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Over the hedge? Exporters' optimal and selective hedging choices*

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Abstract

How do exporting firms manage currency exposures? We examine this issue at the firm level using comprehensive data from the prototype Longitudinal Business Database recently developed by Statistics New Zealand. We use these data to test both optimal and selective hedging theories. Optimal hedging theory hypothesises that firms' hedging choices depend on the probability and cost of financial distress, underinvestment risks, scale, managerial risk aversion, information asymmetry, governance, ownership structures and tax rules. Recent literature suggests that some firms vary hedging positions relative to their optimal position in a selective attempt to 'beat the market'. We examine whether hedging behaviour is consistent with hypotheses derived from optimal hedging theories, and test whether hedging positions change (possibly sub-optimally) when the NZD/AUD is perceived to be 'high' or 'low' relative to an historical average. Optimal and selective hedging theories are both supported by the data. Estimation is over July 2000 to March 2007 (monthly) – a period during which the NZD/AUD varied substantially, making this a particularly pertinent period to test exporters' currency risk management practices.

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Disclaimer

This research uses data that was accessed while Richard Fabling was on secondment to Statistics New Zealand in accordance with security and confidentiality provisions of the Statistics Act 1975. Only people authorised by the Act are allowed to see data about a particular business or organisation. The results of this work have been confidentialised to protect individual businesses from identification. The analysis and interpretation of these results were undertaken while the authors were at the Reserve Bank of New Zealand and Motu, respectively. The opinions, findings, recommendations and conclusions expressed in this report are those of the authors. Statistics New Zealand, the Reserve Bank of New Zealand, Motu and the University of Waikato take no responsibility for any omissions or errors in the information contained here.

The results are based in part on tax data supplied by Inland Revenue to Statistics New Zealand under the Tax Administration Act 1994. This tax data must be used only for statistical purposes, and no individual information is published or disclosed in any other form, or provided back to Inland Revenue for administrative or regulatory purposes. Any person who had access to the unit-record data has certified that they have been shown, have read and have understood section 81 of the Tax Administration Act 1994, which relates to privacy and confidentiality. Any discussion of data limitations or weaknesses is not related to the data’s ability to support Inland Revenue's core operational requirements.

Statistics New Zealand protocols were applied to the data sourced from the New Zealand Customs Service. Any discussion of data limitations is not related to the data’s ability to support that agency’s core operational requirements.

1 Introduction

We analyse the currency hedging behaviour of goods exporters using a rich and comprehensive longitudinal panel of exporting firms. Exporters potentially face major risks arising from currency fluctuations. Under the specific conditions considered by Modigliani and Miller (1958) there is no gain in firm value through hedging these risks; thus hedging will not occur where positive administrative and/or transactions costs to hedging are present. However, hedging of foreign exchange risk by some exporters does occur in practice. A body of theoretical and empirical work on optimal hedging practices explains why such behaviour may be observed. More recently, another phenomenon has been observed: some firms appear to hedge on a selective basis (ie, to alter their hedge positions relative to some optimal level) in an attempt to 'beat the market'.

Our analysis tests both for optimal hedging determinants and for the presence of selective hedging behaviour. We are able to do so at the individual firm level using data from the prototype Longitudinal Business Database (LBD) recently developed by Statistics New Zealand (SNZ), the country's official statistical agency. The LBD covers virtually all New Zealand firms. It includes SNZ firm-level survey data (used, for example, to compile the national accounts) and administrative data that include tax filings relating to firm's annual accounts as well as GST (value added tax) and PAYE (employee income tax) obligations. These data sources enable construction of a wide range of firm-level financial variables that may influence optimal hedging decisions. Additionally, we have daily Customs merchandise trade shipment data linked to firms. This is our source for currency exposures and hedging decisions. It includes data on the currency that each trade was conducted in, a variable indicating whether the trade was hedged back into New Zealand dollars (NZD) and, if so, the exchange rate of the hedging contract. We are therefore able to track exporters' currency hedging decisions on a high frequency longitudinal basis, while at the same time controlling for optimal hedging determinants.

Our study builds on Fabling and Grimes (2008) which presented descriptive data on New Zealand exporters' hedging practices and used aggregated (as opposed to longitudinal unit record) data to test selective hedging behaviour. Fabling and Grimes found considerable differences in hedging behaviour across different sectors, both in a static sense (mean hedge ratios) and a dynamic sense (correlation of hedge ratios). As predicted by some optimal hedging hypotheses (discussed further below), large firms hedge more than smaller firms. However, small firms are the next most comprehensive hedgers, with intermediate-sized firms hedging a lower proportion of currency exposures than either large or small firms. Competing determinants of optimal hedging choices (eg, scale versus potential financial distress) may be behind such observed behaviour; what is clear from this prior study is that hedging propensity is not monotonically related to firm size. However, the study did find a monotonically increasing relationship between hedging propensity and export intensity (exports as a ratio of total sales).

Australia is New Zealand's largest trading partner accounting for 20.6 percent of merchandise exports (and approximately half of manufactured exports) in 2007. Fabling and Grimes (2008) found some tentative evidence of selective hedging behaviour with regard to exporters' Australian dollar (AUD) exposures; aggregate hedge ratios were consistently negatively related to the value of the NZD/AUD cross rate,[1] consistent with exporters locking in perceived low exchange rates. Despite this observed behaviour, statistical tests found no evidence that selective hedging behaviour is beneficial for firms; specifically there was no explanatory power of hedging practices for future exchange rate changes. Fabling and Grimes also found no evidence that changes in forward points (ie, short term interest rate differentials) alter firms' hedging decisions.

These results are consistent with other, mostly recent, explorations of the phenomenon of selective hedging. Building on the ideas of Stulz (1996) and Working (1962), Brown et al (2006) and Meredith (2006) examined whether selective hedging occurs for commodities in the gold and the oil/gas industries respectively. Firms may selectively hedge profitably if they possess a comparative advantage relative to other firms in a market with respect to future price trends (eg, because of specialised supply-side knowledge). Evidence of selective hedging is found in both studies when prices deviate from historical averages. However, neither study finds evidence indicating that selective hedging leads to superior operating or financial performance. Thus firms in both industries may believe that they have a comparative advantage in predicting industry trends which in fact they do not possess.

[1] We express the exchange rate in its mathematical sense; ie, NZD/AUD = x $\Rightarrow$ 1NZD = xAUD.

