentive to keep their exchange rate volatility in a narrow range to avoid penalizing their exporters and importers.

Bilateral trade flows

In both countries, 97% of bilateral imports with the three large economies take place in the non-agricultural sector, [3] and the great majority in manufacturing. The two small open economies however export quite a different basket of goods. While bilateral exports in non-agricultural goods largely outweigh exports in the agriculture sector in Chile, the opposite is observed in New Zealand (Figures 3a and 3b). New Zealand is largely dependent on the agricultural exports for economic growth, comprising 60-80% of total exports depending on the trading partner.

The mining sector is particularly important in Chile. In 2008, mining products accounted for about 60% of total Chilean merchandise exports. Taken together, copper ore, processed copper and refined copper products accounted for 56% of Chile's exports in 2008 (OECD, 2010).

According to Figures 4a and 5a, both countries exhibit an increasing and positive agricultural trade balance with the three large economies. Considering the non agriculture sector, New Zealand’s deficit is increasing over the whole period, particularly in the case of its trade with China (Figure 4b).[4] After a period of stability, Chile faces a strong deterioration of its non agriculture trade balance with all three partners: the US and the Euro Area since 2006 and China since 2007 (Figure 5b).[5]

The countries under study here have concluded some preferential trade agreements (RTA) since 1999 which may explain some of the evolution in trade flows. For instance, the US-Chile free trade agreement signed in June 2003 entered into force on January 2004. The European Community-Chile trade agreement has been in force since February 2003. Lastly a Chile-China agreement was signed in November 2005 and has been in force since October 2006. As regards New Zealand, the New Zealand – China Free Trade Agreement was signed in April 2008 and entered into force on 1 October 2008. New Zealand is the first OECD economy to have signed a preferential trade agreement with China.6

3. Note that non agricultural sector includes both manufacturing and mining.

4. Throughout this paper, non agriculture refers to the mining and manufacturing sectors.

5. Note that data end in 2008, when external demand in particular for some raw materials, was low.

6. Other trade agreements exist, including between the two small, open economies under study. The Trans-Pacific Partnership aims to integrate the economies of the Asia-Pacific region. The

The objectives of such RTAs are to reduce barriers for trade in order to open markets. They also provide some cooperation in areas such as intellectual property, environmental protection, harmonization of technical requirements, trade facilitation, etc. Note that Chile in particular has increased the number of bilateral agreements it adheres to since it became a member of the WTO in 1995.

Figure 3a. Composition of bilateral trade flows (agriculture vs non agriculture) of Chile in 1999 and 2008 with the three trading partners (in %)

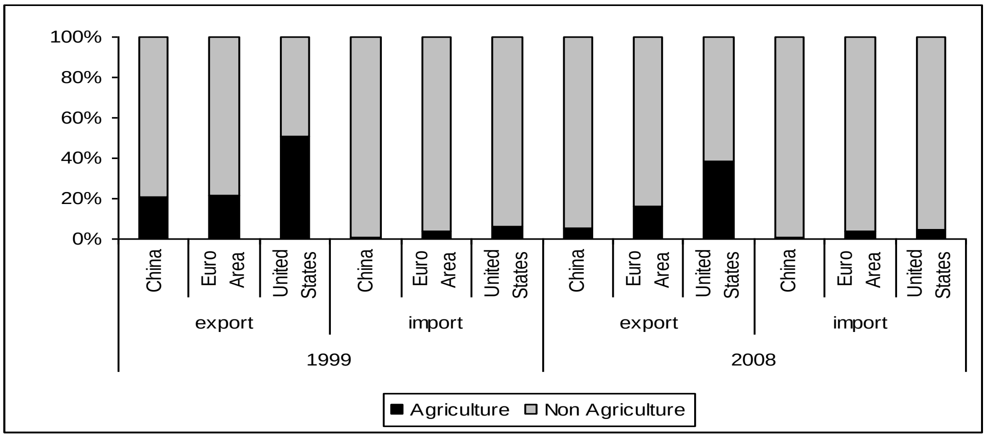
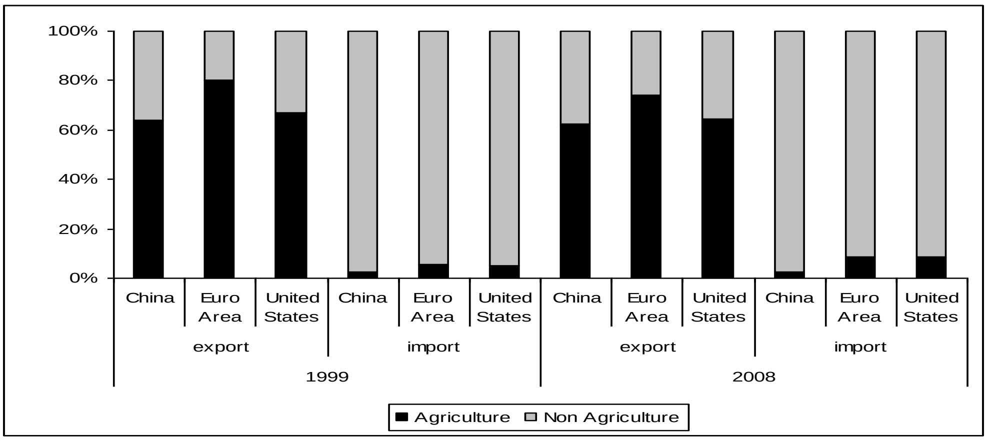


Figure 3b. Composition of bilateral trade flows (agriculture vs non agriculture) of New Zealand in 1999 and 2008 with the three trading partners (in %)



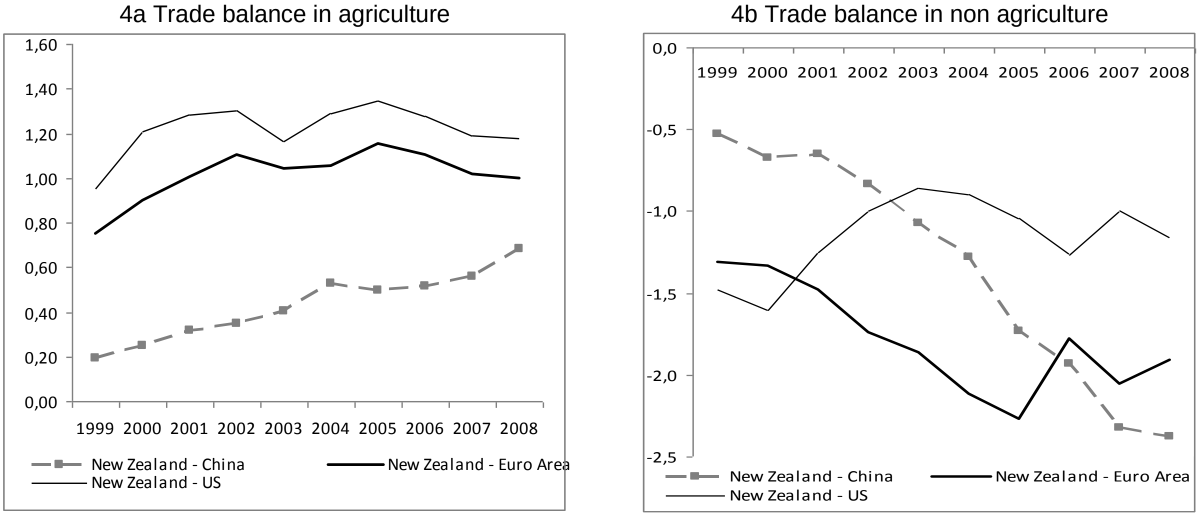
original agreement between Brunei, Chile, New Zealand and Singapore was signed on June, 2005, and entered into force on May, 2006.

Figure 4. Trade balance with partner countries: The case of New Zealand

(in billion euros)

4a Trade balance in agriculture

4b Trade balance in non agriculture



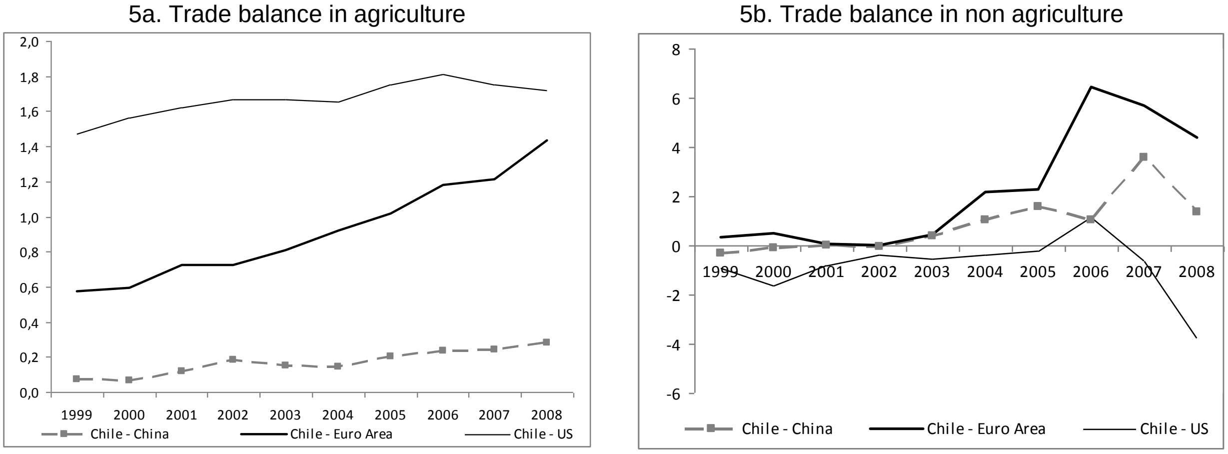
Source: New Zealand Ministry of Foreign Affairs and Trade, Economic Division

Figure 5. Trade balance with partner countries: The case of Chile

(in billion Euros)

5a. Trade balance in agriculture

5b. Trade balance in non agriculture



Source: Central Bank of Chile.

III. Impact of exchange rates and their volatility on trade flows

Econometric methodology[7]

Following Bahmani-Oskooee and Ardalani (2006) and Baek and Koo (2009), this study uses an autoregressive distributed lag (ARDL) model with cointegration to estimate the impact of exchange rates and their volatility on imports and exports in the two small, open economies, Chile and New Zealand. The equations of imports and exports of sector *i* (*i* stands for agriculture or non agriculture) are estimated as a conditional ARDL-error correction model in two separate equations for each country pair (Chile-China, Chile-

7. Some further details concerning the methodological choices made for this study are given in Huchet-Bourdon and Korinek (2011) and in Annexes B and C of this document.

Euro area, Chile-United States; and New Zealand -China, New Zealand- Euro area and New Zealand-United States). Thus equations (1) and (2) are estimated for each bilateral relationship of Chile and New Zealand leading to twelve estimated models.[8]

$$\Delta \ln M_{it} = c_0 + \sum_{k=1}^{n1} c_{1k} \Delta \ln M_{i,t-k} + \sum_{k=0}^{n2} c_{2k} \Delta \ln Y_{country,t-k} + \sum_{k=0}^{n3} c_{3k} \Delta \ln ER_{t-k} + \sum_{k=0}^{n4} c_{4k} \Delta \ln Vol_{t-k} \\ + \delta_0 \ln M_{i,t-1} + \delta_1 \ln Y_{country,t-1} + \delta_2 \ln ER_{t-1} + \delta_3 \ln Vol_{t-1} + \mu_t \quad (1)$$

$$\Delta \ln X_{it} = d_0 + \sum_{k=1}^{n1} d_{1k} \Delta \ln X_{i,t-k} + \sum_{k=0}^{n2} d_{2k} \Delta \ln Y_{partner,t-k} + \sum_{k=0}^{n3} d_{3k} \Delta \ln ER_{t-k} + \sum_{k=0}^{n4} d_{4k} \Delta \ln Vol_{t-k} \\ + \lambda_0 \ln X_{i,t-1} + \lambda_1 \ln Y_{partner,t-1} + \lambda_2 \ln ER_{t-1} + \lambda_3 \ln Vol_{t-1} + \zeta_t \quad (2)$$

Where $X_{i,t}$ is the value of the country's (Chile or New Zealand) exports in sector *i* to the partner economy (China, the Euro area or the United States), $M_{i,t}$ is the value of the country's imports in product *i* from the partner economy, Y is the real income (represented by the GDP or a proxy such as an industrial production index), *ER* stands for the real bilateral exchange rate, i.e. the nominal exchange rate deflated by the ratio of the partner to domestic consumer price indices, and *vol* is a measure of its volatility. All variables are taken in logarithm form which allows estimation of elasticities. A time trend is included. Dummy variables are included to take account of the preferential trade agreements outlined in section "bilateral trade flows" above.

