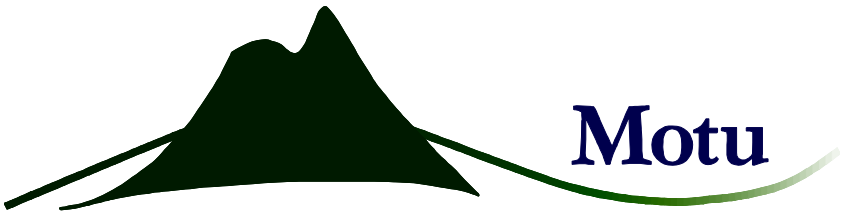

Exchange rate fluctuations and the margins of exports

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Disclaimer

The results in this paper are not official statistics, they have been created for research purposes from the Integrated Data Infrastructure (IDI) managed by Statistics New Zealand. The opinions, findings, recommendations and conclusions expressed in this paper are those of the authors, not Statistics NZ, the New Zealand Treasury or Motu.

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Careful consideration has been given to the privacy, security and confidentiality issues associated with using administrative and survey data in the IDI. Further detail can be found in the Privacy impact assessment for the Integrated Data Infrastructure available from www.stats.govt.nz.

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Abstract
This paper examines the relationship between exchange rate fluctuations and New Zealand export performance. To isolate the impact of the exchange rate, as opposed to contemporaneous (and related) fluctuations in New Zealand's economic performance or overseas market characteristics, we focus on bilateral export relationships at the firm level and control for both time-invariant country characteristics and changes in aggregate economic conditions. We examine two key margins of export adjustment – the probability of exporting (the extensive margin) and the average value of exports per firm (the intensive margin) – and distinguish between impacts on market incumbents and new or potential entrants. Finally, we specifically take account of the potential for interaction between the level and volatility of the exchange rate to affect exporting, as implied by theories of exchange rate hysteresis.

JEL codes
D22; F14; F31

Keywords
Margins of exports; Hysteresis; Exchange rates

1 Motivation

The impact of exchange rate fluctuations on export performance and investment incentives has been a significant topic of debate in New Zealand over the last decade. Alongside a sustained period of appreciation in the 2000s, the New Zealand dollar has exhibited substantial fluctuations against the currencies of major trading partners. Both the level and volatility of the exchange rate are cited by firms as challenging their ability to earn overseas income (Statistics New Zealand, 2012).

We examine the relationship between exchange rate fluctuations and New Zealand export performance. To isolate the impact of the exchange rate, as opposed to contemporaneous (and related) fluctuations in New Zealand's economic performance or overseas market characteristics, we focus on bilateral export relationships at the firm level and control for both time-invariant country characteristics and changes in aggregate economic conditions. We examine two key margins of export adjustment – the probability of exporting (the extensive margin) and the average value of exports per firm (the intensive margin) – and distinguish between impacts on market incumbents and new or potential entrants.

This distinction is important for understanding the sensitivity of aggregate exports to currency movements. If market entry is costly, a substantial fall in the relative value of the New Zealand dollar may be required to induce firms to enter a new market and export adjustment will generally have to come through intensive margin adjustments by existing exporters. Conversely, if individual firms' export supply curves are inelastic due to capacity constraints or quasi-fixed input levels, this will reduce the amount of adjustment that is possible by incumbent exporters.

We specifically take account of the potential for interaction between the level and volatility of the exchange rate to affect exporting, as implied by theories of exchange rate hysteresis (eg, Dixit, 1989; Campa, 2004). In the presence of export market entry costs, firms' market entry decisions are based not only on the current profitability of exporting (affected by the current exchange rate), but also by their expectations of future profitability. By breaking the link between the present and future expectations of the exchange rate, exchange rate volatility increases uncertainty about future profits and may therefore make firms less responsive to current exchange rate movements. While the individual impacts of exchange rate levels and volatility have received some attention in the empirical literature, this paper is, to our knowledge, the first study to address the interaction between levels and volatility.[1]

[1] In this sense, our paper is closest to Fitzgerald & Haller (2014), who compare firm level responses to exchange rate fluctuations with responses to tariff reductions. While the former involves significant uncertainty, the latter can be treated as having a permanent effect on expected export

We find significant impacts of bilateral exchange rate levels on both the propensity to export and the value of exports per firm×country relationship. On average, a ten percent increase in the bilateral exchange rate (corresponding to around one standard deviation over the sample period) reduces average exports to that destination by around three percent among committed exporters, and reduces the probability of a new firm entering the destination by around 0.04 percentage points. While the probability of exit is found to be unresponsive to exchange rate changes in general, this appears to be driven by a small group of high-value, committed export relationships. When we exclude those firm×country relationships which are observed in every year (and hence are unresponsive to observed exchange rate changes by definition) we find that a ten percent increase in the bilateral exchange rate reduces the probability of remaining in that market by 0.07 percentage points among the remaining exporters.

Consistent with theories of export hysteresis, export propensity is found to be more sensitive to exchange rate levels for destinations with low to moderate exchange rate volatility, consistent with firms placing greater weight on current exchange rates where these are seen as providing a stronger signal of future rates. In contrast, in countries where exchange rates have been historically volatile, firms do not appear to be influenced by the current level of the exchange rate when making market entry and exit decisions.

Estimated exchange rate impacts for exports to Australia differ strongly from those observed for other markets, consistent with Australia's geographic and cultural proximity providing a special environment for New Zealand exporters. While appreciation of the New Zealand dollar is negatively related to both export propensity and the value of exports per firm in other markets, for Australia we find that the probability of exporting increases with the bilateral exchange rate, perhaps suggesting that Australia has been seen as something of a "safe haven" in the face of global macroeconomic shocks.

We also compare the degree of exchange rate sensitivity across different types of firms finding, in particular, that greater product differentiation (a proxy for the ability to exercise market power) reduces exchange rate sensitivity, both in terms of export propensity and the value of export receipts among continuing exporters. In addition, we find that more sophisticated exporters (those that export to a greater number of countries) are less sensitive to bilateral exchange rates with their existing markets, both in terms of the value of exports and the probability of exiting the market. However, these firms appear to take a more calculated approach to market entry, with entry propensity being more strongly affected by the level of

returns. Fitzgerald & Haller (2014) show that firm-level exports react more strongly to the permanent tariff change than to temporary exchange rate movements.

the bilateral exchange rate than that of smaller exporters.

Section 2 sets out our conceptual framework and summarises the firm-level literature on the impacts of exchange rate fluctuations on export behaviour. Section 3 outlines the data and empirical methodology. Section 4 describes aggregate relationships between exchange rates and export performance and presents the firm-level empirical results. Section 5 concludes.

2 Conceptual Framework

Real appreciations of the New Zealand dollar relative to trading partner currencies affect the profitability of firms' export activities.[2] As the value of the New Zealand dollar rises, exporters must make a choice between maintaining market share relative to local producers by fixing the local currency price they charge consumers and accepting a reduction in their NZD-converted per-unit return, or maintaining their margins by fixing the NZD-converted per-unit return and instead accepting a reduction in demand as the local currency price increases in line with the exchange rate. In practice, pass-through of exchange rate movements is, on average, incomplete for New Zealand exporters (Fabling & Sanderson, 2015), suggesting a mixed strategy. Whichever strategy they follow, New Zealand dollar appreciations (depreciations) can be expected to reduce (increase) the total value of firms' export sales.[3]

In a static sense, this implies a negative relationship between the level of the New Zealand dollar relative to trading partner currencies, and the NZD-converted value of bilateral trade. However, exchange rate fluctuations can also be expected to have an indirect effect on future export receipts, due to costs and frictions associated with altering the volume of exports to a given destination. Recent advances in trade theory draw attention to the role of sunk entry costs in determining which firms export and under what conditions (eg, Melitz, 2003). These models assume that firms will enter an export market only when their expected future profits from that market outweigh the initial costs of entry. Under this assumption, exchange rate fluctuations can influence entry and exit decisions in a range of ways.

[2] Throughout the paper we define the exchange rate as the number of foreign currency units required to purchase one New Zealand dollar (NZD). An appreciation of the exchange rate implies an increase in the value of the NZD, reducing the competitiveness of New Zealand exporters.

[3] The strategy followed and the consequent impact of exchange rate fluctuations on export profitability will be affected by a range of factors, including the elasticity of demand in foreign markets, the share of production costs which are incurred in the foreign currency, and whether firms engage in exchange rate hedging.

If firms assume that exchange rates follow a random walk, their expectations of future rates (and hence future export profitability) will be correlated with the current level of the currency. Thus, current exchange rate levels can be expected to impact on export decisions through their impact on both the current value of exports (through direct impacts on the NZD-converted return on each unit of exports, or the quantity of New Zealand goods demanded in overseas markets), and the expected future value of exports (as high current levels raise the expected probability of high future levels). Alternatively, if firms believe that exchange rates are mean reverting, we would expect to see a much weaker relationship between the current level of the exchange rate and entry/exit decisions, as only firms which place a high value on current profits (for example due to a high discount rate, low entry costs, or very lumpy sales) will be influenced by current levels.[4]

Consensus forecasts of the NZD/USD exchange rate suggest that forward-looking exchange rate expectations over a two year horizon are anchored by the current level,[5] implying that even if analysts have definite expectations about the future direction of exchange rate changes, the current level remains an important factor in setting exchange rate expectations over the medium term. It is plausible that this relationship may be stronger for the currencies of smaller trading partners, as firms and analysts are less likely to have developed expectations about the future prospects of these countries and may therefore rely more heavily on current rates as an indicator.

Volatility in the exchange rate adds additional complexity to entry and exit decisions, by increasing the uncertainty associated with future export returns. When firms incur a sunk cost of market entry, a wedge is created between the exchange rate level at which firms would choose to enter a market and that at which incumbent exporters (including those with otherwise similar characteristics) would choose to exit. As firms require a more favourable exchange rate level to compensate for the uncertainty in future returns, volatility is expected to make entry decisions less responsive to changes in current exchange rate levels. Similarly, if firms anticipate that future movements may reverse a decline in export profitability, they may be more inclined to ride out unfavourable movements in the short-term.[6]

[4] Results from Fabling & Grimes (2015) suggest that New Zealand exporters to Australia anticipate mean reversion when exchange rates are at extremes (outside the 25th to 75th percentile of the historical distribution).