The use of selective hedging in interest rate and currency markets appears to be much more widespread than can be explained solely by firms' comparative advantage in specific markets (Dolde, 1993; Bodnar, Hayt and Marston, 1996; Glaum, 2000 and 2002; Faulkender, 2005). It is possible that the practice is influenced by managerial characteristics and incentive sets within the firm (Beber and Fabbri, 2006). For instance, managers' remuneration may be more closely tied to upside performance relative to budget (through bonuses) than to downside results. Alternatively, managers may mistakenly believe that markets are mean-reverting when they are not; or, at least, more mean-reverting than they actually are.[2] It is, however, possible that actions which appear to represent selective hedging behaviour (eg, observed changes in hedge ratios based on the use of forward exchange rate contracts) are offset by changes in other forms of hedging, such as balance sheet hedges, use of natural hedges and invoicing exports in local currency. These last two alternatives are explored in our empirical work.

In order to model selective hedging behaviour, one must first model optimal hedging behaviour. We define optimal hedging as follows: Let V_{jZt} be the market value of firm j, with a set of characteristics, Z, in period t. The firm chooses an optimal hedging policy, h*, from a feasible vector of hedging choices, $H = (h_1, \ldots, h^*, \ldots, h_N)$ such that $V_{jZt} | h^* = \sup(V_{jZt} | h_i, i=1,\ldots,N)$. If firm j has the same characteristics, Z, in period t+1 as in period t then, with efficient markets, h* will again be the optimal hedging choice. By contrast, if the firm varies its hedging choice (after controlling for its characteristics), and especially if the variation is in response to market movements of the variable to be hedged, we define the firm to be practicing selective hedging.

Determinants of optimal hedging choices explored in prior theoretical and empirical studies chiefly reflect responses to maximise firm value in the presence of deviations from frictionless, full information markets. Such deviations may include: the existence of financial distress costs, which may induce increased hedging by highly leveraged firms and firms with poor liquidity (Smith and Stulz, 1985; Nance et al, 1993); underinvestment costs which may increase hedging by firms with strong growth prospects, so

[2] Some implied New Zealand evidence on this view comes from Brookes et al (2000), who report that corporates consider forward rate contracts advantageous for short-term hedging transactions owing to their relative flexibility: "Contracts can readily be rolled forward, or closed out, according to the firm's view of the exchange rate" (p.27). They indicate that selective hedging based on the level of the exchange rate relative to historical averages (ie, on perceived mean-reverting exchange rate behaviour) is practiced by a sizeable portion of exporters.

preserving internally generated funds to be used for expansion (Bessimbinder, 1991; Froot, Scharfstein and Stein, 1993); scale and export intensity, leading to increased hedging by larger firms and/or by firms with large ratios of exports/sales (Graham and Rodgers, 2002; Lel, 2004); convex tax schedules which, even with a proportional tax schedule (as in New Zealand), may induce greater hedging by firms with existing tax losses (Smith and Stulz, 1985); and country-specific factors such as accounting conventions, regulatory restrictions or the nature of capital markets (Bodnar and Gebhardt, 1999; Bodnar et al, 2003). In some cases, optimal hedging may reflect maximisation of the managerial value function (rather than that of shareholders), being impacted by managerial risk aversion and governance characteristics (Breedan and Viswanath, 1998).

Our access to New Zealand's LBD enables formulation of longitudinal financial proxies representing a range of potential optimal hedging determinants hypothesised in the studies cited above. One feature that sets our study apart from prior studies of firm hedging behaviour is the breadth of our coverage. Almost invariably, prior studies have concentrated on small subsets of firms that are often quite homogeneous in certain respects, for instance very large US firms (Bodnar and Gentry, 1993; Geczy et al, 1997; Allayannis and Ofek, 2001; Hentschel and Kothari, 2001), large European firms (De Ceuster et al, 2000) or firms in specific commodity markets (Tufano, 1996; Haushalter, 2000; Brown et al, 2006; Meredith, 2006). These selective samples mean that most such results are not generalisable across the great bulk of firms in an economy, most of which are not exchange-listed and which cover a wide range of sectors. By contrast, our data source includes almost all private sector firms across the country, with currency hedging information available for virtually all firms that have exported a merchandise item at any time between 2000 and 2007. This provides wide coverage of firms across sectors and across size and age cohorts. It also enables us to use estimation methods that minimise selection issues (for instance, regarding which firms choose to export to a certain market in a certain currency at a certain time).

Another key factor that sets our study apart from others is the longitudinal nature of our data. Rather than using a single cross-section as in many prior studies (eg, Geczy et al, 1997), we use longitudinal data (aggregated to a monthly frequency) over seven years. Thus our results are less subject to the criticism of cross-sectional studies that the results may be time-specific and so not generalisable under different economic conditions. The longitudinal nature of the data is key to estimating whether selective hedging occurs.

In section 2 of the paper, we outline our hypotheses and discuss modelling issues that must be dealt with. In particular, we are careful to delineate two separate approaches to dealing with potential selection bias. Section 3 outlines our data sources and provides some descriptive statistics of relevant variables. Section 4 presents our results, both with respect to optimal hedging determinants and selective hedging practices. Our major results, particularly with respect to selective hedging, are robust to a variety of specification tests, splitting the population across various dimensions, and different ways of handling selection issues. Section 5 concludes and discusses future directions for research. A major unresolved issue, given we find strong evidence that many firms practice selective hedging, is why they should do so when prior evidence (and efficient markets) indicates that such behaviour, on average, adds no value to the firm. Our split population results give one clue in this direction but cannot fully explain the propensity of firms across all types to engage in selective hedging.

2 Hypotheses and Modelling Issues

We estimate the determinants of exporters' hedging decisions, focusing on currency hedging decisions of New Zealand firms that export merchandise goods to Australia. Between 2004 and 2007, almost equal proportions of these exports were denominated in Australian dollars (AUD) and New Zealand dollars (NZD), at 47.1 percent and 43.3 percent respectively (Fabling and Grimes, 2008). A small proportion was denominated in other currencies, chiefly USD, but these trades are not our focus for the remainder of the paper. The aggregate share of AUD-denominated exports hedged back to NZD varied between 20 percent and 32 percent over the same period.

The presence of exports in both AUD (hedged and unhedged) and NZD raises a definitional and modelling issue to be addressed: Is the currency of denomination a choice variable of exporters, or are exporters 'currency-takers', at least over the relevant time horizon? If currency is not a choice variable for the exporter, we can define hedged transactions as AUD exports that are explicitly hedged back to NZD (eg, by forward contracts).[3] If currency is a choice variable, we need to define hedged transactions as also including all NZD-denominated exports. We adopt two different model specification approaches catering for each of these possibilities.

[3] Brooks et al (2000) find that forward contracts are the predominant form of currency hedging used by New Zealand exporters.