Measures of exchange rate volatility[9]

There is no consensus among researchers as to how to measure exchange rate volatility. Three measures of volatility are shown in Figures 6a-6f below for each of the six country pairs. The short-term measure of volatility, the 12-month moving standard deviation measure (represented by the solid line) is quite close to the one measured in the long-run, based on 5-year moving standard deviation. The results shown here seem to confirm Mabin's 2010 study which states that New Zealand experienced high short-term exchange rate volatility. It may mean that small open economies' exporters have difficulties insuring against exchange risk, even in the short run. The measure that seems to pick up the most volatility is that using GARCH.[10] Only results based on the 5-year

8. The methodology outlined here is the same as that used in the companion paper which examined China, the Euro area and the United States. More details on the methodology are provided in annexes B and C of this document and in Huchet-Bourdon and Korinek (2011).

9. See Huchet-Bourdon and Korinek (2011) for a discussion of possible measures of volatility and a summary of findings by other researchers of their impacts on trade.

10. GARCH models are Generalized Autoregressive Conditional Heteroskedasticity models and are designed to model and forecast conditional variances. This procedure models the variance of each period's disturbance term as a function of the errors in the previous period. The variance of the dependent variable is modelled as a function of past values of the dependent variable and exogenous variables. See Annex C for a more detailed discussion of volatility measures.

moving standard deviation and GARCH model as measurements of exchange rate volatility are reported thereafter[11].

Figure 6. Evolution of the exchange rate volatility measures by country pair (standard deviation)

Figure 6a. New Zealand-China

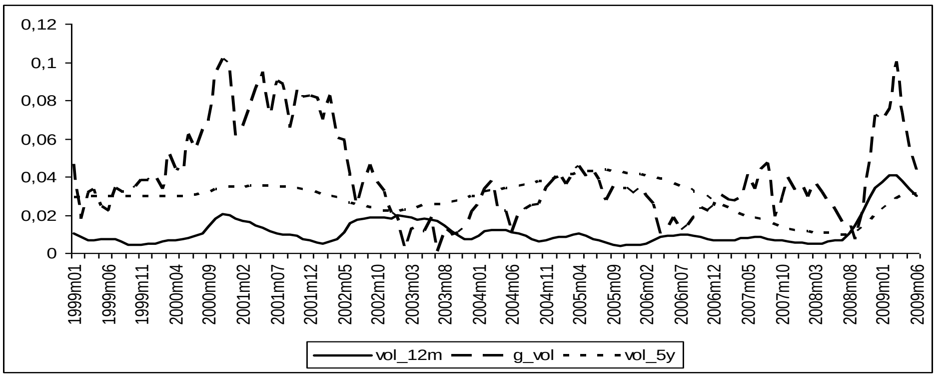


Figure 6b. New Zealand-Euro Area

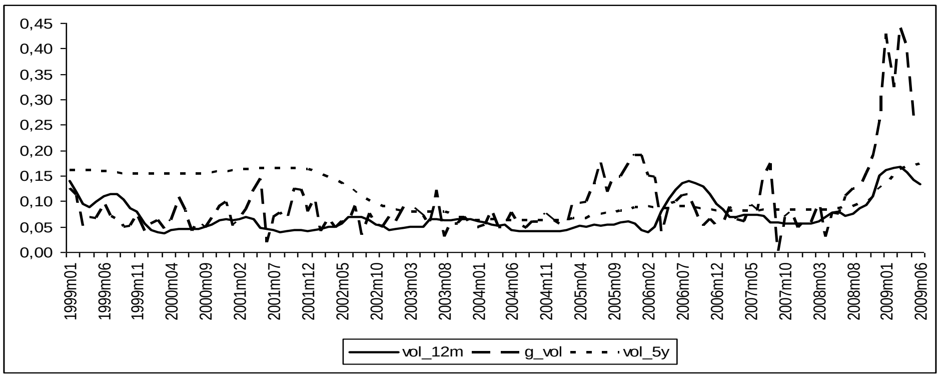
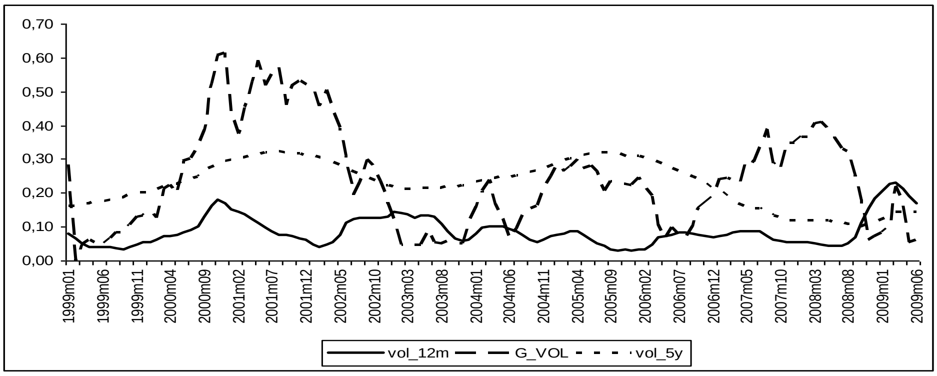


Figure 6c. New Zealand-United States



11. This allows comparison with results for the three large economies in the companion study which were presented with these two definitions. Results with the 12-month moving standard deviation measure for volatility are close to those presented using the other two definitions.

Figure 6d. Chile-China

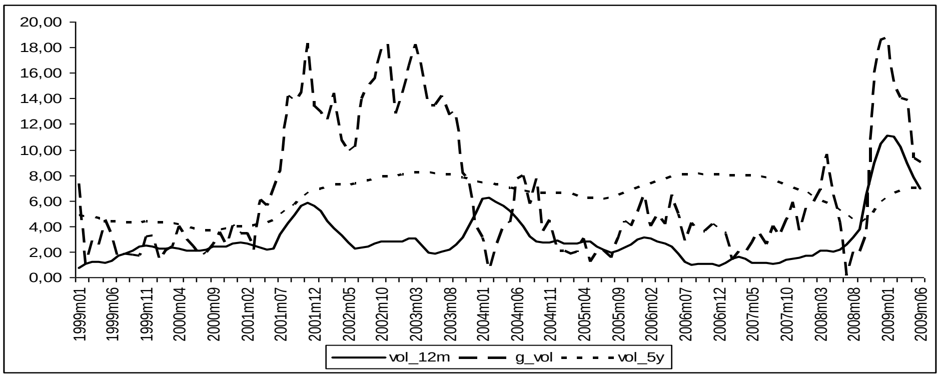


Figure 6e. Chile - Euro Area

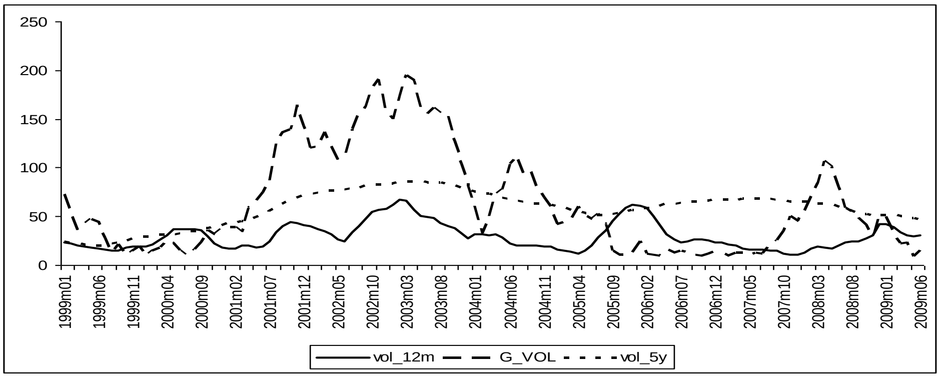
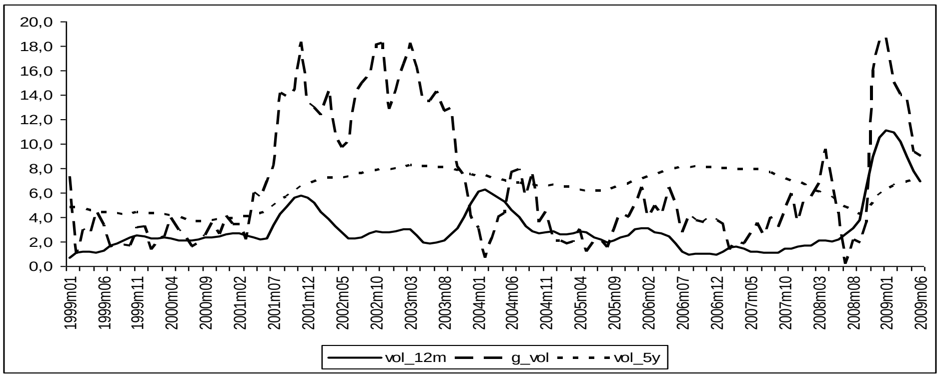


Figure 6f. Chile – United States



Note: vol_12m refers to the standard deviation over the previous 12 months; g_vol refers to a GARCH-based measure of volatility; and vol_5y refers to the standard deviation of the previous 60 months (5 years).

Empirical results

Model estimates reveal that income, exchange rates and exchange rate volatility significantly affect bilateral trade in the short run. Since cointegration is supported through our models (Annex D and G), we focus on long-term effects of these variables on bilateral trade.[12]

Impact of exchange rates on trade

Although difficult to generalize, the long-term impacts of exchange rates on trade are of a broadly similar magnitude in the two small, open economies as in the large economies examined in the companion paper (see Huchet-Bourdon and Korinek, 2011). In both cases, not all elasticities are statistically different from zero, i.e. in a number of cases, there is no apparent relationship between changes in the exchange rate and trade flows. In other cases, however, impacts can be significant. There is no clear delineation of results in these two case studies, in terms of sector (agriculture/non-agriculture) or in terms of trading partner.[13]

The methodology used here captures the impact of the exchange rate level, exchange rate volatility and income, on bilateral trade flows.[14] Many market fundamentals affect the relationship between the exchange rate and trade such as: the product composition of exports/imports; the price elasticity of each of the traded products; the country’s market share of the product globally; the share of the good in the basket of exported/imported products; the import content of exports ; price transmission mechanisms in the product/country markets such as, for example, the degree to which traders can reduce their prices in order to absorb some of the price effects created by changes in the exchange rate; trade costs and their share in the traded price of the good; and the terms of the contract such as its duration and the currency in which it is denominated. All these factors have a bearing on the aggregate results that are reported here. Many have opposite impacts on the relationship between the exchange rate and trade flows.