[5] Unpublished Treasury analysis based on data from Consensus Economics (www.consensuseconomics.com).

[6] Berthou (2008) examines the exchange rate responsiveness of bilateral exports, finding that New Zealand and Australia have among the lowest estimated elasticities of export value to the exchange rate. They argue that this may reflect the relative remoteness of the two countries, increasing the costs involved in each bilateral trade flow. However, it is not clear that this explanation can explain the country-specific results, as a number of European countries (including Germany,

At the same time, exchange rate volatility can be expected to have a direct effect on both the probability of exporting, and the desired level of exports. Clark (1973) (and later refinements by Hooper & Kohlhagen, 1978) show that risk aversion can generate a negative relationship between exchange rate volatility and exports, even with no change in the expected exchange rate level. If firms (managers) are risk averse, the firm's utility function is a direct function of the level of volatility. For a given expected value of future export profits, exchange rate volatility increases the uncertainty around that expectation, which reduces the perceived value to the risk-averse firm. This may affect decisions to export to particular markets, or encourage firms to limit their export intensity to reduce potential variation in overall profits.

While hysteresis is generally considered to primarily affect decisions about market entry and exit, there may also be hysteresis in the value of trade among incumbent exporters. This can occur if firms are locked into contractual arrangements to supply a good, have established distribution channels that generate an ongoing fixed cost which is insensitive to the volume of exports, or may reflect past investments in advertising and promotion.

While the individual impacts of exchange rate levels and volatility have received some attention in the empirical literature, this paper is, to our knowledge, the first study to address the interaction between level and volatility as implied by theoretical models of export hysteresis. In his seminal work on exchange rate hysteresis, Campa (2004) argues that exchange rate volatility may affect firm decisions about whether or not to enter export markets due to sunk costs of entry, as firms will be less willing to bear these up-front costs in the face of uncertain future returns. However, after the firm has borne these costs, volatility of the exchange rate should not affect export volumes, as the question of how much to export is a static decision based only on the current level of the exchange rate. In contrast, exchange rate levels affect both the decision of whether to export,[7] and, if so, how much. Campa (2004) examines the exporting behaviour of Spanish manufacturing firms finding that, while exchange rate levels have a significant effect on both export participation and export revenues, exchange rate volatility has no independent effect on either margin.[8]

Finland, Belgium, and Switzerland) also have estimated elasticities which are not significantly different from zero.

[7] Under the assumption that current exchange rates influence firms' expectations of the future exchange rate levels.

[8] Firm-level exchange rates are defined as either a weighted average of bilateral exchange rates with the firm's export partners in 1990 and 1994 (for exporters), or a weighted average of bilateral exchange rates with the top four export partners of other firms in the same industry (for non-exporters in both 1990 and 1994). The conditional variance of the exchange rate expected at

In contrast to Campa (2004), Greenaway et al. (2010) find that exchange rate uncertainty[9] affects export intensity among UK manufacturers, but not the export participation decision. Moreover, they suggest that the direction of uncertainty (whether the realised exchange rate is higher or lower than the expected exchange rate) influences the intensive margin effect. Both papers focus on exchange rate fluctuations at the firm or industry level, weighted by observed export destination composition, and then relate this to firm-level export participation. More recently, researchers have begun to distinguish the impacts of bilateral exchange rates on destination-specific export performance.

Fitzgerald & Haller (2014) compare firm-level reactions to changes in relative exchange rate levels across destination countries to those associated with changes in tariffs, identifying impacts on both the intensive and extensive margins among Irish manufacturing, mining and utilities firms. They find that firms are less responsive to changes in the exchange rate than to changes in tariffs, which they attribute to the greater certainty associated with tariff reductions. They also find that the aggregate impact of both exchange rate changes and tariff cuts is primarily due to changes in the export revenues received by incumbent exporters for their existing product line, rather than adjustments in either the number of entering and exiting exporters, or the number of products exported by incumbents.

This latter finding is supported by Berman et al. (2012), who show that while export market entry and exit among French firms are responsive to changes in exchange rates, the small size and lower productivity of the marginal entrant means they have little impact on aggregate export revenues. They find that around 90 percent of the aggregate impact of exchange rate fluctuations on export revenues are due to changes on the intensive margin. At the same time, Berman et al. (2012) find that the impact of exchange rate fluctuations on export revenues differs systematically across firms, with more productive firms inclined to absorb the exchange rate change into their margins, and hence exhibit a lower exchange rate response in terms of both export volume and unit values (though potentially a stronger impact on profitability).

We add to the literature by examining whether the predictions of the Dixit (1989) and Campa (2004) models are supported by observed patterns of exporting at the firm×country level, allowing for the current level of the exchange rate to interact with its recent volatility in determining firms' export decisions. We also follow Berman et al. (2012) in considering differences in export responses to exchange

the start of each year is forecast based on a GARCH(1,1) model using the behaviour of historical exchange rates up to the end of the previous year.

[9]Uncertainty is measured as the difference between the spot rate and the three month forward rate from three months earlier.

rate fluctuations across a range of firm characteristics.

3 Data and methodology

Firm-level data is sourced from the Longitudinal Business Database, which brings together a range of administrative and survey data linked to the Longitudinal Business Frame (see Fabling, 2009). In particular, this paper uses detailed shipment-level filings of merchandise trade data provided to the New Zealand Customs Service between January 1999 and September 2011. We supplement these trade data with firm-level activity indicators generated from goods and services tax (GST) returns, and aggregate data on bilateral real exchange rates and destination countries' gross domestic product (GDP) and population (see table A.1 for sources and construction of these data series). We limit attention to the 172 export destinations with available macroeconomic data.

The population of interest is defined as all active firms which exported to one or more of those destinations between January 2002 and September 2011, a total of 21,954 firms.[10] Firm and macroeconomic data from January 1999 onwards are used to generate indicators of firms' export history and bilateral exchange rate measures.[11]

We separately examine the impact of exchange rate fluctuations on the intensive (New Zealand dollar value of exports per firm×country relationship) and extensive (probability of observing positive firm×country exports) margins. The intensive margin analysis makes use of over 700,000 quarterly firm-level trade observations over this period, where an observation is defined as the NZD-converted value of firm-level exports to a particular destination in that quarter.[12] For the extensive margin analysis, we allow exchange rates to differentially affect firms' decisions to enter a market and their decision to continue exporting to an existing market, by distinguishing between incumbent exporters (defined as firms which have exported to that destination at least once over the previous three years) and potential entrants to the market.

When considering entry into new export markets, the relevant population includes

[10] All firm counts reported in this paper have been random rounded base three in accordance with Statistics New Zealand confidentiality requirements.

[11] A small number of shipments valued at less than NZD1000 are excluded from all calculations as they are below the threshold for mandatory Customs reporting.

[12] Trade data is available daily. We use quarterly aggregations to improve the identification of entry and exit at the firm level, while maintaining an ability to apply a plausible "representative" exchange rate to each period.

not only those firm×country export relationships which actually occurred, but also all other potential relationships which could have occurred. With 21,954 firms, 172 destinations and 39 quarters (2002Q1-2011Q3), this gives over 145 million potential trade observations, of which less than 0.02 percent are actually observed. We restrict this to a more manageable number in two ways. Firstly, we exclude any quarters in which the firm is inactive (defined as neither exporting nor filing a GST return with Inland Revenue). We then take a random sample of around 2.3 million observations from the active population, proportionate to the number of actual trade observations with each country (N_j) over the analysis period. Observations from Australia, the most common trade destination, are selected with a probability of one, while those from all other countries are selected with probability N_j/N_{Aust}.[13] This weighting scheme attempts to ensure that results reflect the impact of exchange rate fluctuations on actual export patterns, rather than a hypothetical world in which all markets are served equally.[14]

The impact of exchange rate fluctuations on the intensive margin is estimated through OLS regressions based on the following model:

$$\ln X_{ijt} = \beta_1 \ln RER_{jt} + \beta_2 \ln CoV_{jt} + \mathbf{Z}_{it}\gamma + \mathbf{V}_{jt}\phi + \mathbf{S}_i\eta + \psi_t + \mu_j + \epsilon_{ijt} \qquad (1)$$

where X_{ijt} is the value of exports by firm i to country j in quarter t, RER_{jt} captures the level of the bilateral real exchange rate between New Zealand and country j, CoV_{jt} is exchange rate volatility measured as the coefficient of variation of the monthly RER_{jt} over the previous 12 quarters,[15] $\mathbf{Z}_{it}$ captures the value and recency of firm i's past export experience, $\mathbf{V}_{jt}$ captures time-varying destination characteristics, $\mathbf{S}_i$ captures the seasonality of the firm's export product mix, and ψ_t and μ_j are a full set of quarter and destination dummies, respectively.[16] To allow for hysteresis in both the probability of exporting and the value of exports

[13] Excluding non-active firms gives us a little over 715,000 observations for Australia. For a country such as the United States, which sees approximately half as many actual quarterly trade observations as Australia, we would therefore select a random sample of around 358,000 observations from the pool of actual and potential firm trade quarters.

[14] For robustness, all extensive margin results are re-estimated using the same set of observations from Australia and a non-overlapping sample of observations from all other countries. The main results are robust to the alternative sample.

[15] The coefficient of variation is the standard deviation divided by the mean. Alternative measures of exchange rate volatility were also considered, including the gap between the maximum and minimum exchange rate levels over the past 12 quarters, and the gap between the 90th and 10th percentiles, both normalised by the mean level. The correlation between the three measures was very high (above 0.92 in all bilateral comparisons), and results for the main analysis did not differ markedly when using the alternative measures.