In the first approach, we treat currency of denomination as exogenous and model the decisions of firms to hedge (or leave unhedged) their AUD exports to Australia. In the second approach, we model the decisions of firms to hedge either by explicitly covering their AUD-denominated exports back to NZD or by denominating exports in NZD versus the alternative of denominating exports in AUD and leaving those transactions unhedged. Under either approach, because of the nature of our longitudinal panel, we are able to model optimal hedging determinants and selective hedging decisions together.

A number of econometric issues prevent use of simple OLS regression under either approach. In particular we face selection and truncation issues. Using the first approach (exogenous currency of denomination) as our baseline model, let H_{it} be the proportion of firm i's AUD-denominated exports to Australia in month t that are hedged,[4] given that firm i exports in AUD in t; and noting that $0 \leq H_{it} \leq 1$. This is a truncated regression problem with both selection effects and a limited range for the observed dependent variable. The selection issue arises since we are conditioning only on firms that export in AUD in month t. This variable may be a choice variable of the firm not only for currency denomination reasons (as in our second approach) but also because the export decision itself, including its timing, may be a choice variable.

Specifically, consider two latent variables, H_{it}^* and Z_{it}^*, generated by the bivariate process in (1) where $\mathbf{X_{it}}$ and $\mathbf{W_{it}}$ are vectors of observations on exogenous (or predetermined) variables, $\boldsymbol{\beta}$ and $\boldsymbol{\gamma}$ are unknown parameter vectors, σ is the standard deviation of μ_{it}, and ρ is the correlation between μ_{it} and ν_{it}. We only observe the sign of Z_{it}^* so the variance of ν_{it} is restricted to 1.

$$\begin{bmatrix} H_{it}^* \\ Z_{it}^* \end{bmatrix} = \begin{bmatrix} \mathbf{X_{it}}\boldsymbol{\beta} \\ \mathbf{W_{it}}\boldsymbol{\gamma} \end{bmatrix} + \begin{bmatrix} \mu_{it} \\ \nu_{it} \end{bmatrix} \qquad \begin{bmatrix} \mu_{it} \\ \nu_{it} \end{bmatrix} \sim NID\left(\ , \begin{bmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{bmatrix} \right) \tag{1}$$

The variables that we observe are H_{it} (the proportion of firm i's AUD exports in t that are hedged) and Z_{it} (a binary variable denoting whether firm i exports in AUD in t) where:

$$H_{it} = H_{it}^* \text{ if } Z_{it}^* > 0; \qquad H_{it} \text{ unobserved otherwise}$$

[4] Value calculations for this variable use AUD as numeraire.

$$Z_{it} = 1 \quad \text{if} \quad Z^*_{it} > 0; \qquad Z_{it} = 0 \text{ otherwise} \tag{2}$$

To deal with these selection and truncation issues we use Heckman's two-step (Heckit) method involving a selection equation plus a structural equation that estimates the parameters of interest.[5] The selection equation is a probit estimating whether firm i exports in AUD in t. This equation is used to obtain consistent estimates of $\boldsymbol{\gamma}$ which, in turn, are used to construct estimates of v_{it}.

The structural equation estimates the parameters of the hedging function given the decision to export in AUD. Specifically, we estimate the tobit equation:

$$H_{it} = \mathbf{X_{it}}\,\boldsymbol{\beta} + \rho\sigma\, v_{it} + e_{it} \tag{3}$$

where the inverse Mills ratio (using $\mathbf{W_{it}}$ and the estimated γ from the probit equation) is used to proxy v_{it}. This approach yields consistent estimates of $\boldsymbol{\beta}$ conditional on the assumption of bivariate normality. Since $\sigma \neq 0$, the t-statistic on the inverse Mills ratio (IMR) in (3) can be used to test the null hypothesis of $\rho=0$. The precision of estimates is dependent on the information in $\mathbf{W_{it}}$ relative to $\mathbf{X_{it}}$; accordingly, we include extra elements in the selection equation that do not appear in the structural equation. We test robustness of our approach by estimating an alternative structural equation that divides the IMR observations into deciles, then using these deciles in place of the IMR in (3), so not relying on the linearity assumption implicit in (1) and (3).

In our application, the elements of $\mathbf{X_{it}}$ comprise variables hypothesised to be important in the optimal hedging literature together with dynamic exchange rate variables to test for the presence of selective hedging. Additional explanatory variables are available for inclusion in $\mathbf{W_{it}}$ since the selection equation includes variables that predict whether firms (a) export; and (b) export in AUD. These variables are not included in the structural equation that predicts whether firms will choose to hedge any resulting AUD exposures.

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[5] See Davidson and MacKinnon (2004). Full information maximum likelihood (FIML) provides an alternative estimation method. In a recent application using both full sample and truncated sample data, Johansson (2007) finds that, while similar point estimates are obtained, the FIML estimates are less efficient than those obtained from the Heckit method.

Under our first approach (assuming that exporters are "currency-takers"), the dependent variable in the first stage regression is a binary variable. Specifically, $XAUD_{it} = 1$ if firm i exports to Australia in AUD in month t, and zero otherwise.[6] The dependent variable in the second stage regression ($H1_{it}$, taking the role of H_{it}) is the proportion of AUD-denominated exports of firm i hedged in month t.

In the second approach (where the exporter chooses the currency of trade), the dependent variable in the first stage regression is a binary variable (XAU2) where $XAU2_{it} = 1$ if firm i exports to Australia in AUD or NZD in month t, and zero otherwise. The dependent variable in the second stage regression ($H2_{it}$) is the proportion of firm i's exports to Australia in t that are either denominated in NZD, or in AUD and hedged back to NZD.

Variables included in $\mathbf{X_{it}}$ that are hypothesised to influence optimal hedging decisions are listed in the appendix (together with the expected coefficient sign in the tobit equation). Two hedging experience variables are included: ZHK and MHK; the former (binary) variable measures whether firm i has ever hedged an export previously (ie, since August 1997, the date when these data were first captured) while MHK measures the inverse of the number of months since the last hedging transaction. Both are expected to be positive,[7] consistent with hedging being more likely where there is some in-house expertise. An alternative specification tests whether the results are robust to the specification of the functional form in MHK by replacing MHK with three dummy variables depending on whether the most recent hedging transaction was less than 1 year ago, between 1 and 3 years ago, and over three years ago; these are denoted MHK_1YR, MHK_3YR and MHK_>3YR respectively.[8]

Our access to taxation and other financial data enables us to specify two financial variables related to the probability and cost of financial distress: DER is a measure of the debt-equity ratio (defined here as debt/(debt + equity)); and ICR is the interest coverage ratio. In each case, an increase in the variable indicates a financially more fragile position (ceteris paribus), so increasing the incentive to hedge currency risk (thus coefficients are

[6] That is, $XAUD_{it}$ takes the role of Z_{it}; i and t subscripts are henceforth suppressed in the text where the meaning is clear.
[7] Here and elsewhere, we describe the alternative hypothesis against the null of zero.
[8] Corresponding variables are included for our second approach, with hedging experience defined also to include prior exports denominated in NZD.

hypothesised to be positive).[9] Another financial variable relates to the firm's tax position. New Zealand has a proportional (linear) company tax regime for firms with positive profits. However, a firm with a tax loss carry-forward faces a convex tax schedule, so has the incentive to lock in a tranche of tax-free profits. The variable ZTX is a binary denoting whether a firm has a tax-loss carry-forward position, with the hypothesis implying a positive coefficient.