Some phenomena affecting the relationship between exchange rates and trade are not accounted for in these models. These include for example the impact of changes in exchange rates other than those of the bilateral country pair in question; or substitution by suppliers/consumers in third countries. These results are therefore partial equilibrium and should be viewed in this context.

The results found here concerning the impact of the exchange rate on trade should be interpreted in terms of a number of characteristics of the countries under study. They are both smaller economies and therefore have smaller domestic markets. In the face of a price hike, due to an appreciation in their own currency (for exporters) or an appreciation in the currency of trading partners (for importers), they have less recourse to turn to their domestic market. In addition, contrary to the three large economies studied previously,

12. One exception is agricultural exports of Chile with the United States which does not exhibit a statistically significant long term relationship.

13. In the previous study on the three large economies, it was found that exports were more sensitive to changes in the exchange rate, as was the agriculture sector. These results are not confirmed in this study on the two small, open economies.

14. As in the previous study, the effects measured are those of the real exchange rate, i.e., the nominal exchange rate deflated by the ratio of foreign to domestic consumer prices, on bilateral nominal trade flows.

Chile and New Zealand are not net exporters of sophisticated manufacturing products that are often part of a long global value chain. Copper, at different stages of processing, accounts for over half of Chile's exports. A significant proportion of New Zealand's exports are in agriculture, in particular to the three trading partners examined here. 62-74% of New Zealand's exports to China, the Euro area and the United States are agricultural products.

Results using the Garch volatility measure show that a hypothetical 10% depreciation in the NZ dollar leads to a 13.4% increase in agricultural exports of New Zealand to the Euro Area and a 16.6% increase in their mining/manufacturing exports to the Euro Area (Table 2). Similarly, it leads to an increase in exports to China in both sectors (7.3 % in agriculture and 11.6% in manufacturing and mining in the case of Garch model), confirmed by results using the alternative measure of exchange rate volatility. Exports to the United States increase by 10.4% in agriculture, using the Garch models, and 0% in the manufacturing and mining sectors (10.9% using the alternative model specification). These results suggest that the exchange rate has a strong effect on New Zealand's exports with all three major trading partners in both broad sectors.

Table 2. Estimated long-run effects on trade of a 10% depreciation in New Zealand

	Garch			5-year MSD	
	Agr	Non Agr		Agr	Non Agr
New Zealand / China			New Zealand / China		
X	7.3%	11.6%	X	5.9%	12.5%
M	0.0%	0.0%	M	5.8%	0.0%
New Zealand / Euro Area			New Zealand / Euro Area		
X	13.4%	16.6%	X	0.0%	21.4%
M	8.8%	11.8%	M	9.4%	21.8%
New Zealand / US			New Zealand / US		
X	10.4%	0.0%	X	7.2%	10.9%
M	-49.5%	0.0%	M	9.7%	0,00%

X: exports ; M: imports

Regarding the impact of the exchange rate on imports to New Zealand, in the same case of a 10% hypothetical depreciation of the NZ dollar, no change is observed in imports from China. There may be a number of reasons for this: New Zealand importers may be particularly price inelastic as regards the types of goods they import from China; or it may be the case that even with a depreciation in the currency of its trading partner, Chinese goods remain highly competitive. It may also be the case that New Zealand does not have the capacity to respond to demand for some products that are imported from China regardless of price differentials. Baek and Koo (2009) find a similar result using a different sample, and suggest that foreign exporters may squeeze their profit margins to offset the increase in their export prices in order to maintain their share of the market. It may be noted that a similar result was found in the companion study for the Euro Area: a 10% depreciation in the Euro did not result in lower imports from China (Huchet-Bourdon and Korinek, 2011). Imports into New Zealand from the United States are also unaffected by a 10% depreciation in the NZ dollar in the manufacturing/mining sector, although imports in the agriculture sector are negatively and very strongly impacted (in GARCH models – this strong result is somewhat mitigated by a positive impact in the case of the alternative model specification using the five year moving standard deviation). In the case of New Zealand – Euro area trade, long-term imports of New Zealand show an unexpected positive coefficient regardless of the measure of volatility used. The effect on New Zealand's imports of a 10% depreciation in its currency are therefore not robust across countries and broad sectors in this sample. It may be noted, however, that it does not seem likely that a depreciation of its currency will result in a shift toward domestic suppliers in the manufacturing sector.

In the case of Chile, imports from China and the Euro area are relatively unaffected by a hypothetical 10% depreciation of the Chilean peso (Table 3). Changes in imports from the Euro area are not very significantly different from zero in either sector regardless of the measure of volatility used. Imports from China in non-agriculture products are somewhat affected by changes in the exchange rate. A 10% depreciation in the Chilean peso results in a 6-7% decrease in non-agricultural imports. Imports from the United States, however, are very significantly affected by a depreciation in the peso. A 10% depreciation in the Chilean peso results in a 17-23% decrease in non-agricultural imports, depending on the measure of volatility used. The different bilateral import effects between Chile and two of its main trading partners could be explained by the product composition of its import basket. The very strong effects for the United States may mean that goods imported from the United States are particularly price elastic, perhaps because they are easily substitutable by other exporters or domestic suppliers. It may also mean that contracts undertaken with US exporters are of a particularly short-term nature and that changing suppliers is less costly than in the case of some other countries. The impact of the exchange rate on Chilean imports is therefore highly dependent on the trading partner, the broad sector, and other elements such as the measure of volatility used.

Chile’s exports are impacted by an exchange rate depreciation in a complex fashion. Intuitively, one would expect a depreciation in the peso to increase exports across the board, making them more affordable to buyers abroad. This is indeed the result as regards exports from Chile to the United States in non-agricultural goods (recall that more than half of Chile exports overall are in the mining sector), where a 10% depreciation in the peso results in a 7-12% increase in exports to the United States (depending on the model specification). Exports of agricultural goods to the United States, however, are unaffected by changes in the exchange rate. In an opposing fashion, exports to the Euro area are very strongly affected as regards agriculture (34-42% depending on the model).

Perhaps the most surprising result, however, is the impact of a hypothetical 10% depreciation in the peso on Chile’s exports in the mining/manufacturing sector to China. A 10% depreciation in the peso results in a 9-12% decrease in exports to China in mining and manufacturing. A similar result is found in one of the models for Chile’s non-agricultural exports to the Euro area. China is a large importer of products of the extractive industries and has exercised a strong demand for certain raw materials during the period studied. It can be assumed that demand for raw materials such as copper in China are relatively price inelastic. Chile is the world’s largest copper exporter, and among the largest exporters of molybdenum, lithium and some other raw materials. This would explain why demand may not be positively affected by a depreciation in the exchange rate.

Table 3. Estimated long-run effects on trade of a 10% depreciation in Chile

	Garch	
	Agr	Non Agr
Chile / China		
X	0.0%	-8.6%
M	0.0%	-7.4%
Chile / Euro Area		
X	41.6%	-12.7%
M	0.0%	-1.9%
Chile / US		
X	0.0%	11.9%
M	0.0%	-23.4%

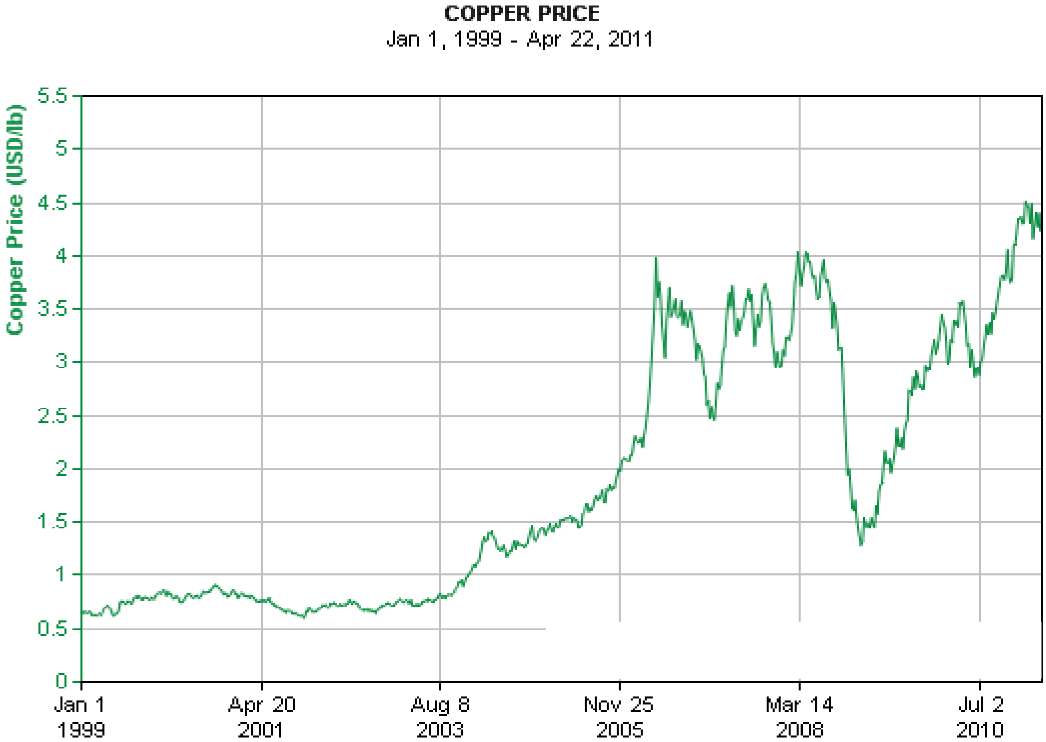
	5-year MSD	
	Agr	Non Agr
Chile / China		
X	10.3%	-11.6%
M	-10.2%	-6.3%
Chile / Euro Area		
X	34.1%	0.0%
M	0.0%	0.0%
Chile / US		
X	0.0%	6.7%
M	-36.0%	-17.6%

X: exports ; M: imports

One possible reason for this surprising result is the important role that copper plays in Chile's exports. Chile is a major player on the international copper market and copper accounts for 56% of its exports overall. A change in the price of copper may therefore impact the value of the Chilean peso. All else equal, the rising price of copper over the past few years – due in part to strong demand from Asia – would have had an appreciative effect on the peso (Figure 7).[15] Chinese demand for copper, however, has been rising in spite of increased copper prices, implying a growth of the value of its imports from Chile. In this way, an appreciation in the peso may be associated with an increase in the value of China's imports from Chile in the mining/manufacturing sector. This mechanism points to the possibility of an endogeneity between copper trade, in particular with China, and the exchange rate, which is not captured in the econometric model used.

15. Note that in recent years, this has indeed been the case. Both the price of copper and the Chilean peso have appreciated considerably over the period 2003-08. Both have fallen in late 2008 and risen again in mid-2009.

Figure 7. Copper price



Source: Infomine, Inc., www.infomine.com

Impact of exchange rate volatility on trade

In terms of the impact of exchange rate volatility on bilateral trade, the two small open economies seem more sensitive to exchange rate volatility than large economies (Table 4).[16] There may be a number of reasons for this. Since small open economies have less room to adjust their exchange rates in the face of exchange rate changes *vis à vis* large economies' currencies their traders may be more directly impacted by exchange rate changes.[17] Secondly, many smaller countries have less diversified export structures and therefore it is more difficult to move into exports of products that are more price inelastic. Thirdly, importers cannot necessarily source their needs in the domestic market in the case that their exchange rate depreciates, making foreign goods more costly. Finally, small countries often have smaller enterprises on average. Some enterprises may not be large enough to practice hedging. Fabling and Grimes (2010) finds that large enterprises hedge most when entering international markets, thereby ensuring against exchange rate

16. Since volatility has a greater effect in the small, open economies than in the large economies studied in the companion paper, an alternative model was tested. Estimations were run without the exchange rate volatility term in order to determine whether volatility may influence the effect of exchange rate level on bilateral flows. When volatility was removed from the specification, the effect of exchange rate is largely unchanged. Generally, the effect of the exchange rate level on trade flows is very slightly higher, if its impact is felt at all, in the specification without the volatility term. Estimates are available from the authors upon request.