[16] In the main analysis, exchange rates are measured in the quarter in which the products were

per market, $\mathbf{Z}_{it}$ includes a set of controls capturing the firm's historical exports to market j, in addition to indicators of the firm's historical exports across all other markets to capture the firm's overall export propensity.[17] These variables are defined in detail in appendix table A.1, and a full set of summary statistics is provided in table A.2. The extensive margin equation is identical except for the dependent variable, which becomes a binary indicator, $\delta(X_{ijt})$, set to one if firm i exported to country j at time t and zero otherwise, and is estimated using a linear probability model to accommodate the size of the dataset and the use of a large number of fixed effects.

One difficulty in estimating the impact of exchange rates on export performance is the issue of selection – if an unfavourable exchange rate causes weaker firms to exit a market, the *average* export value of the remaining firms may actually increase, even if their individual export receipts fall. Ideally, this issue should be dealt with through the use of a selection model (eg, Heckman, 1979), in which export participation is modelled as a first stage equation, and then the secondary equation for export value is adjusted to reflect the impact of non-random selection. However, this modelling technique requires identification of an "exclusion restriction" – one or more variables which can reasonably be expected to affect the probability of exporting, but not the value of exports.[18] Since we lack a valid exclusion variable, we adapt the approach of Fitzgerald & Haller (2014) by estimating separate coefficients

shipped. In sensitivity testing we allowed for lags between the date at which export contracts are signed and shipment of the goods by adjusting the firm and aggregate level information associated with each export shipment to reflect the information available to the firm in the quarter prior to shipment. This adjustment resulted in slightly weaker coefficients in general (suggesting that the contemporaneous exchange rate may indeed be the appropriate indicator), but did not appreciably change the main results.

[17] These controls take the form of a set of dummies indicating whether the firm exported to the country in question in each of the past three years, plus the log of average exports to that country per exporting-year and its square.

[18] Gravity models of aggregate bilateral exporting have been estimated using proxies for the fixed costs of market entry, such as distance and the existence of a common language, as exclusion variables. These are not appropriate in the context of firm-level models as between-firm variation in export propensity is at least as important as cross-destination variation, but entry cost variables are relevant only for the latter. While a selection model can be estimated without an exclusion restriction, the ability to control for selection is then based purely on assumptions regarding functional form. Campa (2004) uses the assumption that exchange rate volatility affects export propensity but not export intensity in order to motivate his use of a Heckman two-stage model. However, as noted above, there may be reasons why firms would choose to limit their exposure to a market in the face of exchange rate volatility while not completely withdrawing from that market – a hypothesis we wish to directly test. Greenaway et al. (2010) instead use simultaneous estimation via maximum likelihood, which they argue is more efficient than a Heckman model. In the absence of an exclusion restriction, this approach also relies on functional form assumptions to control for selection.

on the exchange rate variables for "committed" relationships – defined as those firm×country relationships which are observed in every year of the sample period – and "non-committed" relationships. Thus, the main analysis compares results of equation 1 with the extended equation:

$$\begin{aligned}\ln X_{ijt} =& \beta_1^c[\ln RER_{jt} \times \delta^{committed}] + \beta_1^n[\ln RER_{jt} \times \delta^{non-committed}] \\ &+ \beta_2^c[\ln CoV_{jt} \times \delta^{committed}] + \beta_2^n[\ln CoV_{jt} \times \delta^{non-committed}] \\ &+ \xi\delta^{committed} + \mathbf{X}_{it}\gamma + \mathbf{V}_{jt}\phi + \mathbf{S}_i\eta + \psi_t + \theta_j + \epsilon_{ijt} \qquad (2)\end{aligned}$$

Although committed relationships account for only six percent of all relationships, they make up around 30 percent of all quarterly trade observations and almost 75 percent of total trade value. If the intensive margin impacts differ according to firm or relationship characteristics, the results for committed relationships may not be generalisable to the wider population of exporters. However, given the large share of trade which is captured by these relationships, we take the committed exports estimates as the central estimate of the impact on the intensive margin, since it is not contaminated by exchange rate-induced market selection.

The same approach is applied to the extensive margin for incumbent exporters, though here the emphasis is on results for non-committed exporters, since, by definition, committed exporters do not respond on this margin.[19] As exchange rate cycles are quite persistent over time, the composition of the pool of incumbent exporters may change in response to the exchange rate, which may in turn affect estimates of the extensive margin impact. Suppose there are two types of firms – committed exporters, for which the benefits of exporting are sufficiently high that no observed level of the exchange rate would cause them to exit, and non-committed exporters, for which there is a threshold level of the exchange rate at which the firm chooses to exit the market. As exchange rate levels initially begin to rise, some non-committed exporters will drop out, generating a negative relationship between the exchange rate level and the probability of exporting. However, as levels rise further, the pool of incumbent exporters becomes more and more dominated by committed exporters. Thus, beyond a certain threshold level of the exchange rate, the observed probability of exit will actually decrease, as all remaining incumbent firms will remain in the market at any reasonable exchange rate level. Estimating separate coefficients for committed and non-committed exporters therefore serves

[19] We include results for committed exporters in table 2 for completeness, but note that the interpretation of the extensive margin coefficients for this group relates to their propensity to export in any given quarter, conditional on the firm exporting in at least one quarter of every year.

to disentangle, at least partially, the composition effect from the true exchange rate impact on exit.

As well as considering whether exchange rate levels and volatility have independent effects on export performance, we also explore the role of exchange rate volatility on export hysteresis. In particular, we argued in section 2 that in the presence of sunk entry costs (or quasi-fixed ongoing costs of supplying a market), exchange rate volatility may weaken the relationship between current exchange rate levels and export responses. In order to explore this hypothesis, we augment equations 1 and 2 by introducing an interaction between the level of the exchange rate and a set of three dummies, $\delta^k, k \in (low, med, high)$, to capture whether the currency of the country in question tends to exhibit a low, medium or high degree of volatility relative to the New Zealand dollar (equation 3). The dummies are constructed by taking the mean of the volatility variable across all observations within a country and dividing into three groups: observations in the bottom quartile (low), the two middle quartiles combined (med), and the top quartile (high).[20]

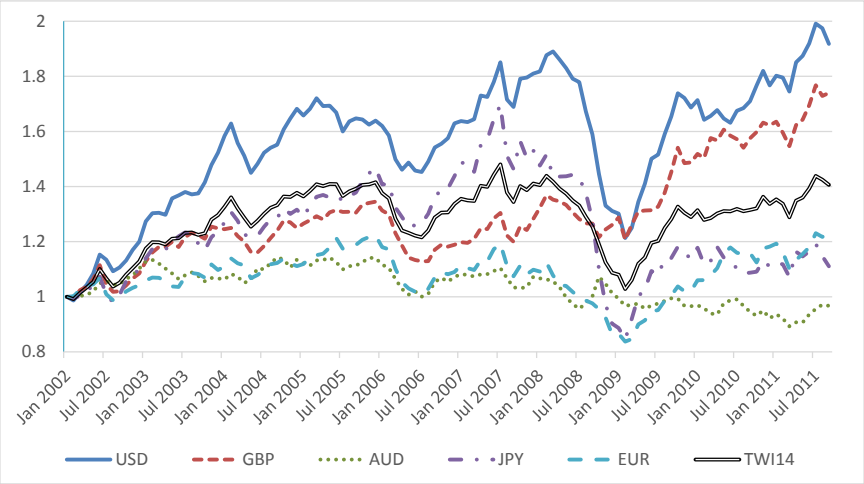
$$\begin{aligned}\ln X_{ijt} =& \beta_1^l[\delta^{low} \times \ln RER_{jt}] + \beta_1^m[\delta^{med} \times \ln RER_{jt}] + \beta_1^h[\delta^{high} \times \ln RER_{jt}] \\ &+ \beta_2 \ln CoV_{jt} + \mathbf{Z}_{it}\gamma + \mathbf{V}_{jt}\phi + \mathbf{S}_i\eta + \psi_t + \theta_j + \epsilon_{ijt} \end{aligned} \tag{3}$$

Finally, we consider whether exchange rate responses differ according to characteristics of the exporter, by interacting the exchange rate level with a categorical indicator of firm characteristics. These indicators capture the firm's currency use and hedging behaviour (NZD use only; some use of non-NZD currencies, no hedging; some use of non-NZD currencies, some hedging), diversity of export markets (exports to 0-2 countries; 3-9 countries; 10+ countries), and extent of product differentiation (10% or less of export value in differentiated goods; 11-89% of value in differentiated goods; 90% or more of value in differentiated goods).[21] This provides an indication of whether exchange rate impacts are felt equally across firms with different levels of export sophistication or market power.

[20] While the extent of economic integration between countries may affect bilateral exchange rates (Broda & Romalis, 2011), this link is not obvious in the classification of destination countries by exchange rate volatility (see table A.3). While Australia and the UK both fall into the group of low volatility exchange rates, this group also includes countries such as Congo, Benin and Niger. Similarly, the high volatility group includes China, Japan and Hong Kong (three of our top 15 export destinations in 2013/14), alongside countries such as Myanmar and Burundi.

[21] Consistent with equation 2, dummies indicating group membership are also included directly in each of these models.

Figure 1: Nominal exchange rate indices, January 2002 - September 2011



4 Results

4.1 Aggregate analysis

Before turning to the firm-level regression analysis, we first describe the relationship between exchange rate fluctuations and export performance at the aggregate level. The New Zealand dollar has experienced varied fortunes against key trading partner currencies (figure 1). While the NZD/USD exchange rate approximately doubled over the analysis period and underwent dramatic swings during and after the Global Financial Crisis (GFC), the bilateral exchange rate with Australia was much more stable, finishing the period just slightly below its original level.