Considerable evidence exists in prior literature that hedging is more prevalent in larger firms than in smaller firms; this has generally been interpreted as a scale effect (eg, Marsden and Prevost, 2005). However, there is reason to doubt the scale argument. For instance, Geczy et al (1997) find a positive relationship between firm size and hedging propensity amongst Fortune 500 firms. All such firms must reasonably be expected to have sufficient scale to be able to hedge currency and other financial risks, so the positive relationship may reflect other factors. Almost uniquely, we are able to differentiate between a pure scale (firm size) effect and other factors that may be positively correlated with scale but imply different causal links; for instance, reflecting diversification. Our scale variable is (log of) real total sales, LSAL. Other variables that may be correlated with sales but that reflect different channels are measures of diversification: DPC (number of product types[10] exported in the past year), DMC (number of markets exported to in the past year), DCC (number of currencies used to export in the past year) and DIC (number of countries imported from in the past year). In each case, we hypothesise that the greater the diversification, the less the need to hedge any particular transaction (so negative coefficients are expected in each case). These diversification variables are likely to be correlated, so we also estimate a specification in which the four variables are replaced by their first principal component (PCA).

Export and import intensity are hypothesised to be potentially important determinants of hedging behaviour, although their impacts on specific hedging choices will be affected by the currency exposures for these transactions. (These variables can be considered as supplements to the explicit diversification variables.) For our first approach, a firm with a high proportion of NZD denominated exports relative to sales (FXNS) may already be well hedged and so choose not to hedge AUD denominated

[9] We also have data on the "quick ratio"; however this variable has a correlation coefficient with the debt-equity ratio of 0.83 (in the tobit sample) and so is dropped from the analysis.
[10] Defined at the Harmonised System ten-digit (HS10) level.

exports (a negative coefficient). Conversely, a firm with a high proportion of AUD denominated exports relative to sales (FXAS) will be heavily exposed to movements in the NZD/AUD and so choose to hedge a greater proportion of its AUD denominated exports (a positive coefficient). A firm with a high proportion of other currency (non-AUD and non-NZD) exports relative to sales (FXOS) has some degree of currency diversification in place and so may choose not to hedge AUD denominated exports. However, such a firm is also likely to have strong experience of currency markets and this may make it more likely that it will hedge; thus the hypothesised coefficient on FXOS is of indeterminate sign. In each of these three cases, we split off re-exports (FXNRS, FXARS, FXORS) since the hypothesised sign in each case is less clear than for standard exports (thus each coefficient has an indeterminate sign). In the second approach, the set of export intensity variables is replaced by simpler variables measuring exports (and re-exports) as a proportion of sales since, in that approach, currency is treated as a choice variable.

Imports may also provide a form of currency hedge. We do not have currency denomination data for imports and do not have data on firms' indirect purchases of imported goods. Instead, we include the proportion of Australian imports relative to sales (FMAS) and the proportion of other country imports relative to sales (FMOS). These are (possibly poor) proxies for offsetting currency exposures stemming from imports. To the extent that these variables proxy for firms' currency import exposures, we hypothesise that FMAS will have a negative coefficient reflecting a natural hedge position; FMOS is of indeterminate sign reflecting a balance of experience and diversification influences.

A strong body of theory (but not such a strong body of empirical results) indicates that firms faced with underinvestment risks are likely to hedge more than other firms in order to lock-in internally generated funds to finance expansion. Traditionally, the difficulty in testing this hypothesis is finding adequate proxies to identify such firms. Our access to balance sheet data enables us to form a relevant proxy: the intangible asset ratio (ITA), defined as the ratio of intangible assets to total assets of the firm. Firms with a high ITA are expected to have greater likelihood of strong growth prospects, and so hedge risks more comprehensively (positive coefficient). Conversely, companies with a high dividend to profit ratio (DTP) signal that they are not constrained by internal capital shortages and thus have less of an incentive to lock in expected profits (negative coefficient). Firms with high capital requirements may face a relatively high need to lock in internally generated funds to finance depreciation or further expansion; we proxy this influence by the depreciation to total expenses ratio (DTE), with the hypothesis implying a positive coefficient.

Governance and ownership structures may be important for determining hedging decisions owing to different risk appetites. We control for four different types of ownership structure: sole proprietor (ZBT_SP), partnership (ZBT_PART), state-owned enterprise (ZBT_SOE) and company (the omitted category in the equation). We have no priors on the coefficient signs for these variables. In addition, we include a control variable (ZBT_FOR) for whether the firm is defined as a foreign-controlled firm in any of the data sources. We hypothesise that foreign owned firms will hedge AUD exposures less than do New Zealand owned firms (thus have a negative coefficient) for two reasons. First, they may be owned by an Australian company in which case the translation exposure offsets the transaction exposure and no hedging is required. Second, non-Australian owned firms will tend to have greater diversification across markets than New Zealand owned firms and so have less incentive to hedge any one source of currency risk.

We include 97 sector controls (HS_k). These take the form of binary variables equal to one if the firm has ever exported a good in the (two-digit) HS Chapter (between 1997 and 2007) and zero otherwise. These variables are not reported (owing to confidentiality restrictions) but are included to ensure that the results are not driven either by sectoral differences in hedging propensities or by sectoral differences in the means of the explanatory variables.

Extra variables are required in the probit equation (ie, variables that appear in $\mathbf{W}_{it}$ that are not included in $\mathbf{X}_{it}$). Under our first approach, we include variables in the probit that help predict whether a firm will export to Australia in AUD (but that do not help explain the subsequent hedging decision). These include dummy binary variables respectively for whether the firm has ever exported prior to month t (FEX), has exported to Australia prior to or in t (FEA and XAU respectively), and has ever exported in AUD prior to t (FAU). We also include variables indicating the (inverse of the) length of time since these actions occurred (MEX, MEA and MAU respectively). Month dummy variables (ZMk) are included given the seasonality in exports.

For the probit equation, we replace ZHK_{it} and MHK_{it} (ie, variables included in the tobit indicating whether the firm has hedged before, and time since hedging) with their respective sector averages (ZHK_ind and MHK_ind). We do so to ensure that we have an independent predictor of currency hedging experience in the probit that is not based on the firm's own hedging experience.