17. Between 60-70% of NZ firms hedge transactions denominated in USD or other currencies (excluding the Australian dollar) (Fabling and Grimes, 2010).

risk. Small enterprises are second most likely to hedge and medium-sized enterprises are least likely to hedge exchange risk. In this way, enterprises in New Zealand, for example, may be less likely to hedge than those in the United States or the Euro zone. Consistent with other studies and with the theoretical literature, however, the direction of the impact (i.e., increasing or decreasing trade) can go either way.[18]

This study finds, furthermore, that in both countries, exports respond less to exchange rate volatility than do their imports. One possible explanation for this finding may come from the fact that these countries are commodity exporters and that their exchange rates often move with the commodity prices (Westpac, 2009). Analysing price data over 17 years since 1992, the study of Westpac (2009) shows that for the majority of New Zealand commodity producers the exchange rate has reduced the overall volatility of commodity producers' revenue per unit by 25% since 1992 by offsetting global market swings. As commodity prices have risen, so has the value of the NZ dollar, thereby insulating exporters somewhat from volatility and smoothing their revenue streams.

Table 4. Estimated long run elasticities of exchange rate volatility with respect to trade

4.a New Zealand

	Garch		5-year MSD	
	Agr	Non Agr	Agr	Non Agr
New Zealand / China				
X	0.00	0.00	0.00	0.00
M	0.00	0.05	-0.58	0.14
New Zealand / Euro Area				
X	0.00	0.10	0.00	0.00
M	-0.09	0.08	0.30	0.22
New Zealand / US				
X	0.00	0.00	0.06	0.20
M	7.52	0.00	-0.22	0.00

4b. Chile

	Garch		5-year MSD	
	Agr	Non Agr	Agr	Non Agr
Chile / China				
X	0.43	0.00	0.36	1.09
M	0.00	0.00	-0.44	0.00
Chile / Euro Area				
X	0.00	0.00	0.00	0.00
M	0.00	0.00	-0.26	-0.15
Chile / US				
X	0.00	0.00	0.00	0.00
M	0.00	0.09	1.33	0.00

Impact of income on trade

It is worth noting that the income variable seems to play a less important role in determining bilateral trade of these small open economies, especially in New Zealand, compared to the three large economies (Huchet-Bourdon and Korinek, 2011). Changes in income seem to affect trade flows, both imports and exports, less than in larger economies. This may be explained by structural factors in countries with small domestic markets: even as incomes rise and demand for goods increase, overseas demand dwarfs domestic demand, especially in the case that exports are less diversified. Their exports are dependent upon foreign demand in their niche markets; their exports to all markets will also be dependent upon major markets' trade since it will be difficult to compete with large countries in third markets due to small countries' lower economies of scale. On the import side, small countries are constrained to import many necessities regardless of the price changes imposed by exchange rate volatility implying that consumers in these countries may be on average more price inelastic than those in larger economies.

18. See Huchet-Bourdon and Korinek (2011) for a discussion of the large body of theoretical work on the impact of exchange rate volatility.

Impact of hypothetical currency depreciations on 2008 trade balances

Changes in the level of real exchange rates impact trade balances and have strong implications for evolving current account balances. Inasmuch, the analysis in this paper allows estimation of a hypothetical impact on 2008 trade balances in the countries examined of a hypothetical 10% depreciation in exchange rates.[19]

In the case of New Zealand, a 10 % depreciation of the NZ dollar in real terms would have improved New Zealand's 2008 agricultural trade balance with China and the United States, regardless of the measure of volatility used (using GARCH volatility, the increase is EUR 55 million with China and EUR 230 million with US). In the case of the Euro area, results are different according to the measure of volatility: while agriculture trade balance would improve with GARCH volatility (by EUR 143 million) it would deteriorate with 5-year MSD volatility (by 20 million euros). Concerning non agricultural sector with GARCH volatility, the same depreciation would have improved New Zealand non agricultural trade balance with China by EUR 53 million but it would have implied a deterioration of non agricultural trade balance with the Euro Area by EUR 205 million while non agricultural trade balance with the United States would be unchanged. This implies that a 10% depreciation of the NZ dollar in 2008 would have brought the New Zealand trade deficit with China to EUR -1.59 billion as opposed to the actual deficit which was EUR -1.7 billion; the trade deficit with the Euro Area would have been EUR -0.98 billion as opposed to EUR -0.91 in 2008 and the trade surplus with the United States would have been EUR 0.25 billion as opposed to 0.02 in 2008.[20]

In the case of Chile, the same experiment of a 10% depreciation of the Chilean peso would have implied an improvement of the agricultural trade balance with the Euro Area (by EUR 655 million) but leaves the agricultural trade balance with China and the United States unchanged. In the non agricultural sector, the same depreciation leads to a deterioration of the non agricultural trade balance by EUR 172 million with China and by EUR 966 million with the Euro area. On the contrary it improves the non agricultural trade balance with the United States by EUR 2.1 billion. The total trade balance of Chile with China according to GARCH model results therefore would have been EUR 1.5 billion as opposed to EUR 1.6 billion in 2008, had the hypothetical 10% depreciation of the peso been in place. With the Euro area, the total trade balance would have been about EUR 5.5 billion as compared with its actual trade balance of EUR 5.8 billion in 2008. The trade balance with the United States in the hypothetical case of a 10% depreciation of the peso would be a surplus of EUR 119 million as compared with the actual deficit which was EUR -2.1 billion in 2008.

Similarly to the conclusion that was reached regarding the three large economies, trade balances, and in particular current account imbalances, in the countries examined here cannot be attributed to exchange rate levels alone. There are many factors at play that imply that exchange rates are only one of a large number of interactions that motivate changes in the trade balance or current account (see Mabin, 2011; Huchet-Bourdon and Korinek, 2011; Huang and Wyplosz among others in Evenett, 2010).

19. This hypothetical calculation was also undertaken for the three large economies in Huchet-Bourdon and Korinek (2011).

20. Results with 5-year MSD volatility are similar.

IV. Conclusion

This study has examined the impact of exchange rates on bilateral trade of two small, open economies with three large partners, China, the Euro area and the United States.

Results reveal that bilateral trade may be affected by the three factors considered here – income, exchange rate, and exchange rate volatility. However results suggest that bilateral trade could be less sensitive to changes in income in small countries than in large economies (see also Huchet-Bourdon and Korinek, 2011). The long-run effects of the levels of real exchange rates on trade are confirmed. Finally, exchange rate volatility seems to be a more important determinant of small open economies' bilateral trade than that of large economies.

The small, open economies' characteristics – small domestic markets, greater reliance on international trade, and a lessened ability to "cushion" suppliers and consumers from international price changes – seem to explain some of the findings here. Chile and New Zealand are more heavily impacted by exchange rate volatility than the three large economies previously examined. This is particularly true as regards imports. On the export side, they may be less impacted by exchange rate volatility since they export a majority of commodities and their exchange rates seem to evolve somewhat with commodity prices. It should be kept in mind that price and exchange rate impacts on exporters are particularly important in smaller economies since in order to grow, firms must quickly turn to export markets due to the reduced size of the domestic market; and because firms in small countries must compete in third markets with firms from larger countries that may benefit from greater economies of scale.

The impact of the exchange rate level on trade in the small economies depends very much on the sector and the trading partner. Results vary and do not allow easy generalizations. In the case of New Zealand, a hypothetical depreciation in its currency would suggest an increase in its exports in all sectors to all major partners.

In the case of Chile, impact of the exchange rate on both Chilean imports and exports are highly dependent on the trading partner, the broad sector, and other elements such as the measure of volatility used. One surprising result found here is that a 10% depreciation in the peso results in a 9-12% *decrease* in exports to China in the mining and manufacturing sector. This may be explained by the impact of the copper price, one of Chile's major export products, on the peso, and China's price inelastic demand for Chile's exports from extractive industries.

This study confirms some previous analysis (Evenett, 2010; Huchet-Bourdon and Korinek, 2011) suggesting that the level of exchange rate is only one factor that influences trade imbalances. Indeed, this study indicates that a depreciation in the exchange rates in Chile and New Zealand would not lead to a strong change in their trade balances with three main trading partners across the board.

Finally, this study makes a significant contribution to the large body of existing research on exchange rates by examining two small, open economies. Most previous studies examine exchange rate changes in large economies and how they impact trade and current accounts. A large proportion of the research examines the United States dollar and its impact on US trade with some of its trading partners – previously, the United Kingdom and more recently, its trade with China. This study compares the impact of exchange rate changes on trade in two small, open economies, on which less analysis has been done.

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Annex A.
Data definitions and sources

Bilateral trade flows of two economies, Chile and New Zealand, with three large economies, China, the Euro Area and the United States, are analyzed. The Euro area corresponds to the European Economic Monetary Union of twelve countries (the eleven founders in 1999 and Greece which joined the Union in 2001).

This study uses monthly data from January 1999 to June 2009 which was the period considered in a previous work on three large economies (see Huchet-Bourdon and Korinek, 2011). The same period and frequency were used for comparison reasons.

Monthly exchange rate data are collected from the International Financial Statistics of the International Monetary Fund. Real exchange rates are defined in the number of local currency per foreign currency. An increase in exchange rate reflects a real depreciation of the national currency. Real exchange rates are derived by multiplying the nominal exchange rate by the ratio of the foreign to local currency consumer price index.

We use the monthly indicator of activity (IMACEC) to proxy changes in GDP which is collected from the Chilean Central Bank. For New Zealand, the quarterly real gross domestic product is collected from OECD. An interpolation methodology is used to obtain monthly data.

Monthly trade flows are available from the Central Bank for Chile (in thousands US dollar) and from the Economic Division of the Ministry of Foreign Affairs and Trade for New Zealand (Millions of New Zealand Dollars). Data include trade in goods; services trade are not fully covered.

Annex B.
Econometric Methodology

Pesaran *et al.* (2001) suggest an alternative technique[1], the Auto-Regressive Distributed Lag (ARDL) or the bounds test approach to cointegration[2] to investigate the relationship between variables. The tests for long run relationship between variables are based on standard F-tests. There is no need for pre-unit-root testing. This is one of the main advantages of the bounds testing approach which makes it relatively more relevant for our topic because the volatility measure could be stationary whereas other variables could be non-stationary (Bahmani-Oskooee and Mitra, 2008). Besides, this technique generally provides unbiased estimates of the long run model and valid t-statistics even when some of the regressors are endogenous (Harris and Sollis, 2003). Inder (1993) and Pesaran and Pesaran (1997) have shown that the inclusion of the dynamics may help correct the endogeneity bias. Finally, the advantage of this approach is that it allows the distinction between short and long run effects.