Figure 2 plots average exports, the average number of active exporters, and average exports per exporter against the average level of the exchange rate over time (left hand side) and the degree of exchange rate volatility (right hand side) across all destinations. Each country's exports and exchange rate variables are weighted by that destination's average export value over the entire period. As such, these graphs present a picture of the relationship between aggregate export receipts (or number

of exporters or average exports per firm) and a trade-weighted index of exchange rate changes over time. Figure 2 shows a negative relationship between total export revenue and exchange rate levels over time, particularly in the early 2000s (left hand side, panel A). This relationship appears to be driven by changes in the average export value per exporter, rather than the number of firms engaged in exporting, as panel B shows little (or if anything a slightly positive) relationship between exchange rate levels and the number of exporting firms. That is, in aggregate, fluctuations in the level of the exchange rate appear to act primarily through the intensive margin of exports. In contrast, the right hand side of figure 2 shows no clear relationship between the degree of exchange rate volatility over time and these same export performance metrics.

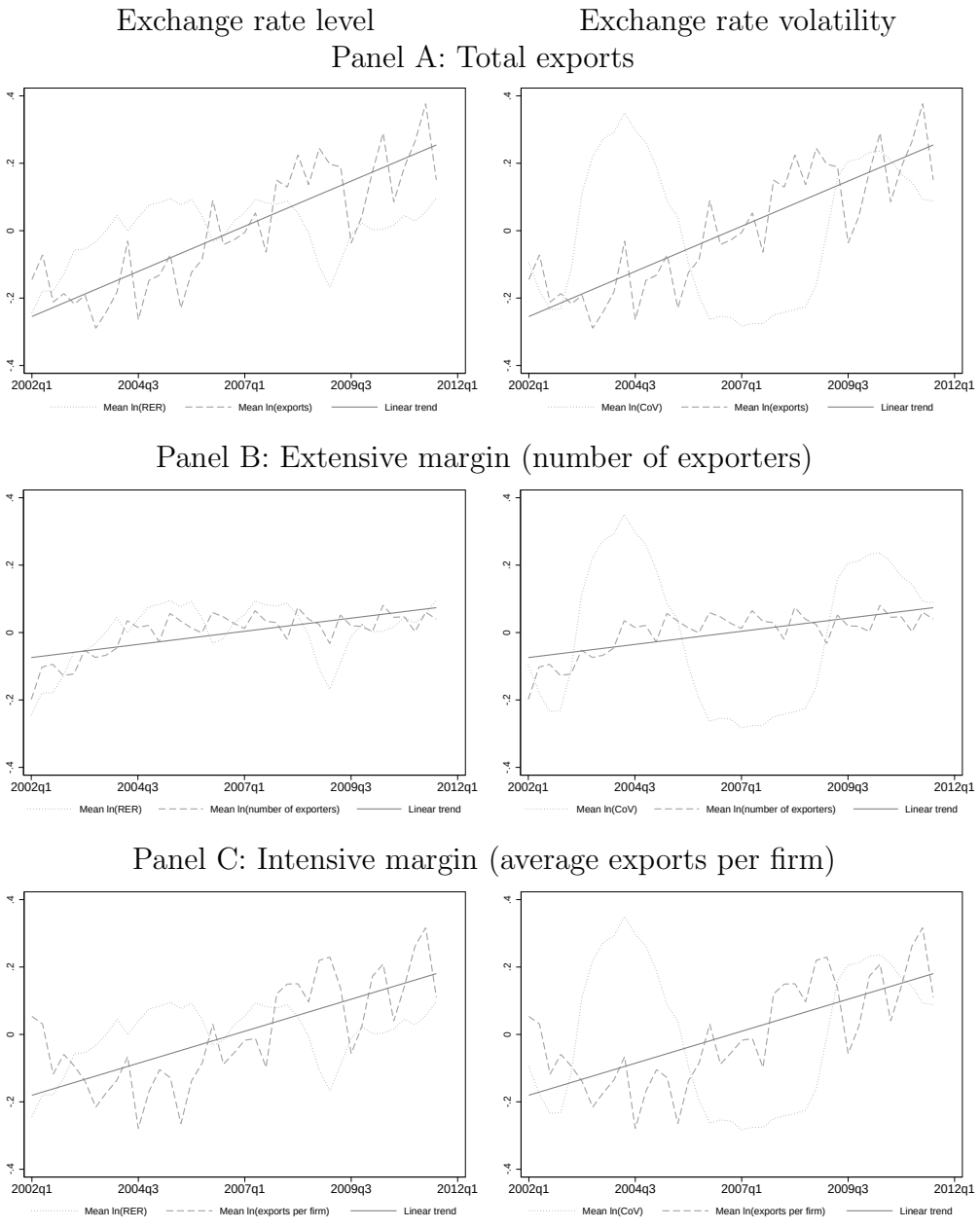
At the country level, however, there is a clear relationship between exchange rate volatility and export performance. Figure 3 plots destination-level averages of each of the three export outcomes against that destination's average exchange rate volatility over the period. Countries whose currencies are more volatile relative to the New Zealand dollar receive lower export values (panel A), and are served by a smaller number of New Zealand firms (panel B). Market selection is also evident – firms exporting to more volatile markets tend to be larger exporters, leading to a positive relationship between country-level exchange rate volatility and average export value per exporting firm (panel C). This may reflect either an unwillingness on the part of smaller exporters to accept the risks associated with volatile exchange rates, or simply a correlation between bilateral exchange rate volatility and other measures of export costs and attractiveness.[22]

While continuing export relationships account for the vast majority of export value in any given year and committed exporters make up the bulk of export value across the period as a whole, the dynamics of entry and exit play an important role for the evolution of aggregate export value over time. Table 1 considers two two-year periods, one at either end of the 2000s, and decomposes export growth across those two periods into that coming from new entrants (those firm×country relationships which are observed in the later period but not the earlier period), from continuing relationships (firm×country relationships observed in both periods) and that lost through exiting relationships (those observed in the initial but not the later period).[23] Over this timeframe, while continuing relationships make up the smallest group in numeric terms, these relationships account for only a slightly lower share of net export value growth than new relationships, with around NZD7.5

[22]Bilateral exchange rate volatility is negatively correlated with destination-country GDP per capita (correlation coefficient -0.39), but not noticeably correlated with distance from New Zealand (correlation coefficient of 0.05).

[23]Changes in annual export values are expressed 2011Q3 dollars, based on the Reserve Bank of New Zealand's quarterly export price deflator.

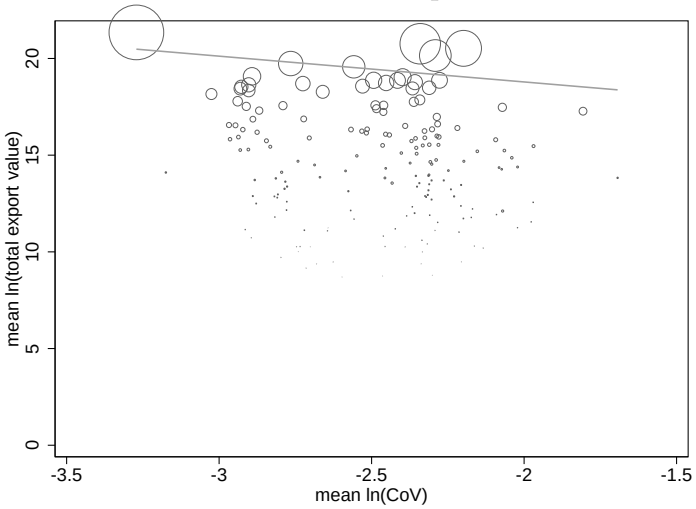
Figure 2: Aggregate export performance and exchange rate movements over time



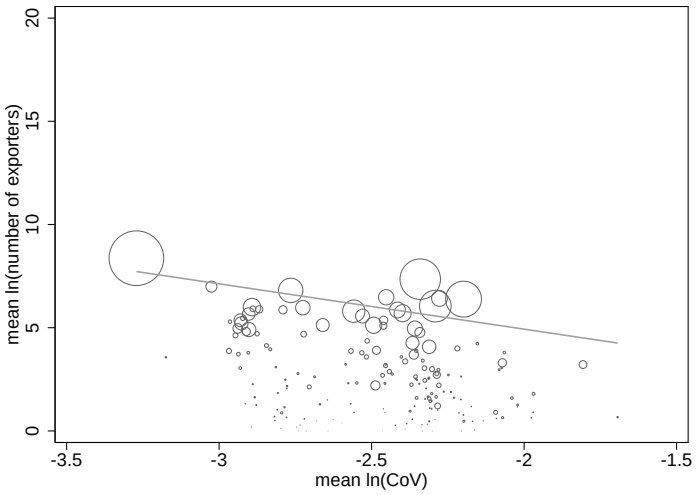
Quarterly observations are averages of the country-level demeaned variables for each quarter. Exchange rates are weighted by total exports to each destination over the full observation period. Graphs include a simple linear trend in the export outcome variables.

Figure 3: Aggregate export performance and exchange rate volatility across countries

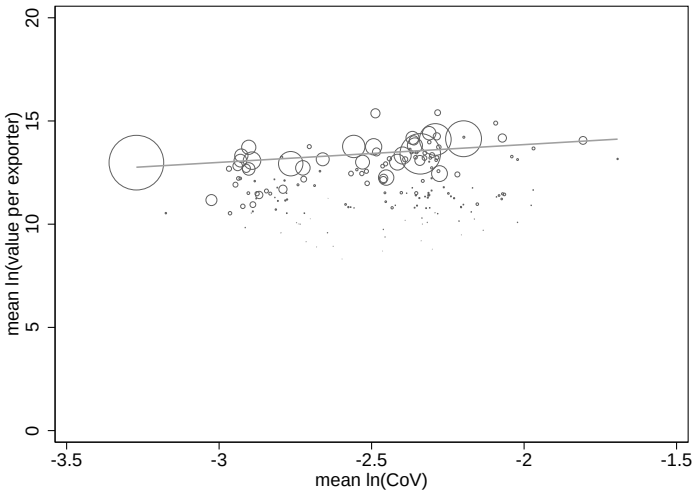
Panel A: Total exports



Panel B: Extensive margin (number of exporters)



Panel C: Intensive margin (average exports per firm)



Destination-level averages of export outcomes plotted against destination-level average exchange rate volatility over the sample period. Graphs also show a fitted linear relationship between the two variables. Observations weighted by mean trade to that destination over the sample period (represented by size of circles).

billion higher annual average exports in the late 2000s compared to the earlier period. The vast majority of this growth (NZD6.9 billion or 92 percent) comes from export relationships which were observed in every year. Changes at the extensive margin make a similar contribution to continuers – new relationships contribute an average of NZD8.2 billion per year in the later period, while NZD7.6 billion worth of export relationships cease over the course of the decade.[24] In the next section we examine the extent to which firm-level patterns of entry, exit and growth are driven by exchange rate fluctuations.