The selective hedging variable, that appears in both $\mathbf{X_{it}}$ and $\mathbf{W_{it}}$, is the deviation of the NZD/AUD exchange rate from its three-year lagged moving average, AUD3:

$$AUD3_t \equiv \frac{NZD/AUD_t}{\sum_{i=1}^{36} NZD/AUD_{t-i}/36}$$

We include $AUD3_t$ plus twelve lagged changes in AUD3 (AUD3d1,…, AUD3d12, where AUD3dx = $AUD3_{t-x+1} - AUD3_{t-x}$). This specification is equivalent to including the current plus twelve lags of AUD3; it enables us to summarise the overall impact of the selective hedging decision solely with reference to the coefficient on $AUD3_t$. We choose the deviation of NZD/AUD from an historical average reference point since the descriptive and anecdotal evidence (eg, Brookes et al, 2000) indicates that at least some exporters make hedging decisions based on backward-looking benchmarks of 'normal' exchange rate levels; ie, they assume at least some degree of mean reversion in the NZD/AUD rate. Fabling and Grimes (2008) used a variety of backward-looking windows in their aggregate hedging study and found similar results when using one, three, five and ten year windows – the three-year window had slightly higher explanatory power for aggregate hedging movements than the other windows. Use of an historical window has the advantage over potential smoothing filters (such as a Hodrick-Prescott filter or a Baxter-King band-pass filter) that it does not use any future data in its construction; thus it includes only information actually available to the firm at time t.

Our null hypothesis, consistent with joint hypotheses of rational behaviour and efficient markets, is that firms do not hedge selectively; the alternative hypothesis of selective hedging implies a negative coefficient on AUD3. Previously cited cross-sectional studies for different countries suggest that many firms engage in some degree of selective hedging in interest rate and exchange rate markets. The puzzle that arises from these studies is why such behaviour might occur, especially within deeply traded financial markets.

In order to investigate this issue more closely we invert the problem. We hypothesise that certain types of firm are more likely than others to display consistent hedging behaviour arising from explicit adoption of firm-specific financial policies. Specifically, we hypothesise that firms for which exporting is a major activity will be most likely to have explicit hedging policies in place and so will not be as prone to engage in selective hedging as less intensive exporters. The latter group may export only irregularly, and so may not have developed an explicit hedging policy. In that situation, the choice of whether or not to hedge a specific export shipment must be addressed on each occurrence. We hypothesise that it is these latter firms that are most likely to be influenced in their hedging decision by the current level of the exchange rate relative to some perceived norm.

This hypothesis implies that firms with low export intensity (exports/total sales) will be more prone to selective hedging than firms with high export intensity. We explicitly test this hypothesis. Similar reasoning applies to firm differences according to degree of trade intensity ((exports + imports)/ total sales), size and foreign-ownership. Financially fragile firms (eg, high leverage) or firms that wish to lock in profits because they are in a tax-loss situation may behave differently to exchange rate fluctuations than do other firms; we test whether selective hedging propensity differs according to these criteria.

Firms as a whole may be more prone to selective hedging at some parts of the perceived exchange rate cycle than at others. Accordingly, we test whether selective hedging behaviour differs according to whether AUD3 is above or below unity (ie, whether NZD/AUD is above or below its past three year average). We also test stability of selective hedging practices across AUD3 quartiles in case distance from the recent mean level affects selective hedging propensity. Thus, not only do we test for the existence of selective hedging within the population, we also try to infer from our firm and exchange rate groupings the processes that might lie behind any observed selective hedging behaviour.

3 Data

Our comprehensive panel comprises all New Zealand-based firms that ever exported to Australia between July 2000 and March 2007, subject to minimum threshold requirements.[11] This period (81 months) constitutes our estimation period and is fixed by the availability of lagged financial data, noting that we use previous financial year data to minimise any endogeneity issues.[12] Subject to the exporting requirement, a firm will be included in the panel if it is "economically active" over two consecutive years from 2000-2007. That is, we adopt an unbalanced panel (although most firms are present in all years). To be "economically active" a firm must be observed in our broad-ranging administrative data as either: selling products, purchasing intermediate inputs, employing staff or holding physical capital. The population includes firms in all sectors other than foreign-located firms,[13] households, and not-for-profits. These restrictions leave us with approximately 12,500 firms in our population.

Our main set of estimates is conducted for firms that have no imputed data attributed to them. We do so to ensure data reliability. With this sample, our probit equation (using our first approach to defining hedging) comprises 647,952 firm-month observations; the tobit equation in our first approach (which includes only firms that export to Australia in AUD in month t) comprises 38,892 firm-month observations. The potential drawback of using only unimputed data is that we may incur some selection bias if firms requiring imputation constitute a non-random sample. To check robustness of our results, we also estimate our baseline probit and tobit equations with all firms that have both unimputed and imputed data;[14] this increases the observation count in the two equations to 948,120 and 53,868, respectively.

The size distribution of firms included in our study is shown in the kernel density graph, Figure 1, for LSAL (logarithm of real sales).[15] The distribution of annual real sales is remarkably symmetric and covers a very broad range of firm sizes extending from well below the mandatory Customs filing threshold (of NZD1,000) to over NZD1billion per annum.

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[11] The key threshold requirements are at NZD$40,000 p.a. of income (to be subject to mandatory GST filing), and $1,000 consignment value (to be subject to mandatory Customs filing). On average over the observation period, 1NZD=0.87AUD=0.57USD. Given the extremely low nature of the thresholds, we can be virtually certain that our data excludes very few trading firms.

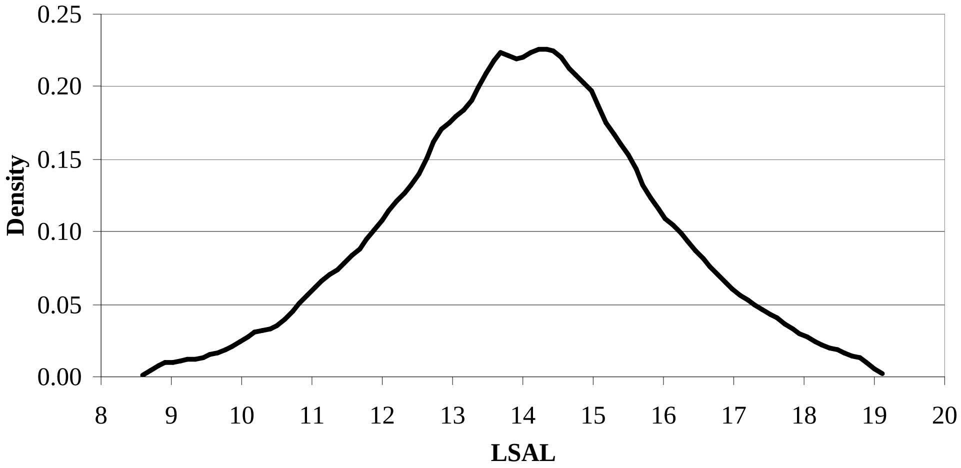
[12] In a very small number of cases financial data has been projected back or forward at the start or end of the observation period to avoid being further limited by rare balance dates.