The equations of imports and exports of product *i* (*i* stands agriculture or manufactured) are modelled as a conditional ARDL-error correction model for each pair countries (Euro area with the United States and then China; the US with China).

$$\begin{aligned}\Delta \ln M_{it} &= c_0 + \sum_{k=1}^{n1} c_{1k} \Delta \ln M_{i,t-k} + \sum_{k=0}^{n2} c_{2k} \Delta \ln Y_{country,t-k} + \sum_{k=0}^{n3} c_{3k} \Delta \ln ER_{t-k} + \sum_{k=0}^{n4} c_{4k} \Delta \ln Vol_{t-k} \\ &\quad + \delta_0 \ln M_{i,t-1} + \delta_1 \ln Y_{country,t-1} + \delta_2 \ln ER_{t-1} + \delta_3 \ln Vol_{t-1} + \mu_t\end{aligned}$$

$$\begin{aligned}\Delta \ln X_{it} &= d_0 + \sum_{k=1}^{n1} d_{1k} \Delta \ln X_{i,t-k} + \sum_{k=0}^{n2} d_{2k} \Delta \ln Y_{partner,t-k} + \sum_{k=0}^{n3} d_{3k} \Delta \ln ER_{t-k} + \sum_{k=0}^{n4} d_{4k} \Delta \ln Vol_{t-k} \\ &\quad + \lambda_0 \ln X_{i,t-1} + \lambda_1 \ln Y_{partner,t-1} + \lambda_2 \ln ER_{t-1} + \lambda_3 \ln Vol_{t-1} + \zeta_t\end{aligned}$$

These equations include a linear combination of the lagged level of all variables (second line of each equation), commonly referred to as an error-correction term. These specifications provide estimates of both short-run and long-run effects. The short-run effects are inferred from the estimates of $c_{1k},..., c_{4k}$ or $d_{1k},..., d_{4k}$ and the long-run effects by δ_0, δ_3 (or λ_0, λ_3 respectively) normalised by δ_0 (λ_0).

The first step in estimating error-correction models is to carry out the F-test for joint significance of the lagged level variables or for their cointegration. A problem arises in

1. Two main approaches were adopted in the past: the two-step residuals based procedure for testing the null of no-cointegration (Engle and Granger (1987) and the system-based reduced rank regression approach due to Johansen (1991, 1995). These methods assume that the variables are integrated of order one (I(1)) or more. Pesaran et al. (2001) develop a new approach for testing the existence of a relationship between variables (they can be stationary I(0), integrated of order one I(1) or mutually cointegrated).
2. Cointegration means a stationary long term relationship: variables are cointegrated if there is a linear combination between the variables which is stationary.

this step that is related to the choice of lag length. Although Pesaran *et al*. (2001) suggest imposing a fixed number of lags on each differenced variable; Bahmani-Oskooee and Ardalani (2006) have demonstrated that the F-test result is sensitive to the lag length. Following Bahmani-Oskooee and Wang (2007), we first estimate by the OLS method different ARDL models for all lags with a maximum of 12 lags. We use both Akaike's information criterion (AIC) and Schwartz Bayesian Criterion (SBC) [3] to select the optimum lags on each variable.

With the optimal lags, the presence of cointegration is then tested through an OLS estimation by restricting all estimated coefficients of lagged level variables equal to zero ($\delta_0 = \delta_1 = \delta_2 = \delta_3 = 0$ or $\lambda_0 = \lambda_1 = \lambda_2 = \lambda_3 = 0$). The null hypothesis of non cointegration is tested against the alternative by the mean of an F-test with an asymptotic non-standard distribution. If the computed F-statistic lies above the upper level of the band, the null is rejected, indicating cointegration. If the computed F-statistic lies below the lower level ban, the null cannot be rejected, supporting the absence of cointegration. If the statistics fall within the band, inference would be inconclusive. This is called a bounds testing procedure since the two sets of critical values provide critical value bounds for all possibilities of the regressors into purely I(0), I(1) or mutually cointegrated.

In a second step, after confirmation of the existence of a long run relationship between the variables in the model, the long run and short run models can be derived. Estimates of δ_0 - δ_3 (λ_0 - λ_3 respectively) are then used to form an error-correction term ECM_{t-1}.[4]

We replace the linear combination of lagged level variables (second line of each equation) by ECM_{t-1}. The error correction model is re-estimated by using the same lag structure as before. When all variables are adjusting toward their long-run equilibrium, the gap between the dependent and the independent variables measured by the coefficient associated to ECM_{t-1} must decrease. In other words, a negative and significant coefficient obtained for ECM_{t-1} not only will be an indication of adjustment toward equilibrium but also an alternative way of supporting cointegration among variables (Bahmani and Ardalani (2006)). The larger the error correction coefficient (in absolute value) the faster is the economy's return to its equilibrium, once shocked.

Finally, we run diagnostic tests. We test for stability of short-run and long-run coefficient estimates by applying the CUSUM and CUSUMQ tests proposed by Brown *et al*. (1975) to the residuals of the error-correction models. We present the conclusion in Tables G.1 and G.2 in Annex G[5]. We also produce a Ramsey Reset specification test, and a LM-test of non autocorrelation of residuals.

3. The AIC and SBC are the two most popular model selection criteria. The strategy consists on choosing the number of lags for which the criteria are the smallest. These model selection criteria measure the "fit" of a given model by its maximized value of the log-likelihood function.
4. ECM(-1) represents the lagged linear combination of the variables: it represents the gap towards the equilibrium in period t-1. Its estimated associated coefficient corresponds to the reaction degree of the dependent variable regards to the previous gap towards the equilibrium.
5. Graphs are available upon request from the authors.

Cusum (cumulative sum) and Cusumq (cusum of squares test) are based on recursive residuals. Cusum is defined as $W_r = \frac{1}{\hat{\sigma}_{ols}} \sum_{j=k+1}^{r} v_j$ r=k+1, k+2, n

Where v_t is the recursive residual based on the first j observations.

The test employs a graphic technique and involves plotting *W* and a pair of straight lines for values of r = k+1, k+2, n. The straight lines are drawn assuming a 5% significance level.

In the same idea, Cusumq is based on the quantities: $WW_r = \frac{\sum_{j=k+1}^{r} v_j^2}{\sum_{j=k+1}^{n} v_j^2}$ r = k+1, k+2, n.

Annex C.
Alternative measures of volatility

The volatility of real bilateral exchange rate (ER) is reported in this paper by variable *vol*. As mentioned in the text, three measures of volatility were tested in empirical analysis. One is a GARCH-based measure. The two others are based on moving standard deviation of ER. For each month this measure is the standard deviation of previous 12 observations ending at current month in the first case. For the alternative case, it is the standard deviation of previous 60 observations (five years). Only empirical results based on the five-year moving standard deviation are reported in the document.

In a simple GARCH model it is assumed that ER itself follows a first order auto-regressive process:

$$ER_t = a_0 + a_1 ER_{t-1} + \varepsilon_t, \qquad (1)$$

where ε_t is white noise with E (ε) = 0 and V (ε) = h^2.

The conditional mean of ER_t is $a_0 + a_1 ER_{t-1}$. In order to forecast the variance of ER, the conditional variance of ε_t which is a time varying variable needs to be estimated. GARCH allows thus the variance of a variable like *ER* to change over time. The theoretical specification of a GARCH(p,q) model which is being used is as follows:

$$h_t^2 = \beta_0 + \beta_1 \varepsilon_{t-1}^2 + ... + \beta_q \varepsilon_{t-q}^2 + \varphi_1 h_{t-1}^2 + ... + h_{t-p}^2 \qquad (2)$$

Where p is the number of GARCH (lagged variance) and q the number of ARCH (lagged residual squared terms)

The GARCH model represented by Equation (2) includes a ARCH term (β's) which states that the variance of the current error term is a function of the variance of error term in the previous periods and a GARCH term (φ's) which summarizes last period's forecast variance. The GARCH (p,q) model is used to generate predicted value of h_t^2 as a measure of volatility of exchange rate.

Before estimating the GARCH model, we carry out an ARCH test. We use the Lagrange multiplier procedure proposed by Engle (1982). The first step is to regress the OLS squared residuals $\hat{\varepsilon}_t^2$ from the regression (1) on a constant and its own lagged values:

$$\hat{\varepsilon}_t^2 = \alpha_0 + \alpha_1 \hat{\varepsilon}_{t-1}^2 + \alpha_2 \hat{\varepsilon}_{t-2}^2 + \ldots + \alpha_q \hat{\varepsilon}_{t-q}^2 + e_t \qquad (3)$$

The ARCH(q) effect is carried out by testing the statistical significance coefficients $\alpha_0 = \ldots = \alpha_q = 0$.

Under the null hypothesis, the conditional homoskedasticity is tested. The LM statistic is asymptotically distributed as a chi-squared χ^2.

In a second step, once conditional heteroskedasticity in the residuals is established, the GARCH model is estimated. The order of GARCH is determined by significance of β's and φ's in (2). Our results suggest that a GARCH (1,1) specification is sufficient[1] for the following pair-countries: Chile-Euro area and Chile-United States, New-Zealand-China, New-Zealand- United States. A GARCH (1,2) is better for Chile-China. A GARCH (2,2) is better for New-Zealand-Euro area [2]

Next, the moving standard deviation measure of volatility is as follows:

$$Vol_t = \left[(1/m).\sum_{i=1}^{m}(ER_{t+i-1} - ER_{t+i-2})^2 \right]^{1/2}$$

ER: exchange rate; m: 12 or 60 observations according to the measure.

1. Other studies found a GARCH (1,1) specification like (Doyle, 2001).

2. All detailed results are available upon request.

Annex D.
Results of F-test for cointegration among variables

Table D.1. Results with GARCH volatility

	Import-Value Model		Export-Value Model	
	Optimum lags	F-statistic	Optimum lags	F-statistic
New Zealand / China				
Agriculture Sector	12,2,0,0	(1.27)	1,0,0,0	7.52
Non-Agriculture Sector	12,0,2,0	(2.11)	1,0,0,0	13.07
New Zealand / Euro Area				
Agriculture Sector	1,0,0,1	10.31	12,0,0,0	4.94
Non-Agriculture Sector	10,3,4,0	5.94	2,0,0,0	4.47
New Zealand / US				
Agriculture Sector	11,0,5,3	(1.83)	12,2,1,0	7.64
Non-Agriculture Sector	4,0,1,4	7.39	1,0,0,0	14.46
	Import-Value Model		**Export-Value Model**	
	Optimum lags	**F-statistic**	**Optimum lags**	**F-statistic**
Chile / China				
Agriculture Sector	1,5,0,0	10.06	1,9,0,8	11.03
Non-Agriculture Sector	1,11,0,0	6.82	4,1,0,2	5.80
Chile / Euro Area				
Agriculture Sector	1,11,6,1	7.01	12,0,0,0	5.34
Non-Agriculture Sector	1,12,11,2	10.47	3,1,0,0	4.38
Chile / US				
Agriculture Sector	1,0,0,0	4.64	12,1,1,3	3.99
Non-Agriculture Sector	2,0,1,0	9.12	3,0,0,0	4.95

Note: Critical values at 5% and 10 % if the model includes a constant and a trend are [4.066; 5.119] and [3.484; 4.458]

Critical values at 5% and 10 % if the model includes a constant only are [3.219; 4.378] and [2.711; 3.800].

Results that are reported in italic mean that we cannot conclude. Those in brackets correspond to a rejection of the test.

A trend is included in the models Chile-China, Chile-US non agriculture exports, New Zealand-China, New Zealand-Euro Area imports, New Zealand-US.

Table D.2. Results with five-year standard deviation volatility measure

	Import-Value Model		Export-Value Model	
	Optimum lags	**F-statistic**	**Optimum lags**	**F-statistic**
New Zealand / China				
Agriculture Sector	12,12,0,11	*3.78*	3,0,0,1	10.13
Non-Agriculture Sector	12,0,12,12	4.50	1,0,0,0	11.07
New Zealand / Euro Area				
Agriculture Sector	1,0,0,0	9.95	6,4,0,11	9.37
Non-Agriculture Sector	12,0,12,7	5.65	2,0,0,0	3.96
New Zealand / United States				
Agriculture Sector	11,4,1,0	5.28	12,0,1,0	7.84
Non-Agriculture Sector	4,0,11,2	9.89	6,2,8,7	7.50
	Import-Value Model		**Export-Value Model**	
	Optimum lags	**F-statistic**	**Optimum lags**	**F-statistic**
Chile / China				
Agriculture Sector	1,0,0	12.20	9,9,1,9	6.85
Non-Agriculture Sector	1,10,0,2	8.06	3,2,0,3	6.55
Chile / Euro Area				
Agriculture Sector	1,3,0,0	8.83	12,0,0,0	5.19
Non-Agriculture Sector	1,12,11,2	13.96	3,0,0,1	5.45
Chile / US				
Agriculture Sector	11,11,2,6	5.52	12,0,0,0	4.13
Non-Agriculture Sector	2,0,1,0	7.99	1,1,0,10	15.58

Note: Critical values at 5% and 10 % if the model includes a constant and a trend are [4.066; 5.119] and [3.484; 4.458]

Critical values at 5% and 10 % if the model includes a constant only are [3.219; 4.378] and [2.711; 3.800].