4.2 Firm-level regression analysis

In order to identify the impact of the exchange rate separately from other confounding influences, such as macroeconomic conditions, we now turn to a regression analysis at the firm×country level. Table 2 presents results based on equations 1 and 2, in which only direct effects of exchange rate fluctuations are considered. By including country and time fixed effects, exchange rate impacts are identified from the correlation between deviations in quarterly NZD-converted export receipts from their country-specific mean value, and deviations in the current bilateral exchange rate measures from their country-specific mean. This estimation strategy serves to isolate the impact of exchange rate fluctuations from other (potentially related) variables, including country characteristics (distance, language, relative income levels) and aggregate economic performance in New Zealand (through the inclusion of time fixed effects).

Sensitivity testing to determine whether results were being driven by particular markets indicated that exports to Australia (which makes up nearly 25 percent of all observations) exhibit a different pattern of exchange rate impacts to other major destinations.[25] This may reflect the special position Australia holds for

[24] This decomposition suggests a substantially lower contribution of continuing relationships than found by Fabling & Sanderson (2010). In that paper only 25 percent of growth between 1996-98 and 2006-08 was attributed to new firm×country relationships (the analysis did not separately account for the loss of value from exiting relationships). This may in part reflect the differing economic conditions over the two analysis periods – the 2000s saw a period of sustained exchange rate appreciation from a relatively low base as well as severe economic shocks from the GFC. This may have led to a greater degree of exit over the 2000s if many incumbent exporters were particularly susceptible to exchange rate appreciations, having entered at a time when rates were favourable. The GFC in turn may have elevated exit rates, and potentially increased subsequent entry rates as new exporters moved to fill gaps in the market left by exiting firms.

[25] Sensitivity tests included re-estimating equation 3 three times, each time dropping out the largest export destination from the low (Australia), medium (United States) and high (Japan) volatility country groups respectively. The exclusion of the US and Japan made little difference to the overall results. In contrast, excluding Australia substantially increased the estimated impact of

New Zealand exporters as a geographically and culturally proximate market with minimal barriers to trade, as well as the relative macroeconomic performance of Australia over recent years. All regressions therefore include additional interaction variables to capture the country-specific relationship between the exchange rate and export performance for exporters to Australia.

Table 2 presents results for both the intensive and extensive margin. For the former, exchange rate impacts are estimated for all relationships following equation 1 (column 1) and then with separate coefficients for committed and non-committed relationships following equation 2 (column 2). For the extensive margin, we estimate the relationships for incumbent exporters (columns 3 and 4) separately from potential entrants (column 5), where the former is estimated on the full population of incumbents and the latter on a random sample of actual and potential entrants. We focus on the exchange rate level coefficients that capture the main margin of responsiveness for each of the three exporter types (shown in bold type) – the intensive margin effects among committed export relationships (column 2), the extensive margin for non-committed relationships (column 4), and the entry margin effects for non-incumbents (column 5).

Setting aside Australia, table 2 shows a negative relationship between export performance and the relative level of the exchange rate, $\ln(RER)$, across all three margins. Estimated across all export relationships, a ten percent increase in the level of the exchange rate index is associated with a 1.4 percent fall in the value of exports to a given country (column 1). The estimated impact is consistently signed for committed and non-committed export relationships, but is more than four times as strong for the former group (column 2) presumably, in part, reflecting the fact that non-committed exporters also respond to the exchange rate level via the extensive margin (column 4).[26] Given the relative importance of committed

exchange rates across all three margins. In a second sensitivity test we re-estimated equations 1 and 2 while allowing the exchange rate levels effect to differ for each of New Zealand's top six trade destinations by trade frequency (Australia, Japan, United Kingdom, United States, Korea and China). Coefficients for Australia were significantly different from the base case (all other destinations) at the 1% level across all three margins. Comparing across the major markets, Australian coefficients for the intensive margin differed from those of three of the five main destinations at the 5% level or better, and for the extensive margin differed significantly from all five destinations at the 1% level. Country-specific coefficients for the other five destinations were not significantly different from the base case in 11 out of 15 cases and, where significant, did not affect the sign of the estimated effect.

[26] Market exit could be a deliberate strategy of the firm, recognising that a high exchange rate will impact on profit margins, or could reflect the effect of price sensitivity on the part of foreign market customers if exporters pass some proportion of the exchange rate change onto those customers. Fabling & Sanderson (2015) show that, through invoicing in NZD and being slow to adjust invoiced prices in the face of exchange rate movements, smaller exporters tend to pass a greater proportion of exchange rate changes through to their customers than larger exporters,

exporters to aggregate trade growth (table 1), and the lack of extensive margin contamination, we take the committed results from column 2 – that a ten percent increase in the bilateral exchange rate is associated with a 3.2 percent decrease in export values – as the preferred intensive margin estimate.

Across the full population of incumbent exporters, column 3 suggests that, on average, firms do not exit from export markets in response to the level of the exchange rate. However, allowing for separate estimates for committed and non-committed exporters, column 4 shows a negative impact on the probability of continued exports among non-committed exporters, with a 10 percent rise in the bilateral exchange rate leading to a reduction of 0.07 percentage points in the probability that an existing relationship will continue in the next quarter.[27] The effect on market entry among firms which have not exported to a destination in the prior three years is shown in column 5. Here, a ten percent increase in the level of the exchange rate index would imply a 0.04 percentage point lower probability of a firm entering that market, a substantial change relative to the mean probability of entry of 0.009.

There is also some evidence of a direct effect of changes in the degree of exchange rate volatility on destination-level export values. Among committed exporters, average export values are 3.5 percent lower following a period of 10 percent higher exchange rate volatility (column 2, ln(CoV) coefficient). However, direct impacts of exchange rate volatility on the extensive margin are not significantly different from zero for non-committed incumbents (column 4) or potential entrants (column 5).

In contrast, adding relevant coefficients shows that the value of exports to Australia is largely unresponsive to movements in the bilateral exchange rate, while the probability of exporting (both continued exports by incumbents and entry of new firms) actually increases when exchange rates are high.[28] A similar pattern is observed with respect to exchange rate volatility, which also appears to have no impact on the intensive margin for committed exporters and a positive effect on the probability of exports. One possible explanation is that since bilateral exchange rates are often positively correlated across New Zealand's major export destinations, Australia acts as a "safe haven" destination to soak up excess supply

suggesting that demand effects may be an important explanation.

[27] Recall that the coefficient for the committed margin reflects the probability of observing positive exports in any given quarter, conditional on that relationship being observed in at least one quarter of every year. These coefficients are included for completeness but are less relevant for understanding the extensive margin as they do not indicate long-term exit.

[28] The relevant estimate for Australia in column 2 is $-0.323+0.292 = -0.031$, and is not significantly different from zero. In column 4, the joint coefficient for Australia is $-0.007 + 0.079 = 0.072$, significantly greater than zero at the 1% level. In column 5, the combined entry coefficient is $-0.004 + 0.036 = 0.032$, significantly different from zero at the 1% level.

while minimising the costs associated with exporting in the face of unfavourable exchange rate fluctuations. In addition, given the lower entry costs associated with exporting to Australia, it is likely that the Australian market attracts a larger proportion of intermittent or serendipitous exporters, who may pay less attention to exchange rate fluctuations (implying fewer firms responding negatively, but not a positive coefficient).[29]

Turning to the central hypothesis of this paper, table 3 examines whether exchange rate volatility also has an indirect effect on export performance by mediating the strength of the relationship with exchange rate levels. This analysis follows from equation 3, introducing an interaction between exchange rate levels and a set of dummy variables indicating the average degree of exchange rate volatility at the destination level (classification of countries is detailed in table A.3). While the underlying regressions mirror those in table 2, we report only the exchange rate level coefficients that capture the main margin of responsiveness for each of the three exporter types – the intensive margin effects among committed export relationships (column 1), the extensive margin for non-committed relationships (column 2), and the entry margin effects for non-incumbents (column 3) – corresponding to the coefficients shown in bold in table 2.

Table 3 supports the hypothesis that perceived exchange rate volatility at the country-level dampens the impact of exchange rate levels on export performance, at least for the extensive margin where we might expect the attenuation effect to be strongest.[30] Among incumbent exporters (column 2), a ten percent increase in the bilateral exchange rate reduces the probability of remaining in a market by around 0.10 to 0.13 percentage points, but only in countries with low to moderate exchange rate volatility. For countries where exchange rate volatility is high, firms do not appear to exit in response to an unfavourable exchange rate shift, consistent with a situation in which firms delay exit in the hope that any exchange rate increase will reverse. Similarly, among potential entrants, the probability of entry falls by around 0.04 to 0.05 percentage points in response to a ten percent increase in the bilateral exchange rate in low to moderate volatility countries, but is not affected in high volatility destinations.

[29] As an indication of the relatively lower export sophistication of Australian exports, 15.3 percent of firms exporting to Australia in 2010 are never observed to export to another country. In contrast, among exporters to the US, UK and Japan, single-market exporters account for only 2.5, 1.7 and 4.3 percent of 2010 exporters respectively.

[30] Recall that the link between exchange rate volatility and export hysteresis relies on there being some form of fixed costs which create a wedge between the exchange rate level at which a new firm would find it profitable to enter a market, and that at which an incumbent would choose to exit. These dynamics affect the extensive margin but are expected to be less relevant for the intensive margin.