[13] Foreign-owned firms located in New Zealand are included.

[14] The imputed data is supplied by Statistics New Zealand and is constructed using a mix of historical, donor and linear interpolation methods.

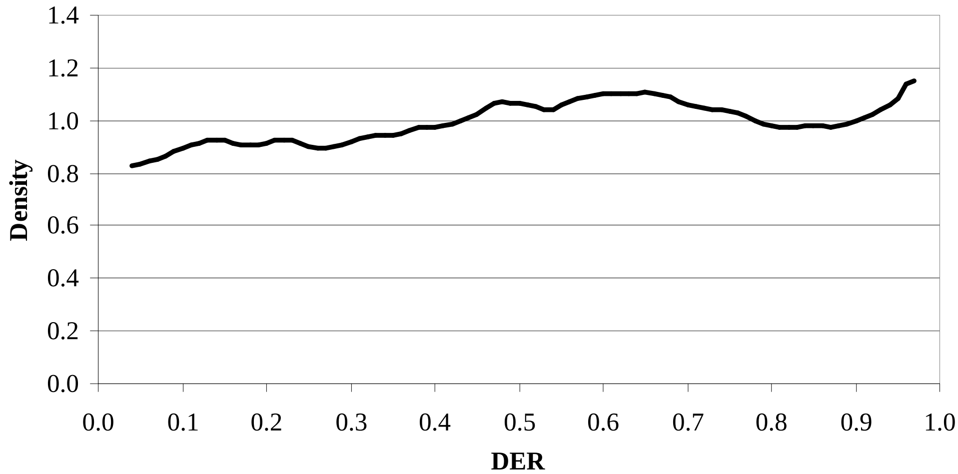
[15] The kernel density is calculated excluding the top 1% and bottom 1% of the distribution due to confidentiality restrictions.

Figure 1
Distribution of LSAL (logarithm of real sales)



* Kernel density plot using Epanechnikov kernel function. Top and bottom one percent of distribution excluded to comply with Statistics NZ confidentiality rules

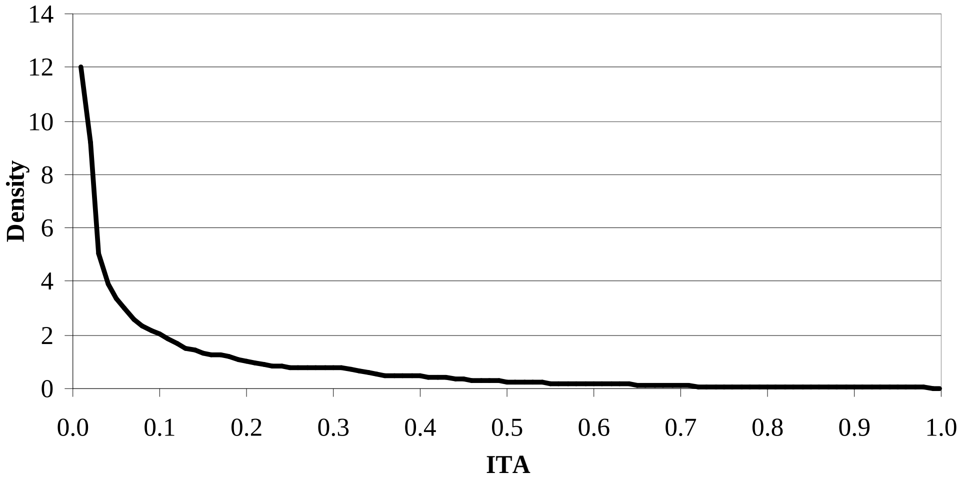
Figure 2
Distribution of DER (Debt/(Debt+Equity))



* Kernel density plot using Epanechnikov kernel function. Observations at zero (17.7%) and one (15.2%) excluded to enable the distribution at intermediate values to be seen more clearly.

The distribution of firms' financial states also varies considerably. Figure 2 plots the kernel density of DER (debt to equity ratio), excluding firms with DER=0 (17.7 percent of firms) and firms with DER=1 (15.2 percent of firms). Slightly fewer than half of firms have DER less than 0.5. By contrast, Figure 3 shows that ITA (intangible assets/total assets) is heavily skewed towards zero; 73.6 percent of firms have ITA=0.[16] For the large bulk of firms, intangible assets comprise less than 10 percent of total assets.

Figure 3
Distribution of ITA (Intangible Assets/Total Assets)

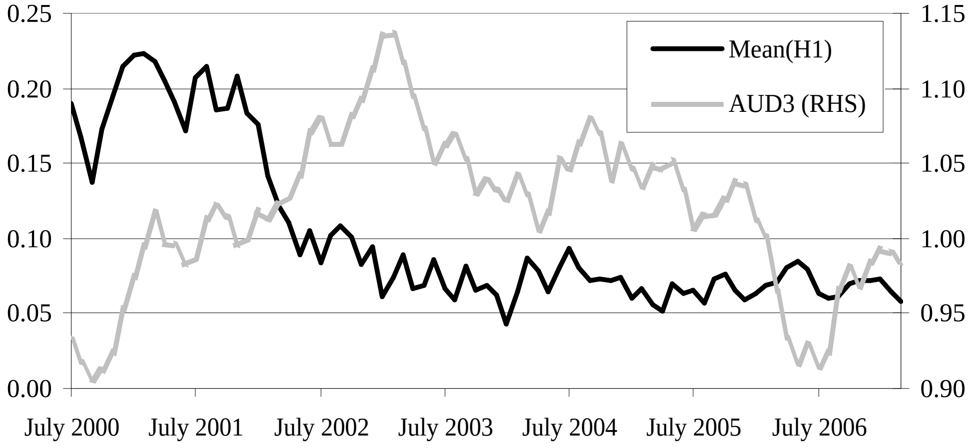


* Kernel density plot using Epanechnikov kernel function. Observations at zero (73.6%) excluded to enable the distribution at other values to be seen more clearly.