Results that are reported in italic mean that we cannot conclude. Those in brackets correspond to a rejection of the test.

A trend is included in the models Chile-China, Chile-US non agriculture exports, New Zealand-China, New Zealand-Euro Area imports, New Zealand-US.

Annex E.
Estimated short-run effects

GARCH results

Table E.1. Estimated short-run effects of import function (vol= GARCH)

Pair country and Variables	Lag order											
	0	**1**	**2**	**3**	4	5	**6**	**7**	**8**	**9**	**10**	**11**
						New Zealand - China						
						AGRICULTURE SECTOR						
ΔLnY	-6.22 (1.44)	9.28** (2.13)										
ΔlnER	0.00 (0.00)											
ΔlnVol	-0.01 (0.50)											
						NON-AGRICULTURE SECTOR						
ΔLnY	-0.29 (0.56)											
ΔlnER	0.34 (1.22)	0.82*** (2.72)										
ΔlnVol	0.03** (2.03)											
						New Zealand - Euro Area						
						AGRICULTURE SECTOR						
ΔLnY	-0.27 (0.61)											
ΔlnER	0.56** (2.07)											
ΔlnVol	-0.00 (0.45)											
						NON-AGRICULTURE SECTOR						
ΔLnY	2.97 (1.04)	4.64 (1.30)	5.17* (1.70)									
ΔlnER	0.69 (1.47)	-0.15 (0.32)	-2.16*** (4.57)	-1.74*** (3.41)								
ΔlnVol	0.08*** (3.99)											
						New Zealand – United States						
						AGRICULTURE SECTOR						
ΔLnY	-0.71 (0.99)											
ΔlnER	-0.61 (1.19)	-1.50 (0.34)	-10.55** (2.41)	3.85*** (3.43)	-1.83** (2.32)							
ΔlnVol	6.00 (1.57)	-7.33 (1.61)	-8.29*** (3.05)									
						NON-AGRICULTURE SECTOR						
ΔLnY	-0.51 (0.62)											
ΔlnER	0.90 (1.46)											
ΔlnVol	3.44 (1.61)	1.07* (1.92)	0.65 (1.13)	1.14** (2.05)								

Note: t-ratios in absolute value are reported in brackets.

Table E.2. Estimated short-run effects of export function (vol= GARCH)

Pair country and Variables	Lag order											
	0	**1**	**2**	**3**	**4**	**5**	**6**	7	8	9	10	11
New Zealand - China												
AGRICULTURE SECTOR												
ΔLnY	0.61											
	(0.98)											
ΔlnER	0.41**											
	(2.34)											
ΔlnVol	0.02											
	(0.49)											
NON-AGRICULTURE SECTOR												
ΔLnY	2.14***											
	(3.60)											
ΔlnER	0.84***											
	(4.80)											
ΔlnVol	0.02											
	(0.73)											
New Zealand - Euro Area												
AGRICULTURE SECTOR												
ΔLnY	0.43											
	(1.53)											
ΔlnER	0.73***											
	(2.99)											
ΔlnVol	0.00											
	(0.20)											
NON-AGRICULTURE SECTOR												
ΔLnY	1.98***											
	(3.60)											
ΔlnER	0.98**											
	(2.32)											
ΔlnVol	0.06*											
	(1.70)											
New Zealand – United States												
AGRICULTURE SECTOR												
ΔLnY	1.22	5.76***										
	(0.57)	(2.67)										
ΔlnER	-0.19											
	(0.44)											
ΔlnVol	-0.55											
	(0.65)											
NON-AGRICULTURE SECTOR												
ΔLnY	0.67											
	(1.27)											
ΔlnER	-0.03											
	(0.07)											
ΔlnVol	0.21											
	(0.34)											

Note: t-ratios in absolute value are reported in brackets.

Table E.3. Estimated short-run effects of import function (vol= GARCH)

Pair country & Variables	Lag order											
	0	**1**	**2**	**3**	4	5	**6**	**7**	**8**	**9**	**10**	**11**
Chile - China												
AGRICULTURE SECTOR												
ΔLnY	-0.02 (0.02)	-2.52 (1.50)	-1.35 (0.99)	-1.42 (1.34)	- 3.75*** (3.19)							
ΔlnER	-0.68 (1.43)											
ΔlnVol	0.00 (0.06)											
NON-AGRICULTURE SECTOR												
ΔLnY	-0.23 (0.67)	- 6.60*** (4.33)	-5.80*** (3.96)	-4.81*** (3.58)	-3.30** (2.50)	-3.01*** (2.91)	-2.14** (2.32)	-1.41* (1.68)	-1.08 (1.42)	-1.16* (1.98)	0.87** (2.00)	
ΔlnER	-0.44** (2.27)											
ΔlnVol	-0.03 (1.56)											
Chile - Euro Area												
AGRICULTURE SECTOR												
ΔLnY	0.35 (0.83)	-1.01 (1.51)	-1.61** (2.38)	-0.00 (0.00)	-0.32 (0.49)	0.59 (0.95)	0.83 (1.32)	1.29** (2.20)	0.43 (0.76)	0.42 (0.86)	0.96** (2.38)	1.12** (2.13)
ΔlnER	0.66 (1.19)	0.19 (0.33)	-1.01 (1.60)	1.99*** (3.41)	-1.26** (2.14)	-1.30** (2.28)						
ΔlnVol	-0.05 (1.46)											0.07 (1.41)
NON-AGRICULTURE SECTOR												
ΔLnY	1.56*** (2.83)	-0.76 (1.32)	-0.30 (0.53)	0.38 (072)	1.09** (2.11)	1.68*** (3.29)	1.74*** (3.37)	1.50*** (2.88)	1.76*** (3.37)	1.38** (2.62)	1.37** (2.55)	0.68 (1.28)
ΔlnER	0.11 (0.30)	0.09 (0.24)	0.39 (0.99)	0.42 (1.09)	0.30 (0.77)	-0.92** (2.52)	0.16 (0.40)	-0.19 (0.50)	-0.11 (0.29)	-0.22 (0.56)	1.16*** (3.00)	
ΔlnVol	0.02 (1.20)	0.03 (1.45)										
Chile – United States												
AGRICULTURE SECTOR												
ΔLnY	1.56*** (3.61)											
ΔlnER	-0.66 (1.32)											
ΔlnVol	0.00 (0.03)											
NON-AGRICULTURE SECTOR												
ΔLnY	1.12*** (6.54)											
ΔlnER	0.27 (0.60)											
ΔlnVol	0.04** (2.39											

Note: t-ratios in absolute value are reported in brackets.

Table E.4. Estimated short-run effects of export function (vol= GARCH)

Pair country and Variables	Lag order											
	0	**1**	**2**	**3**	**4**	**5**	**6**	7	8	9	10	11
Chile - China												
AGRICULTURE SECTOR												
ΔLnY	-1.19	2.54	1.76	-0.01	-0.72	-2.43	-3.81**	-3.79***	-1.47			
	(1.46)	(1.32)	(0.93)	(0.00)	(0.45)	(1.60)	(2.56)	(2.85)	(1.54)			
ΔlnER	-0.40											
	(0.76)											
ΔlnVol	-0.03	-0.28***	-0.32***	-0.26***	-0.09	-0.12	-0.17**	-0.13**				
	(0.40)	(2.93)	(3.55)	(3.13)	(1.09)	(1.57)	(2.39)	(2.05)				
NON-AGRICULTURE SECTOR												
ΔLnY	0.22											
	(0.31)											
ΔlnER	-0.65											
	(1.64)											
ΔlnVol	-0.06	-0.11**										
	(1.21)	(2.13)										
Chile - Euro Area												
AGRICULTURE SECTOR												
ΔLnY	1.38***											
	(5.32)											
ΔlnER	0.48***											
	(4.31)											
ΔlnVol	0.01											
	(0.48)											
NON-AGRICULTURE SECTOR												
ΔLnY	4.32***											
	(2.97)											
ΔlnER	-0.41*											
	(1.76)											
ΔlnVol	0.02											
	(0.59)											
Chile – United States												
AGRICULTURE SECTOR												
ΔLnY	-0.57											
	(0.29)											
ΔlnER	-0.27											
	(0.54)											
ΔlnVol	0.00	-0.15***	-0.08*									
	(0.02)	(3.26)	(1.69)									
NON-AGRICULTURE SECTOR												
ΔLnY	3.41***											
	(3.71)											
ΔlnER	0.53*											
	(1.85)											
ΔlnVol	-0.03											
	(1.12)											

Note: t-ratios in absolute value are reported in brackets.

Volatility measured as a five-year moving standard deviation

Table E.5. Estimated short-run effects of import function (vol= 5-year MSD)

Pair country and Variables	Lag order											
	0	1	2	3	4	5	6	7	8	9	10	11
New Zealand - China												
AGRICULTURE SECTOR												
ΔLnY	-7.38	2.32	-16.21**	-6.68	-5.20	-8.91	1.62	-12.38*	-8.85	0.34	-10.66	-9.01
	(1.54)	(0.38)	(2.45)	(0.99)	(0.77)	(1.21)	(0.23)	(1.75)	(1.20)	(0.05)	(1.58)	(1.50)
ΔlnER	0.53*											
	(1.98)											
ΔlnVol	1.10	-5.23**	2.55	-2.11	-0.67	1.94	-2.95	2.06	0.39	-4.11	5.47***	
	(0.90)	(2.30)	(1.16)	(0.94)	(0.29)	(0.80)	(1.22)	(0.90)	(0.17)	(1.63)	(2.86)	
NON-AGRICULTURE SECTOR												
ΔLnY	0.94*											
	(1.69)											
ΔlnER	0.62**	0.13	0.36	-0.23	0.17	0.38	0.58*	-0.19	0.36	0.51	0.73**	0.81**
	(2.02)	(0.42)	(1.17)	(0.70)	(0.52)	(1.13)	(1.75)	(0.57)	(1.09)	(2.47)	(2.00)	(2.40)
ΔlnVol	-0.72	0.64	0.40	-1.97*	1.90*	-1.85	2.03	-1.86	0.22	-1.00	3.32**	-3.27***
	(1.35)	(0.72)	(0.41)	(1.91)	(1.72)	(1.54)	(1.62)	(1.45)	(0.18)	(0.74)	(2.44)	(3.37)
New Zealand - Euro Area												
AGRICULTURE SECTOR												
ΔLnY	1.42											
	(1.44)											
ΔlnER	0.60**											
	(2.14)											
ΔlnVol	0.19											
	(1.59)											
NON-AGRICULTURE SECTOR												
ΔLnY	5.14***											
	(4.16)											
ΔlnER	0.85*	-1.96***	-3.75***	-2.91***	-1.52**	-2.41***	-0.62	-0.91	-1.35**	-0.93*	-0.86	-0.64
	(1.76)	(3.38)	(6.56)	(4.57)	(2.40)	(4.06)	(1.10)	(1.65)	(2.44)	(1.70)	(1.60)	(1.21)
ΔlnVol	1.39**	-0.98	-0.74	0.29	0.44	-1.72*	2.00***					
	(2.02)	(1.13)	(0.86)	(0.34)	(0.50)	(1.96)	(2.73)					
New Zealand – United States												
AGRICULTURE SECTOR												
ΔLnY	3.82	3.43	-11.02**	5.25								
	(1.00)	(0.80)	(2.59)	(1.38)								
ΔlnER	-0.19											
	(0.40)											
ΔlnVol	-0.34***											
	(4.23)											
NON-AGRICULTURE SECTOR												
ΔLnY	1.00											
	(0.81)											
ΔlnER	1.20*	0.69	1.70**	0.92	2.10***	0.02	1.72**	1.26*	0.85	1.70**	1.30*	
	(1.88)	(1.05)	(2.60)	51.34)	(2.93)	(0.03)	(2.28)	(1.71)	(1.17)	(2.45)	(1.82)	
ΔlnVol	-0.63	-2.05										
	(0.40)	(1.33)										

Note: t-ratios in absolute value are reported in brackets.