As Australia is in the group of low volatility destinations, the joint coefficients for Australia in table 3 reflect the sum of the coefficients on $\ln(\text{RER})\times\delta^{low}$ and $\ln(\text{RER})\times\delta^{Aust}$. By construction, these are almost identical to those observed in table 2, showing no significant effect of exchange rate rises on the intensive margin and a positive relationship between exchange rate levels and the probability of exporting to Australia.

In table 4 we test whether firms' reactions to exchange rate fluctuations differ depending upon various measures of their export sophistication. Our hypothesis is that larger, more sophisticated exporters, and those with greater market power may be less affected by exchange rate shocks due to their greater ability to spread or absorb risk (either across markets by operating a differentiated portfolio, or over time through improved access to finance or explicit exchange rate hedging) and/or a less elastic demand curve which enables them to maintain prices and demand in the face of exchange rate movements. Panels A and B focus on export sophistication and risk, distinguishing firms by their use of non-NZD invoice currencies and hedging experience[31] and the number of destination countries they export to over the sample period respectively, while panel C focuses on the potential for pricing (market) power, by distinguishing firms by the extent to which they export differentiated products.

Again we report only the key coefficients identified in bold in the table 2, and focus on the general results (top three rows) rather than those specific to Australia. Panel A suggests that export receipts of the most sophisticated exporter group – those that engage in explicit exchange rate hedging – are the most sensitive to exchange rate movements, except in the extensive margin case for non-committed incumbents. While explicit exchange rate hedging activity may imply a greater level of sophistication, it may also imply greater risk aversion on the part of the firm or that hedging behaviour itself is driven in part by the recognition that exchange rate movements will impact heavily on the firm's export receipts. Meanwhile, stronger impacts on export propensity among non-committed incumbents invoicing in the NZD may reflect demand influences – firms which price their goods in NZD are less likely to receive offshore orders when those NZD prices appreciate relative to other potential suppliers.

A consistent pattern also emerges when using number of export destinations as an indicator of firms' export sophistication (panel B). Here, the expected relationship between export sophistication and exchange rate sensitivity emerges for both the committed intensive margin and for non-committed incumbent exporters, with

[31] Fabling & Sanderson (2015) find that use of foreign currencies is associated with stronger export performance, while Fabling & Grimes (2015) show that more successful exporters are also more likely to engage in explicit exchange rate hedging.

firms engaged in a small number of markets experiencing more negative effects on both the probability of remaining in a market and the value of exports per quarter. In contrast, the entry margin shows the opposite relationship – firms which export to a larger number of destinations are more sensitive to exchange rates when considering whether to enter a new market, perhaps reflecting that these additional destinations are of marginal importance to the firm relative to their existing markets.

Panel C (differentiated products) results show a clear relationship between product differentiation and exchange rate sensitivity, with those firms that export mainly undifferentiated products (the "low" group) being significantly more affected by exchange rate movements across all three key margins. This consistency is particularly striking as many of New Zealand's largest exporting firms are primarily involved in the exports of raw materials, so that a substantial proportion of firms with low shares of differentiated goods are large, experienced exporters.

5 Conclusions

This paper has explored the impact of exchange rate fluctuations on firms' exports. We show that a rise in value of the New Zealand dollar relative to the currencies of trading partners reduces, in general, both the probability that firms will export and the value of NZD-converted export receipts per exporter. However, estimated exchange rate impacts for Australia, New Zealand's largest trading partner, differ substantially from those for other countries, consistent with Australia having played a special role in buffering New Zealand exporters against exchange rate shocks over the past decade.

In terms of the aggregate influence of exchange rates on export receipts, the most significant impacts (at least in the short-run) are intensive margin adjustments among committed export relationships. These relationships account for almost three-quarters of aggregate export receipts over the period from 2002 to 2011, and are materially affected by exchange rate movements – on average, a ten percent increase in the bilateral exchange rate (corresponding to around one standard deviation over the period) reduces average exports to that destination by around three percent among committed exporters, consistent with incomplete exchange rate pass-through in the short run. These committed exporters, by construction, have been able to continue exporting throughout the period, despite large fluctuations in bilateral exchange rates. However, when we exclude this small group of high-value relationships, extensive margin impacts are also significant, affecting both the probability of entry among potential exporters and the probability that incumbent

firms will continue to export.[32]

We also examine the relative strength of exchange rate responses across a range of firm characteristics finding, in particular, that greater product differentiation (a proxy for the ability to exercise market power) reduces exchange rate sensitivity, both in terms of export propensity and the value of export receipts among continuing exporters. In addition, we find that more sophisticated exporters (those that export to a greater number of countries) are less sensitive to bilateral exchange rate with their existing markets, both in terms of the value of exports and the probability of exit. However, these firms are more inclined to avoid entering new markets when the relevant exchange rate is high, consistent with taking a more calculated approach to market entry.

Finally, the results provide new evidence on the link between exchange rate fluctuations and export hysteresis. Firms' decisions to enter and exit markets appear to be more sensitive to the level of the exchange rate in countries where exchange rates have historically been more stable. This finding is consistent with the work of Fitzgerald & Haller (2014), who examine the more extreme case of exporter responses to permanent (tariff-related) versus transitory (exchange rate-related) shocks. Our work shows that, even in the absence of certainty, firms are more likely to respond to shocks that have a greater probability of persistence.

[32] While export receipts are certainly lower when bilateral exchange rate levels are high, this does not automatically translate to differences in the profitability of exporting at various points in the exchange rate cycle. In particular, we do not distinguish between changes in export volume and changes in the NZD value received for each unit, nor do we have information about the profit margins associated with exporting or how these change with exchange rate fluctuations.

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Tables

Table 1: Decomposition of real export value growth, 2001Q1-2002Q4 to 2009Q4-2011Q3

	Share of firms	Share of change in exports	Change in average annual exports ($bn)
Continuing relationships	0.230	0.926	7.5
Committed	*0.092*	*0.848*	*6.9*
Non-committed	*0.138*	*0.078*	*0.6*
Entries	0.428	1.007	8.2
Exits	0.342	-0.933	-7.6
Total	1.000	1.000	8.1

Decomposition of difference in real (2011Q3) export values between two 2-year periods: 2001Q1-2002Q4 and 2009Q4-2011Q3. Values deflated using the Reserve Bank of New Zealand's export price index. A continuing relationship is a firm×country combination which is observed in both periods. An entry is a firm×country combination observed in 2009Q4-2011Q3 but not in 2001Q1-2002Q4. An exit is a firm×country relationship observed in the earlier period but not the later period. Column 3 reports the gross difference in annual export values for each group between the earlier and later periods, averaged across the two years for each period.

Table 2: Exchange rate fluctuations and export performance

	Intensive margin		**Extensive margin**		
			Incumbent		Entry
	(1)	(2)	(3)	(4)	(5)
ln(RER)	-0.139**		0.004		**-0.004****
	[0.019]		[0.003]		**[0.001]**
ln(RER)×δ^{Aust}	0.270**†		0.072**†		**0.036**†**
	[0.064]		[0.013]		**[0.006]**
ln(CoV)	-0.014*		-0.002*		**0.000**
	[0.006]		[0.001]		**[0.000]**
ln(CoV)×δ^{Aust}	0.080**†		0.024**†		**0.006**†**
	[0.021]		[0.005]		**[0.002]**
ln(RER)×$\delta^{committed}$		**-0.323****		-0.001	
		[0.025]		[0.007]	
ln(RER)×$\delta^{committed}$ × δ^{Aust}		**0.292****		0.090**†	
		[0.066]		[0.013]	
ln(CoV)×$\delta^{committed}$		**-0.035****		-0.019**	
		[0.008]		[0.002]	
ln(CoV)×$\delta^{committed}$ × δ^{Aust}		**0.040**		0.040**†	
		[0.029]		[0.007]	
ln(RER) ×$\delta^{non-committed}$		-0.073**		**-0.007***	
		[0.021]		**[0.003]**	
ln(RER) ×$\delta^{non-committed}$ × δ^{Aust}		0.315**†		**0.079**†**	
		[0.066]		**[0.013]**	
ln(CoV) ×$\delta^{non-committed}$		-0.005		**0.001**	
		[0.007]		**[0.001]**	
ln(CoV) ×$\delta^{non-committed}$ × δ^{Aust}		0.114**†		**0.019**†**	
		[0.027]		**[0.005]**	
$\delta^{committed}$		1.124**		0.197**	
		[0.116]		[0.029]	
Observations	700,044	700,044	2,046,351	2,046,351	2,370,840
R^2	0.660	0.660	0.344	0.369	0.017
Mean of dependent variable	10.251	10.251	0.296	0.296	0.009
Proportion committed relationships	0.314	0.314	0.127	0.127	0.000

** $p < 0.01$, * $p < 0.05$. Robust standard errors in brackets. All regressions include country and quarter fixed effects, seasonal dummies, export history variables, and time-varying macro characteristics of destination countries (log GDP per capita and log population). In columns 2, 4 and 5 bold text indicates the key coefficients of interest – coefficients for committed export relationships in the intensive margin regression(column 2), coefficients for non-committed export relationships in the extensive margin regression for incumbents (column 4) and extensive margin coefficients for actual and potential entrants (column 5). The entry regression (column 5) uses a random sample of observations from the population of potential entrants, proportionate to the number of actual trade observations with each country (N_j) over the analysis period. In each column, † indicates combined coefficients for Australia (main effect plus coefficient on Australia interaction) which are significantly different from zero at the 5% level or better.