The mean monthly value of H1 (the hedging variable in our first approach) is shown in Figure 4. For the first one to two years of the observation period it ranges mostly between 15 percent and 20 percent, before dropping to between 5 percent and 10 percent over the final five years. The drop coincided with a sharp rise in AUD3 (deviation of NZD/AUD from its lagged three year average), also shown in Figure 4. Thereafter, several periods of inverse movements between the two series occur. The correlation coefficient between the two series over the study period is -0.35, consistent with the aggregate indicators of selective hedging in Fabling and Grimes (2008). In our econometric work, presented in section 4, we are able to test whether this inverse relationship holds up at the unit record firm level once we control for other (optimal hedging) influences; we also test whether the relationship is consistent across the different quartiles of AUD3.

[16] Our econometric estimates in section 4 include firms with DER=0, DER=1 and ITA=0. These observations have only been excluded from Figures 2 and 3 to enable the distribution at other values to be seen more clearly.

Figure 4
Mean Monthly Value of H1 (AUD Hedging Proportion) and AUD3 (NZD/AUD deviation from lagged 3 year average)



4 Results

4.1 Estimated Equations

In reporting results, we concentrate on those using our first definition of hedging (where the currency of denomination is exogenous to the firm) and use only unimputed data. Subsequently, we report results that incorporate imputed data and describe results using our second hedging definition (including NZD exports as hedged exports). Our reporting focuses primarily on the tobit (rather than the probit) results since our interest is in the currency hedging decision rather than the prior export decision. We report both the optimal hedging findings and the selective hedging results which are estimated together. The latter constitute the most novel aspect of our study. In particular, the extensive controls that we include for optimal hedging determinants and the comprehensive nature of firm sizes and sectors in our dataset make the results with respect to selective hedging particularly rigorous compared with those in prior studies.[17]

Table A.2 in the appendix presents results using the first hedging definition. All columns, except the final two, report results for the sample that uses

[17] The 97 sector controls are jointly significant (p=0.000) in every equation, but their coefficients are not reported for confidentiality reasons.

only unimputed data. Column 1 presents the probit equation used to predict whether firm i exports to Australia in AUD in month t (p-values are shown in square parentheses for each coefficient). We are able to predict the exporting choice with a high degree of precision (pseudo-R2=0.682). We calculate the inverse Mills ratio from the probit regression for inclusion in the tobit equation.

Our main tobit equation (column 2) contains the optimal hedging and selective hedging variables described in section 2 plus the inverse Mills ratio (IMR). The latter is highly significant implying that the selection equation is required. Note, however, that when we omit this ratio (column 5) the results do not change markedly. One potential criticism of including the raw IMR is that the implied linearity assumption may not be appropriate. To test sensitivity of the results to an alternative specification, we include a set of binary dummy variables indicating whether the observation is in the second to tenth IMR deciles (the first decile being the omitted variable). These results are reported in column 6; again other results are not sensitive to this alternative specification. Thus we concentrate on the main results in column 2.

4.2 Optimal Hedging

All but one of the optimal hedging variables that are significant at the 5 percent level have the expected (alternative hypothesis) sign. The hedging experience variables (ZHK and MHK) are both highly significant (p=0.000) indicating that firms have an increased potential to hedge if they have past hedging experience.

Natural hedging opportunities affect the propensity to hedge AUD exports. Firms that export in a large number of currencies (DCC) and that import from a large number of countries (DIC) are less likely to hedge their AUD exposures. Other natural hedge proxies (DPC and DMC) are not significant, possibly because these four variables are highly correlated with one another (the six bivariate correlation coefficients range between 0.31 and 0.68). In column 4, we replace the four variables with their first principal component (PCA). The principal component is highly significant and negative indicating that natural hedge opportunities reduce the need to hedge explicitly. Other results are not materially affected.

The hypothesis that firms facing under-investment risks tend to hedge more intensively is supported. Firms with high intangible asset ratios (ITA) hedge a higher proportion of their AUD exposures (this result holds even with the inclusion of extensive sector controls in the equation). This result is robust across all specifications including when imputed data is used (column 11), although the significance and size of the coefficient falls in that case. One of the difficulties in testing the under-investment hypothesis in past work has been the difficulty of finding a suitable proxy for firms with high growth prospects. The intangible asset ratio provides an appealing proxy for such firms, but has not generally been available to past researchers, and imputation techniques are unlikely to be able to replicate such a variable with high precision. The drop in size and significance of ITA in column 11 is consistent with these observations.

Three other financial variables are significant in the main tobit regression. The tax-loss carry-forward position (ZTX) is significantly positive indicating that such firms wish to lock in profits so as to ensure use is made of their tax-loss position. The debt-equity ratio (DER) is significantly positive, indicating that firms with a more fragile balance sheet structure (relative to sector norms) are more likely to hedge. However, the interest coverage ratio (ICR) is significantly negative. This is the only variable, significant at 5 percent, that has a sign different from that hypothesised. One problem with inclusion of both DER and ICR is that the two variables are moderately positively correlated (correlation coefficient = 0.27). In column 3, we omit ICR; DER continues with a positive coefficient (p = 0.116); other coefficients are little changed. The results for the financial variables, therefore, provide some support for the hypothesis that firms with more fragile balance sheets (and/or with tax losses) tend to increase their hedging of exchange rate exposures.

One important finding relates to firm size. Our firm scale variable (LSAL) is not significant (even at the 20 percent level) in the main tobit regression; when imputed data is added (column 11) the variable remains insignificant (and the point estimate is slightly negative). The insignificance of scale is robust across the specifications without ICR, with PCA, and without IMR (columns 3-5), albeit with some limited significance (p=0.087) when the alternative IMR specification is used.

One reason why prior studies may have (mistakenly) reported a firm scale hedging effect is if a positive correlation existed between firm size and other firm characteristics that were omitted from those analyses. To test this possibility, column 7 presents results for an equation that omits the hedging experience and diversification (and related) variables.[18] These variables have moderate to high positive correlations with firm size. The results in column 7 indicate a sizeable and significant firm scale effect (p=0.000 for LSAL) when these variables are omitted. Column 8 reintroduces the two hedging experience variables, but continues to omit the diversification variables; firm scale returns to insignificance. Together, these results indicate that larger firms tend to have experience in hedging exchange rate risk. However, once firms (of whatever size) gain this experience, there is no subsequent firm scale effect. We can thus provide a rationale for, and an interpretation of, the firm scale effects found in prior studies.

To test the robustness of this result we include an alternative definition of the hedging experience variables in column 9. Rather than including a dummy variable indicating prior hedging experience plus a variable calculated as the inverse of the number of months since last hedging experience, column 9 includes just three binary dummy variables indicating whether a firm has most recently hedged (a) in the past year; (b) one to three years ago; or (c) more than three years prior (with never having hedged being the omitted variable). The three coefficients diminish in size as the most recent experience is extended back in time, with only the two more recent variables being significant. These results accord with the hypothesis that prior (but not too distant prior) hedging experience is an important determinant of current hedging choices. Firm size is now found to be significant, albeit with a much smaller coefficient than in column 7. Nevertheless, the explanatory power of this variant of the equation is not as high as for the main equation, so the main equation is preferred.