Table E.6. Estimated short-run effects of export function (vol = 5-year MSD)

Pair country & Variables	Lag order											
	0	1	2	3	4	5	6	7	8	9	10	11
New Zealand - China												
AGRICULTURE SECTOR												
ΔLnY	1.06*											
	(1.81)											
ΔlnER	0.46**											
	(2.63)											
ΔlnVol	1.17***											
	(2.72)											
NON-AGRICULTURE SECTOR												
ΔLnY	2.10***											
	(3.59)											
ΔlnER	0.91***											
	(5.39)											
ΔlnVol	0.06											
	(0.96)											
New Zealand - Euro Area												
AGRICULTURE SECTOR												
ΔLnY	-1.10	-1.59	-2.62*	-4.64***								
	(0.80)	(1.12)	(1.84)	(3.48)								
ΔlnER	0.31											
	(0.92)											
ΔlnVol	0.27	-1.61	-0.96	1.97*	-0.04	-1.25	-0.59	-0.10	-2.09	5.17***	-1.38	
	(0.35)	(1.59)	(0.95)	(1.91)	(0.04)	(1.25)	(0.55)	(0.08)	(1.64)	(4.23)	(1.38)	
NON-AGRICULTURE SECTOR												
ΔLnY	1.58***											
	(2.84)											
ΔlnER	1.24***											
	(2.74)											
ΔlnVol	-0.09											
	(1.16)											
New Zealand – United States												
AGRICULTURE SECTOR												
ΔLnY	-0.53											
	(1.15)											
ΔlnER	-0.44											
	(1.10)											
ΔlnVol	0.11**											
	(2.15)											
NON-AGRICULTURE SECTOR												
ΔLnY	0.25	5.36**										
	(0.11)	(2.34)										
ΔlnER	0.01	-0.60	0.12	-1.00**	-1.35**	-1.23**	-0.55	-1.53***				
	(0.02)	(1.20)	(0.25)	(2.06)	(2.59)	(2.46)	(1.09)	(3.09)				
ΔlnVol	2.46*	-5.07***	6.11***	-4.38**	5.65***	-4.86**	1.80					
	(1.99)	(2.76)	(3.12)	(2.23)	(2.82)	(2.33)	(1.29)					

Note: t-ratios in absolute value are reported in brackets.

Table E.7. Estimated short-run effects of import function (vol= 5-year MSD)

Pair country & Variables	Lag order											
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Chile - China												
AGRICULTURE SECTOR												
ΔLnY	0.79 (0.97)											
ΔlnER	-0.71* (1.87)											
ΔlnVol	-0.31** (1.99)											
NON-AGRICULTURE SECTOR												
ΔLnY	-0.28 (0.79)	-8.46*** (5.62)	-7.74*** (5.55)	-6.73*** (5.28)	-5.71*** (5.60)	- 4.81*** (4.92)	-4.06*** (5.19)	-3.21*** (4.88)	-2.63*** (5.17)	- 2.23*** (6.12)		
ΔlnER	-0.42** (2.04)											
ΔlnVol	1.41* (1.72)	-2.61*** (3.28)										
Chile - Euro Area												
AGRICULTURE SECTOR												
ΔLnY	0.54 (1.52)	-1.02** (2.15)	-1.46*** (3.85)									
ΔlnER	-0.04 0.23)											
ΔlnVol	-0.18* (1.86)											
NON-AGRICULTURE SECTOR												
ΔLnY	2.45*** (3.99)	0.36 (0.50)	0.72 (1.09)	1.36** (2.17)	2.12*** (3.44)	2.77*** (4.46)	2.76*** (4.50)	2.46*** (3.99)	2.62*** (4.29)	2.29*** (3.67)	2.23*** (3.59)	1.52** (2.46)
ΔlnER	0.15 (0.38)	-0.29 (0.71)	-0.36 (0.86)	-0.21 (0.51)	-0.08 (0.20)	- 1.34*** (3.30)	-0.12 (0.28)	-0.51 (1.26)	-0.47 (1.15)	-0.42 (1.03)	0.68 (1.65)	
ΔlnVol	0.75 (0.80)	1.58* (1.77)										
Chile – United States												
AGRICULTURE SECTOR												
ΔLnY	**1.36** **-1.46)**	**-2.46**** **(2.13)**	**-2.50*** **(1.87)**	**-2.52*** **(1.81)**	**-0.31** **(0.21)**	**1.28** **(0.93)**	**3.17**** **(2.27)**	**2.28*** **(1.75)**	**2.97**** **(2.35)**	**2.57**** **(2.41)**	**4.11***** **(4.72)**	
ΔlnER	**0.90** **(0.62)**	**2.65*** **(1.74)**										
ΔlnVol	**-1.62** **(0.34)**	**-3.48** **(0.46)**	**-1.17** **(0.15)**	**15.94**** **(2.16)**	**-14.57**** **(2.13)**	**7.30*** **(1.76)**						
NON-AGRICULTURE SECTOR												
ΔLnY	1.12*** (5.11)											
ΔlnER	0.37 (0.86)											
ΔlnVol	(0.02 (0.23)											

Note: t-ratios in absolute value are reported in brackets.

Table E.8. Estimated short-run effects of export function (vol = 5-year MSD)

Pair country & Variables	Lag order											
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Chile - China												
AGRICULTURE SECTOR												
ΔLnY	-1.54	2.22	1.58	-1.03	-1.84	-2.75**	-4.41***	-4.55***	-1.95**			
	(1.81)	(0.88)	(0.65)	(0.44)	(0.86)	(1.42)	(2.68)	(3.42)	(2.16)			
ΔlnER	-0.16											
	(0.13)											
ΔlnVol	0.24	-8.59**	7.53*	3.95	-4.46	4.84	1.19	-5.63	7.64***			
	(0.09)	(2.01)	(1.81)	(0.93)	(1.05)	(1.19)	(0.30)	(1.50)	(2.82)			
NON-AGRICULTURE SECTOR												
ΔLnY	-0.26	1.47**										
	(0.37)	(2.08)										
ΔlnER	-0.79**											
	(2.19)											
ΔlnVol	0.81	0.42	-2.77									
	(0.44)	(0.15)	(1.38)									
Chile - Euro Area												
AGRICULTURE SECTOR												
ΔLnY	1.36***											
	(5.14)											
ΔlnER	0.42***											
	(2.98)											
ΔlnVol	0.02											
	(0.50)											
NON-AGRICULTURE SECTOR												
ΔLnY	1.94***											
	(3.41)											
ΔlnER	-0.26											
	(0.89)											
ΔlnVol	-2.35**											
	(2.08)											
Chile – United States												
AGRICULTURE SECTOR												
ΔLnY	0.62											
	(1.21)											
ΔlnER	0.04											
	(0.15)											
ΔlnVol	0.18**											
	(2.42)											
NON-AGRICULTURE SECTOR												
ΔLnY	2.28											
	(0.78)											
ΔlnER	0.76*											
	(1.83)											
ΔlnVol	1.61	0.18	-2.46	13.72***	-3.26	-4.00	6.00	-5.42	1.93	4.25*		
	(0.57)	(0.04)	(0.56)	(3.15)	(0.72)	(0.97)	(1.57)	(1.42)	(0.54)	(1.82)		

Note: t-ratios in absolute value are reported in brackets.

Annex F.
Estimated long-run effects

Table F.1. Estimated long-run effects –Import model (vol=GARCH)

	constant	lnY	lnER	LnVol	ECM_{t-1}
New Zealand - China					
Agr Sector	7.25 (0.31)	-0.82 (0.95)	0.00 (0.00)	-0.01 (0.52)	-1.04** (2.62)
Non Agr Sector	8.59 (1.14)	-0.51 (0.55)	-0.27 (1.01)	0.05* (1.67)	-0.57** (2.35)
New Zealand - Euro Area					
Agr Sector	5.01 (0.84)	-0.42 (0.62)	0.88** (2.07)	-0.09** (2.27)	-0.64*** (7.57)
Non Agr Sector	-9.22** (2.36)	1.66*** (3.75)	1.18*** (3.02)	0.08*** (2.81)	-1.00*** (3.31)
New Zealand – United States					
Agr Sector	8.52 (1.20)	-0.85 (1.06)	-4.95* (1.81)	7.52* (1.96)	-0.83** (2.54)
Non Agr Sector	9.24 (1.24)	-0.52 (0.62)	-3.47 (1.42)	5.34 (0.13)	-0.98*** (6.57)

Table F.2. Estimated long-run effects –Export model (vol=GARCH)

	constant	lnY	lnER	LnVol	ECM_{t-1}
New Zealand - China					
Agr Sector	-0.83 (0.17)	1.07 (0.97)	0.73** (2.40)	0.03 (0.50)	-0.56*** (6.86)
Non Agr Sector	-9.18** (2.32)	2.95*** (3.38)	1.16*** (4.96)	0.03 (0.72)	-0.73*** (8.61)
New Zealand - Euro Area					
Agr Sector	0.70 (0.28)	0.80 (1.55)	1.34*** (2.78)	0.00 (0.21)	-0.54*** (3.61)
Non Agr Sector	-12.53*** (3.28)	3.36*** (4.26)	1.66** (2.55)	0.10* (1.71)	-0.59*** (5.51)
New Zealand – United States					
Agr Sector	6.35*** (4.91)	-0.38 (1.34)	1.04*** (2.81)	-0.32 (0.66)	-1.74*** (7.08)
Non Agr Sector	0.79 (0.24)	0.91 (1.28)	-0.05 (0.07)	0.28 (0.33)	-0.74*** (10.20)

Note: t-ratio in absolute value are reported in brackets.