Table 3: Allowing for interaction between exchange rate level and volatility

	Intensive margin	**Extensive margin**	
		Incumbent	Entry
	(committed)	(non-committed)	
	(1)	(2)	(3)
ln(RER)×δ^{low}	-0.273**^{a}	-0.013*^{a}	-0.004**^{a}
	[0.037]	[0.006]	[0.001]
ln(RER)×δ^{med}	-0.361**^{a,b}	-0.010*	-0.005**^{b}
	[0.030]	[0.004]	[0.001]
ln(RER)×δ^{high}	-0.275**^{b}	0.001^{a}	-0.001^{a,b}
	[0.034]	[0.005]	[0.001]
ln(RER)×δ^{Aust}	0.247**	0.086**†	0.037**†
	[0.072]	[0.014]	[0.006]
ln(CoV)	-0.039**	0.000	0.000
	[0.008]	[0.001]	[0.000]
ln(CoV)×δ^{Aust}	0.042	0.019**†	0.006**†
	[0.029]	[0.005]	[0.002]
Observations	700,044	2,046,351	2,370,840
R^2	0.660	0.369	0.017

** $p < 0.01$, * $p < 0.05$. Robust standard errors in brackets. Only key coefficients are presented (those shown in bold in table 2). All regressions include country and quarter fixed effects, seasonal dummies, export history variables, and time-varying macro characteristics of destination countries (log GDP per capita and log population). The entry regression (column 5) uses a random sample of observations from the population of potential entrants, proportionate to the number of actual trade observations with each country (N_j) over the analysis period. In each column, letters indicate pairs of coefficients which differ significantly between low, medium and high volatility destinations at the 5% level or better. In each column, † indicates combined coefficients for Australia (main effect for low volatility countries plus coefficient on Australia interaction) which are significantly different from zero at the 5% level or better.

Table 4: Allowing for interaction between exchange rate level and firm characteristics

Panel A: Invoice currency and hedging

	Intensive margin	**Extensive margin**	
		Incumbent	Entry
	(committed)	(non-committed)	
	(1)	(2)	(3)
$\ln(\text{RER}) \times \delta^{NZD-only}$	-0.236**^{a}	-0.027**^{a,b}	0.000^{a,b}
	[0.048]	[0.006]	[0.001]
$\ln(\text{RER}) \times \delta^{non-hedged}$	-0.242**^{b}	0.001^{a,c}	-0.006**^{a,c}
	[0.034]	[0.004]	[0.001]
$\ln(\text{RER}) \times \delta^{ever-hedged}$	-0.345**^{a,b}	-0.013**^{b,c}	-0.010**^{b,c}
	[0.026]	[0.004]	[0.001]
$\ln(\text{RER}) \times \delta^{NZD-only} \times \delta^{Aust}$	0.209**	0.075**^{†,d,e}	0.031**^{†,d}
	[0.066]	[0.012]	[0.003]
$\ln(\text{RER}) \times \delta^{non-hedged} \times \delta^{Aust}$	0.253**^{c}	0.085**^{†,d}	0.036**^{†,e}
	[0.066]	[0.012]	[0.003]
$\ln(\text{RER}) \times \delta^{ever-hedged} \times \delta^{Aust}$	0.280**^{c}	0.090**^{†,e}	0.035**^{†,d,e}
	[0.066]	[0.012]	[0.003]
$\ln(\text{CoV})$	-0.029**	0.001	0.000
	[0.008]	[0.001]	[0.000]
$\ln(\text{CoV}) \times \delta^{Aust}$	0.034	0.018**†	0.006**†
	[0.028]	[0.005]	[0.001]
$\delta^{NZD-only}$	0.018	0.116**	-0.028**
	[0.202]	[0.030]	[0.005]
$\delta^{ever-hedged}$	0.449**	0.079**	0.022**
	[0.128]	[0.021]	[0.007]
Observations	700,044	2,046,351	2,370,840
R^2	0.661	0.370	0.020

** $p < 0.01$, * $p < 0.05$. Robust standard errors in brackets. Only key coefficients are presented (those shown in bold in table 2). All regressions include country and quarter fixed effects, seasonal dummies, export history variables, and time-varying macro characteristics of destination countries (log GDP per capita and log population). The entry regression (column 5) uses a random sample of observations from the population of potential entrants, proportionate to the number of actual trade observations with each country (N_j) over the analysis period. In each column, letters indicate pairs of coefficients which differ significantly between low, medium and high levels of firm characteristics at the 5% level or better. In each column, † indicates combined coefficients for Australia (main effect for firm sub-group plus coefficient on Australia interaction) which are significantly different from zero at the 5% level or better.

Panel B: Diversity of export destinations

	Intensive margin	**Extensive margin**	
		Incumbent	Entry
	(committed)	(non-committed)	
	(1)	(2)	(3)
$\ln(\text{RER})\times\delta^{low}$	-0.431^{**a,b}	-0.023^{**a,b}	-0.001^{a,b}
	[0.046]	[0.006]	[0.001]
$\ln(\text{RER})\times\delta^{med}$	-0.297^{**a}	-0.007^{a}	-0.009^{**a,c}
	[0.034]	[0.004]	[0.001]
$\ln(\text{RER})\times\delta^{high}$	-0.323^{**b}	-0.007^{b}	-0.018^{**b,c}
	[0.026]	[0.004]	[0.003]
$\ln(\text{RER})\times\delta^{low}\times\delta^{Aust}$	0.304^{**c,d}	0.084^{**†,c,d}	0.035^{**†,d,e}
	[0.067]	[0.013]	[0.003]
$\ln(\text{RER})\times\delta^{med}\times\delta^{Aust}$	0.344^{**c}	0.090^{**†,c}	0.036^{**†,d,f}
	[0.067]	[0.013]	[0.003]
$\ln(\text{RER})\times\delta^{high}\times\delta^{Aust}$	0.377^{**d}	0.098^{**†,d}	0.035^{**†,e,f}
	[0.067]	[0.013]	[0.003]
$\ln(\text{CoV})$	-0.037**	0.001	0.000
	[0.008]	[0.001]	[0.000]
$\ln(\text{CoV})\times\delta^{Aust}$	0.044	0.019**†	0.006**†
	[0.029]	[0.005]	[0.001]
δ^{low}	0.786**	0.054	-0.039**
	[0.190]	[0.029]	[0.006]
δ^{high}	-0.134	0.036	0.055**
	[0.131]	[0.021]	[0.013]
Observations	700,044	2,046,351	2,370,840
R^2	0.662	0.370	0.018

See table notes in panel A.

Panel C: Differentiated product share

	Intensive margin	**Extensive margin**	
		Incumbent	Entry
	(committed)	(non-committed)	
	(1)	(2)	(3)
$\ln(\text{RER})\times\delta^{low}$	-0.413^{**a,b}	-0.027^{**a,b}	-0.011^{**a,b}
	[0.031]	[0.006]	[0.002]
$\ln(\text{RER})\times\delta^{med}$	-0.297^{**a}	0.003^{a}	-0.002^{a}
	[0.033]	[0.005]	[0.001]
$\ln(\text{RER})\times\delta^{high}$	-0.307^{**b}	-0.005^{b}	-0.003^{**b}
	[0.029]	[0.004]	[0.001]
$\ln(\text{RER})\times\delta^{low}\times\delta^{Aust}$	0.266^{**c,d}	0.084^{**†,c,d}	0.034^{**†,c,d}
	[0.066]	[0.012]	[0.003]
$\ln(\text{RER})\times\delta^{med}\times\delta^{Aust}$	0.259^{**c}	0.080^{**†,c}	0.036^{**†,c}
	[0.066]	[0.012]	[0.003]
$\ln(\text{RER})\times\delta^{high}\times\delta^{Aust}$	0.274^{**d}	0.079^{**†,d}	0.037^{**†,d}
	[0.066]	[0.012]	[0.003]
$\ln(\text{CoV})$	-0.022**	0.000	0.000
	[0.008]	[0.001]	[0.000]
$\ln(\text{CoV})\times\delta^{Aust}$	0.034	0.019**†	0.006**†
	[0.028]	[0.005]	[0.001]
δ^{low}	0.710**	0.132**	0.042**
	[0.161]	[0.032]	[0.010]
δ^{high}	-0.111	0.031	0.003
	[0.140]	[0.025]	[0.006]
Observations	700,044	2,046,351	2,370,840
R^2	0.666	0.369	0.018

See table notes in panel A.

Appendix A: Definitions and summary statistics

Table A.1: Variable definitions

Variable name	Definition
Dependent variables	
Intensive margin: $ln(X_{ijt})$	log of total export value by firm i to country j in quarter t.
Extensive margin: $\delta(X_{ijt})$	dummy variable equal to 1 if $X_{ijt} > 0$, zero otherwise.
Macroeconomic variables	
ln(RER)	log of quarterly real exchange rate index, defined as the number of NZD per foreign currency unit adjusted for CPI price levels ($NZD/Curr_f \times P_d/P_f$)
ln(CoV)	log of coefficient of variation of monthly real exchange rate index over the past 12 quarters
ln(GDPpc)	log of annual GDP per capita (2005 USD)
ln(pop)	log of annual population
Export history variables	
$\Delta_{ij}(\delta(X_{t-1}), \delta(X_{t-2}), \delta(X_{t-3}))$	16 dummy variables representing the complete set of permutations of firm exports to country j, or to all other countries $k \neq j$, over the three years prior to quarter t. $\delta(X_{t-m})$ is the extensive margin dummy in the m^{th} prior year. $\Delta(\cdot,\cdot,\cdot)$ aggregates these into unique patterns. Thus, a firm which exported to country j for the first time in the previous year would have $\Delta_{ij}(1,0,0) = 1$, while a firm which exported to any country $k \neq j$ in each of the previous three years would have $\Delta_{ik\neq j}(1,1,1) = 1$.
Prior exports$_{ijt}$	log of annual exports to country j (or to other countries ($k \neq j$)) over 3 prior years, averaged over those years where $X_{ijt} > 0$. Set to 0 if $\sum_{t-3}^{t-1} X_{ij} = 0$.
Seasonal dummies, S_{iq}	Seasonal dummies included to capture seasonality in firms' export product mix. Seasonal weights are calculated for each 2-digit Harmonised System product, based on the seasonality of aggregate exports in that product. Firms are then allocated high, medium, or low season dummies for each quarter of the year (q), according to the mix of products they export.
Firm-level characteristics	
Invoice currency and hedging	
NZD-only	Firm only ever invoices in NZD
non-hedged	Firm ever invoices in a non-NZD currency, but never hedges
ever-hedged	Firm ever invoices in a non-NZD currency and ever hedges against that exposure
Diversity of export destinations	
Low	Firm has exported to between 0 and 2 countries in the past three years
Medium	Firm has exported to between 3 and 9 countries in the past three years
High	Firm has exported to 10 or more countries in the past three years
Differentiated product share	
Low	10 percent or less of firm's export value is in differentiated products (by Rauch, 1999, liberal definition).
Medium	11-89 percent of firm's export value is in differentiated products (by Rauch, 1999, liberal definition).
High	90 percent or more of firm's export value is in differentiated products (by Rauch, 1999, liberal definition).

Data sources	
Exchange rates	Quarterly real exchange rate indices (base 2008) generated using monthly nominal USD exchange rates from the International Monetary Fund's International Financial Statistics (IFS) database (downloaded from Haver, 25/3/2013) and quarterly CPI data. CPI data sourced primarily from IFS database (via Haver). Missing observations patched using data from the International Labour Organisation's Labour Statistics Database (via FAOStat, 25/3/2013) and from national sources (eg national statistical agencies).
Population	Annual population estimates from UNStat, 25/3/2013 (http://unstats.un.org/unsd/snaama/selbasicFast.asp)
Gross Domestic Product	Annual GDP estimates in 2005 USD from UNStat, 25/3/2013 (http://unstats.un.org/unsd/snaama/selbasicFast.asp). Taiwan GDP patched from Haver's EMERGE database.
Export variables	All export variables generated from New Zealand Customs Service Merchandise Trade data, aggregated to quarterly level by firm and destination. Firms are excluded if they export at most once over the period Jan 2002 - Sept 2011. Export observations are excluded if they are below the minimum threshold for mandatory reporting to the Customs Service (NZD1000).

Table A.2: Summary statistics

Intensive Margin

	Committed		Non-committed		All	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
$\ln(X_{ijt})$	11.352	[2.170]	9.747	[1.851]	10.251	[2.094]
Prior exports$_{ijt}$	12.796	[2.146]	8.749	[4.68]	10.020	[4.472]
Prior exports$_{ik\neq jt}$	13.944	[4.117]	11.656	[5.036]	12.374	[4.884]
ln(RER)	4.611	[0.120]	4.613	[0.125]	4.612	[0.123]
ln(CoV)	-2.817	[0.502]	-2.738	[0.493]	-2.763	[0.497]
ln(GDPpc)	9.817	[1.174]	9.645	[1.271]	9.699	[1.244]
ln(pop)	16.733	[2.074]	16.680	[2.179]	16.697	[2.147]
Invoice currency and hedging experience						
$\delta^{NZD-only}$	0.033	[0.180]	0.130	[0.337]	0.100	[0.300]
$\delta^{ever-hedged}$	0.669	[0.471]	0.438	[0.496]	0.510	[0.500]
Diversity of export destinations	29.768	[26.580]	18.458	[19.267]	22.009	[22.451]
δ^{low}	0.083	[0.276]	0.229	[0.42]	0.183	[0.387]
δ^{high}	0.637	[0.481]	0.424	[0.494]	0.491	[0.500]
Share of differentiated goods	0.667	[0.409]	0.734	[0.39]	0.713	[0.397]
δ^{low}	0.219	[0.414]	0.181	[0.385]	0.193	[0.395]
δ^{high}	0.554	[0.497]	0.633	[0.482]	0.608	[0.488]
Observations	219,819		480,225		700,044	

Extensive Margin

	Incumbents						**Entry**	
	Committed		Non-committed		All		All	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
$\delta(X_{ijt})$	0.843	[0.364]	0.216	[0.412]	0.296	[0.456]	0.009	[0.095]
Prior exports$_{ijt}$	12.562	[2.086]	9.756	[1.859]	10.113	[2.108]	0.000	[0.000]
Prior exports$_{ik\neq jt}$	13.790	[4.131]	11.335	[4.770]	11.647	[4.764]	7.317	[5.131]
ln(RER)	4.611	[0.121]	4.616	[0.125]	4.616	[0.124]	4.615	[0.129]
ln(CoV)	-2.810	[0.502]	-2.713	[0.486]	-2.725	[0.489]	-2.702	[0.488]
ln(GDPpc)	9.817	[1.171]	9.625	[1.285]	9.650	[1.273]	9.552	[1.302]
ln(pop)	16.727	[2.075]	16.664	[2.196]	16.672	[2.181]	16.642	[2.265]
Invoice currency and hedging experience								
$\delta^{NZD-only}$	0.038	[0.191]	0.165	[0.371]	0.149	[0.356]	0.418	[0.493]
$\delta^{ever-hedged}$	0.653	[0.476]	0.381	[0.486]	0.415	[0.493]	0.119	[0.324]
Diversity of export destinations	28.910	[25.863]	16.369	[17.704]	17.963	[19.392]	4.409	[5.554]
δ^{low}	0.087	[0.281]	0.217	[0.412]	0.200	[0.400]	0.760	[0.427]
δ^{high}	0.625	[0.484]	0.385	[0.487]	0.416	[0.493]	0.036	[0.187]
Share of differentiated goods	0.674	[0.408]	0.778	[0.361]	0.765	[0.369]	0.850	[0.307]
δ^{low}	0.217	[0.412]	0.141	[0.348]	0.151	[0.358]	0.086	[0.280]
δ^{high}	0.562	[0.496]	0.679	[0.467]	0.664	[0.472]	0.767	[0.423]
Observations	260,100		1,786,248		2,046,351		2,370,840	

Table A.3: Classification of destination countries by bilateral exchange rate volatility

Low Volatility	Medium volatility		High volatility
Albania (AL)	Netherlands Antilles (AN)	Latvia (LV)	Afghanistan (AF)
Austria (AT)	Aruba (AW)	Morocco (MA)	Anguilla (AI)
Australia (AU)	Bosnia and Herzegovina (BA)	Marshall Islands (MH)	Armenia (AM)
Belgium (BE)	Bangladesh (BD)	Macedonia, the former Yugoslav Rep. of (MK)	Angola (AO)
Burkina Faso (BF)	Bermuda (BM)	Mali (ML)	Argentina (AR)
Bulgaria (BG)	Brunei Darussalam (BN)	Macao (MO)	Azerbaijan (AZ)
Benin (BJ)	Bahamas (BS)	Mauritius (MU)	Barbados (BB)
Congo (CG)	Bhutan (BT)	Mexico (MX)	Burundi (BI)
Cote d'Ivoire (CI)	Botswana (BW)	Malaysia (MY)	Bolivia, Plurinational State of (BO)
Cameroon (CM)	Belarus (BY)	Mozambique (MZ)	Brazil (BR)
Cyprus (CY)	Belize (BZ)	Namibia (NA)	Congo, Dem. Rep. of the (CD)
Germany (DE)	Canada (CA)	Nicaragua (NI)	China (CN)
Denmark (DK)	Central African Republic (CF)	Nepal (NP)	Cuba (CU)
Estonia (EE)	Switzerland (CH)	Oman (OM)	Dominican Republic (DO)
Spain (ES)	Chile (CL)	Panama (PA)	Ecuador (EC)
Finland (FI)	Colombia (CO)	Peru (PE)	Egypt (EG)
Fiji (FJ)	Costa Rica (CR)	Papua New Guinea (PG)	Ethiopia (ET)
France (FR)	Cabo Verde (CV)	Philippines (PH)	Gambia (GM)
Gabon (GA)	Czech Republic (CZ)	Pakistan (PK)	Guinea (GN)
United Kingdom (GB)	Dominica (DM)	Poland (PL)	Hong Kong (HK)
Equatorial Guinea (GQ)	Algeria (DZ)	Qatar (QA)	Haiti (HT)
Greece (GR)	Grenada (GD)	Romania (RO)	Iran, Islamic Republic of (IR)
Croatia (HR)	Georgia (GE)	Russian Federation (RU)	Japan (JP)
Hungary (HU)	Ghana (GH)	Saudi Arabia (SA)	Kenya (KE)
Ireland (IE)	Guatemala (GT)	Singapore (SG)	Saint Kitts and Nevis (KN)
Iceland (IS)	Guinea-Bissau (GW)	Slovakia (SK)	Libya (LY)
Italy (IT)	Guyana (GY)	San Marino (SM)	Moldova, Republic of (MD)
Kiribati (KI)	Honduras (HN)	Suriname (SR)	Madagascar (MG)
Luxembourg (LU)	Indonesia (ID)	El Salvador (SV)	Myanmar (MM)
Malta (MT)	Israel (IL)	Swaziland (SZ)	Mongolia (MN)
New Caledonia (NC)	India (IN)	Chad (TD)	Maldives (MV)
Niger (NE)	Jamaica (JM)	Thailand (TH)	Malawi (MW)
Netherlands (NL)	Jordan (JO)	Timor-Leste (TL)	Nigeria (NG)
Norway (NO)	Kyrgyzstan (KG)	Tunisia (TN)	Paraguay (PY)
French Polynesia (PF)	Cambodia (KH)	Turkey (TR)	Rwanda (RW)
Portugal (PT)	Korea, Republic of (KR)	Taiwan, Province of China (TW)	Solomon Islands (SB)
Sweden (SE)	Kuwait (KW)	Ukraine (UA)	Seychelles (SC)
Slovenia (SI)	Kazakhstan (KZ)	Uganda (UG)	Sierra Leone (SL)
Senegal (SN)	Lao People's Democratic Republic (LA)	United States (US)	Syrian Arab Republic (SY)
Togo (TG)	Saint Lucia (LC)	Saint Vincent and the Grenadines (VC)	Trinidad and Tobago (TT)
Tonga (TO)	Sri Lanka (LK)	Viet Nam (VN)	Tanzania, United Republic of (TZ)
Vanuatu (VU)	Lesotho (LS)	Yemen (YE)	Uruguay (UY)
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