Table F.3. Estimated long-run effects –Import model (vol=GARCH)

	constant	lnY	lnER	LnVol	ECM_{t-1}
Chile - China					
Agr Sector	-14.97	5.26**	-0.90	-0.00	-0.76***
	(1.18)	(2.00)	(1.44)	(0..06)	(8.34)
Non Agr Sector	-26.55**	9.22***	-0.74**	-0.05	-0.60***
	(2.61)	(4.10)	(2.20)	(1.60)	(6.12)
Chile - Euro Area					
Agr Sector	-2.07	3.01***	-0.48	0.04	-0.58***
	(0.49)	(5.39)	(1.38)	(0.64)	(6.21)
Non Agr Sector	3.12***	2.26***	-0.19**	-0.01	-1.23***
	(3.21)	(10.21)	(2.00)	(0.66)	(11.79)
Chile – United States					
Agr Sector	2.73	3.46***	-1.46	0.00	-0.45***
	(0.28)	(3.95)	(1.38)	(0.04)	(6.06)
Non Agr Sector	15.00***	2.63***	-2.35***	0.09**	-0.43***
	(4.96)	(9.36)	(6.83)	(2.42)	(7.69)

Table F.4. Estimated long-run effects –Export model (vol=GARCH)

	constant	lnY	lnER	LnVol	ECM_{t-1}
Chile - China					
Agr Sector	23.64*	-2.90	-0.52	0.43***	-0.76***
	(1.71)	(1.12)	(0.76)	(3.67)	(8.17)
Non Agr Sector	-4.98	1.81	-0.86*	0.03	-0.76***
	(0.73)	(1.47)	(1.79)	(0.42)	(5.11)
Chile - Euro Area					
Agr Sector	-70.19**	11.89***	4.16***	0.08	-0.12***
	(2.60)	(2.97)	(2.67)	(0.43)	(2.74)
Non Agr Sector	1.76	3.93***	-1.27*	0.05	-0.32***
	(0.22)	(3.13)	(1.71)	(0.56)	(3.72)
Chile – United States					
Agr Sector	-188.13	31.47	8.63	0.28	-0.07
	(0.46)	(0.50)	(0.46)	(0.46)	(0.51)
Non Agr Sector	-30.02***	7.62***	1.19*	-0.07	-0.45***
	(2.73	(4.15)	(1.80)	(1.12)	(4.22)

Note: t-ratio in absolute value are reported in brackets.

Table F.5. Estimated long-run effects –Import model (vol = 5-year MSD)

	constant	lnY	lnER	LnVol	ECM_{t-1}
New Zealand - China					
Agr Sector	-67.04*** (6.95)	7.88*** (6.70)	0.58* (1.66)	-0.58*** (4.40)	-0.91*** (3.06)
Non Agr Sector	-3.16 (0.61)	0.96 (1.52)	0.16 (0.99)	0.14** (2.30)	-0.97*** (2.72)
New Zealand - Euro Area					
Agr Sector	-16.64*** (1.30)	2.22 (1.46)	0.94** (2.16)	0.30* (1.63)	-0.64*** (7.42)
Non Agr Sector	-28.31*** (3.39)	3.85*** (3.93)	2.18*** (4.62)	0.22* (1.98)	-1.33*** (4.03)
New Zealand – United States					
Agr Sector	-12.59* (1.86)	1.68** (2.16)	0.97*** (5.05)	-0.22*** (4.25)	-1.51*** (4.62)
Non Agr Sector	-1.04** (2.23)	0.80 (0.82)	0.20 (0.73)	-0.04 (0.54)	-1.25*** (7.13)

Table F.6. Estimated long-run effects –Export model (vol = 5-year MSD)

	constant	lnY	lnER	LnVol	ECMt-1
New Zealand - China					
Agr Sector	-2.27 (0.66)	1.38* (1.81)	0.59*** (2.75)	0.08 (0.98)	-0.77*** (7.31)
Non Agr Sector	-8.52** (2.23)	2.87*** (3.39)	1.25*** (5.54)	0.08** (0.96)	-0.73*** (8.69)
New Zealand - Euro Area					
Agr Sector	1.28 (0.79)	0.79** (2.18)	0.33 (0.93)	-0.04 (0.71)	-0.95*** (7.49)
Non Agr Sector	-10.58** (2.63)	2.73*** (3.18)	2.14*** (3.10)	-0.16 (1.17)	-0.58*** (5.37)
New Zealand – United States					
Agr Sector	6.15*** (5.07)	-0.30 (1.20)	0.72*** (7.33)	0.06** (2.31)	-1.72*** (7.09)
Non Agr Sector	-4.33 (1.12)	1.86** (2.34)	1.09*** (3.42)	0.20*** (2.95)	0.92*** (6.16)

Note: t-ratio in absolute value are reported in brackets.

Table F.7. Estimated long-run effects –Import model (vol = 5-year MSD)

	constant	lnY	lnER	LnVol	ECMt-1
Chile - China					
Agr Sector	3.99	1.15	-1.02*	-0.44**	-0.69***
	(0.64)	(0.95)	(1.90)	(2.11)	(7.84)
Non Agr Sector	-35.93***	11.28***	-0.63**	0.04	-0.67***
	(3.51)	(5.08)	(2.02)	(0.42)	(6.89)
Chile - Euro Area					
Agr Sector	0.20	2.19***	-0.05	-0.26*	-0.72***
	(0.08)	(4.29)	(0.23)	(1.97)	(8.35)
Non Agr Sector	2.01**	2.08***	(0.19	-0.15*	-1.27***
	(2.19)	(7.53)	(0.68)	(1.94)	(12.48)
Chile – United States					
Agr Sector	10.94	3.41**	-3.60***	1.33**	-0.46***
	(0.93)	(2.66)	(2.81)	(2.38)	(3.88)
Non Agr Sector	11.05***	2.79***	-1.76***	0.04	-0.40***
	(2.79)	(7.01)	(3.94)	(0.23)	(7.08)

Table F.8. Estimated long-run effects –Export model (vol = 5-year MSD)

	constant	lnY	lnER	LnVol	ECMt-1
Chile - China					
Agr Sector	10.04	-1.49	1.03***	0.36*	-1.80***
	(1.26)	(0.94)	(3.43)	(1.88)	(5.87)
Non Agr Sector	21.30**	1.77	-1.16**	1.09***	-0.69***
	(2.17)	(3.39)	(2.47)	(2.79)	(4.78)
Chile - Euro Area					
Agr Sector	-61.55***	10.97***	3.41***	0.18	-0.12***
	(4.03)	(3.80)	(3.23)	(0.48)	(3.46)
Non Agr Sector	-5.54***	4.62***	-0.63	0.08	-0.42***
	(2.91)	(5.20)	(0.83)	(0.43)	(4.48)
Chile – United States					
Agr Sector	-11.24	3.71	0.25	1.09	-0.17
	(0.33)	(0.79)	(0.14)	(1.26)	(1.27)
Non Agr Sector	-24.28***	6.80***	0.67*	-0.10	-1.14***
	(4.80)	(8.85)	(1.87)	(0.82)	(11.83)

Note: t-ratio in absolute value are reported in brackets.

Annex G.
Diagnostic tests

Table G.1. Diagnostic tests with GARCH volatility measure

	Import-Value Model				
	$\bar{R}^2$	**CUSUM**	**CUSUMQ**	**LM**[a]	**RESET**[b]
New Zealand / China					
Agr Sector	0.46	*unstable*	stable	20.60	2.82
Non-Agr Sector	0.62	stable	stable	20.98	0.12
New Zealand / Euro Area					
Agr Sector	0.33	stable	stable	27.60	0.88
Non-Agr Sector	0.62	stable	*unstable*	21.58	0.47
New Zealand / US					
Agr Sector	0.57	stable	stable	12.42	0.02
Non-Agr Sector	0.50	stable	stable	7.65	0.03
	Export-Value Model				
	$\bar{R}^2$	**CUSUM**	**CUSUMQ**	**LM**	**RESET**
New Zealand / China					
Agr Sector	0.28	stable	stable	28.22	0.26
Non-Agr Sector	0.42	*unstable*	stable	18.07	0.14
New Zealand / Euro Area					
Agr Sector	0.42	stable	stable	17.56	0.18
Non-Agr Sector	0.44	stable	stable	20.27	0.28
New Zealand / US					
Agr Sector	0.59	stable	stable	15.03	0.43
Non-Agr Sector	0.60	stable	stable	24.81	3.58

Table G.2. Diagnostic tests with GARCH volatility measure

	Import-Value Model				
	$\bar{R}^2$	CUSUM	CUSUMQ	LM[a]	RESET[b]
Chile / China					
Agr Sector	0.42	stable	stable	18.43	0.12
Non-Agr Sector	0.57	stable	stable	17.80	1.44
Chile / Euro Area					
Agr Sector	0.51	unstable	stable	13.29	0.04
Non-Agr Sector	0.71	stable	stable	16.85	0.27
Chile / US					
Agr Sector	0.23	unstable	stable	22.93	0.20
Non-Agr Sector	0.49	stable	stable	16.58	0.08
	Export-Value Model				
	$\bar{R}^2$	CUSUM	CUSUMQ	LM	RESET
Chile / China					
Agr Sector	0.43	stable	stable	16.50	0.30
Non-Agr Sector	0.45	*stable*	stable	5.90	0.89
Chile / Euro Area					
Agr Sector	0.76	stable	stable	19.77	1.09
Non-Agr Sector	0.47	stable	stable	18.96	0.10
Chile / United States					
Agr Sector	0.83	stable	stable	12.87	1.50
Non-Agr Sector	0.43	stable	stable	8.05	0.15

Table G.3. Diagnostic tests with five-year moving standard deviation volatility measure

	Import-Value Model				
	$\bar{R}^2$	CUSUM	CUSUMQ	LM[a]	RESET[b]
New Zealand / China					
Agr Sector	0.54	stable	stable	20.79	0.48
Non-Agr Sector	0.69	stable	*stable*	19.50	0.43
New Zealand / Euro Area					
Agr Sector	0.31	stable	stable	28.22	0.22
Non-Agr Sector	0.62	stable	stable	14.41	0.20
New Zealand / US					
Agr Sector	0.60	stable	stable	26.82	0.02
Non-Agr Sector	0.53	stable	stable	17.16	0.08
	Export-Value Model				
	$\bar{R}^2$	CUSUM	CUSUMQ	LM	RESET
New Zealand / China					
Agr Sector	0.36	*unstable*	stable	17.61	1.34
Non-Agr Sector	0.42	*unstable*	stable	26.40	0.16
New Zealand / Euro Area					
Agr Sector	0.48	stable	stable	23.18	0.02
Non-Agr Sector	0.43	stable	Stable	18.90	0.03
New Zealand / US					
Agr Sector	0.62	stable	stable	16.00	2.64
Non-Agr Sector	0.73	stable	stable	23.51	0.14

[a] The Lagrange Multiplier Test (LM) of residual correlation is distributed as χ^2 with 12 degrees of freedom. At the 5% (1%) level of significance, its critical value is 21.03 (26.22)

[b] Ramsey's Reset test for functional misspecification is distributed as χ^2 with one degree of freedom. At the 5% significance level its critical value is 3.84.

Table G.4. Diagnostic tests with 5-year moving standard deviation volatility measure

	Import-Value Model				
	$\overline{R}^2$	**CUSUM**	**CUSUMQ**	LM[a]	RESET[b]
Chile / China					
Agr Sector	0.37	stable	stable	18.82	0.57
Non-Agr Sector	0.58	stable	stable	23.59	0.16
Chile / Euro Area					
Agr Sector	0.43	stable	stable	10.43	2.80
Non-Agr Sector	0.73	stable	stable	12.59	0.87
Chile / US					
Agr Sector	0.53	stable	stable	19.65	0.59
Non-Agr Sector	0.46	unstable	stable	15.66	0.03
	Export-Value Model				
	$\overline{R}^2$	**CUSUM**	**CUSUMQ**	**LM**	**RESET**
Chile / China					
Agr Sector	0.55	stable	stable	26.40	0.84
Non-Agr Sector	0.46	stable	stable	10.18	2.39
Chile / Euro Area					
Agr Sector	0.76	unstable	stable	18.54	1.07
Non-Agr Sector	0.48	unstable	stable	14.93	0.07
Chile / US					
Agr Sector	0.83	stable	stable	14.05	0.53
Non-Agr Sector	0.59	stable	stable	20.09	0.66

[a] The Lagrange Multiplier Test (LM) of residual correlation is distributed as χ^2 with 12 degrees of freedom. At the 5% (1%) level of significance, its critical value is 21.03 (26.22)

[b] Ramsey's Reset test for functional misspecification is distributed as χ^2 with one degree of freedom. At the 5% significance level its critical value is 3.84.