4.3 Selective Hedging

We find no evidence that the decision to export to Australia in AUD is driven by the level of the NZD/AUD relative to its past three year average (AUD3). This result, from the probit equation, holds regardless of whether imputed data is included or excluded with $p \approx 0.45$ on AUD3 in columns 1 and 10. In turn, this finding implies that our first hedging definition is appropriate since currency of export denomination is unaffected by actual exchange rate levels.

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[18] That is, omitting ZHK, MHK (hedging experience) and FXNS, FXNRS, FXAS, FXARS, FXOS, FXORS, FMAS, FMOS, DPC, DMC, DCC, DIC (diversification).

In the tobit equations, by contrast, we find consistent evidence that AUD3 affects the proportion of AUD exposures that is hedged. All specifications, including when imputed data is included, have a negative coefficient on AUD3 with a high degree of significance (p=0.000). Our estimates imply that a 1 percent rise in the NZD/AUD cross rate relative to its lagged three year average (with all other variables held at their means) induces an initial fall in H1 (the proportion of AUD export exposures that is hedged) from a mean level of 9.4 percent to 8.1 percent.[19] This confirms that the selective hedging effect is of a material economic magnitude as well as being statistically significant. The coefficient on AUD3 is extremely stable across specifications except when the hedging experience variables (ZHK, MHK) are omitted (column 7). In this case, the coefficient jumps markedly in absolute value. This finding, which suggests that there is an interplay between hedging experience and the propensity to hedge selectively, is congruent with our hypothesis that firms with different exporting experience may respond differently to exchange rate fluctuations.

We explore this hypothesis in more depth by allowing for different AUD3 coefficients for different types of firm in the tobit specification. Row 1 of Table 1 reports the AUD3 coefficient for two classes of firm defined according to their export intensity; "low firms" ("high firms") have export intensity below (above) the median for the population. We interact a dummy variable delineating the two subsets of firms with AUD3 (and with the AUD3dx variables) and report the resulting AUD3 coefficients and p-values for each firm class. The final column of the table reports the p-value and conclusion for the null hypothesis that the two AUD3 coefficients are the same.

We are able to reject the null hypothesis of identical AUD3 coefficients when firms are split according to their export intensity. High export intensity firms hedge more consistently across NZD/AUD fluctuations than do less export intensive firms. While this result is consistent with our alternative hypothesis, we nevertheless find that even high export-intensive firms engage in selective hedging (p=0.000).

We perform similar tests along other dimensions, dividing firms into two categories for each of trade intensity (row 2, Table 1), scale (row 3), foreign

[19] This calculation combines the effects of the coefficients on $AUD3_t$ and $AUD3d1_t$ (since $AUD3_t$ appears in both terms). The dynamic effect on hedging propensities beyond the initial period will depend on the subsequent dynamic behaviour of NZD/AUD (and hence of AUD3) which we do not model here.

versus domestic ownership (row 4), leverage (row 5) and tax-loss position (row 6). In each of these cases, we cannot reject the hypothesis that selective hedging behaviour is identical across the two firm classes.

Table 1
AUD3 coefficients for different firm and AUD3 splits including tests of coefficient difference

Split according to:	Coefficient On "Low"	Coefficient On "High"	Different?
Export Intensity	-8.318	-5.948	YES
(Low = below median)	[0.000]	[0.000]	[0.024]
Trade Intensity	-7.695	-6.789	NO
(Low = below median)	[0.000]	[0.000]	[0.390]
Scale (LSAL)	-7.164	-7.208	NO
(Low = below median)	[0.000]	[0.000]	[0.967]
Foreign Ownership (ZBT_FOR)	-7.079	-7.725	NO
(Low = domestic ownership)	[0.000]	[0.000]	[0.601]
Leverage (DER)	-6.643	-7.697	NO
(Low = below median)	[0.000]	[0.000]	[0.318]
Tax-Loss Position (ZTX)	-7.138	-7.553	NO
(Low = no tax-loss carry-forward)	[0.000]	[0.000]	[0.752]
AUD3	-10.967	-8.883	NO
(Low = below one)	[0.000]	[0.000]	[0.428]

Tobit equation results corresponding to Column 2 of Table A.2, but with AUD3 (and AUD3dx) coefficients interacted with binary dummy variables. Binary dummy variables created as indicated for each case in the initial column. AUD3 coefficients only are reported. p-values in brackets.

Row 7 reports results from applying the same test (for all firms) where the split depends on whether AUD3 is greater or less than unity. We cannot reject symmetry in selective hedging behaviour in this case. We investigate this result further by dividing AUD3 into its four quartiles recognising the possibility that the intensity of selective hedging behaviour may differ according to the degree of exchange rate departure from recent norms as well as the direction of that departure. We find that the selective hedging coefficient is not significantly different from zero when AUD3 is in the third quartile (ie, the exchange rate is a little below its recent past) but it remains significantly negative for each of the other three quartiles. Furthermore, we cannot reject the null hypothesis of equal coefficients across all four AUD3 quartiles, indicating that behaviour is consistent across different directions and magnitudes of exchange rate fluctuation.

The tests reported in Table 1 indicate that selective hedging behaviour is prevalent across disparate classes of firm and across different exchange rate outcomes relative to history. The only case where we find a significant difference in firm selective hedging behaviour is where firms differ in their export intensity. Firms that are more heavily reliant on exports tend to hedge more consistently than do other, perhaps opportunistic, exporters. Nevertheless, even here, we find that high export intensity firms still tend to engage significantly in selective hedging.

The analysis above has been conducted using our first hedging definition, which appears to be the appropriate definition given our probit results. Nevertheless, we have also estimated the models using our second hedging definition (including NZD-denominated exports to Australia as hedged transactions). We again find no impact of AUD3 within the probit equation (p=0.566),[20] while continuing to find a statistically significant impact of AUD3 in the tobit specification (p=0.000), albeit with a smaller absolute magnitude for the coefficient (-1.487). Thus even if firms have the ability to choose their currency of denomination, their broad hedging decision remains responsive to the level of NZD/AUD relative to its historical average.

5 Conclusions

Firms that have currency exposures must decide whether they should hedge these exposures and, if so, how. Costs of financial distress, under-investment risks, tax considerations, expertise, experience and the presence of natural hedges all potentially impact on the optimal hedging decision. Firms must also decide whether to maintain a consistent hedging policy or whether to vary their hedging positions in response to currency movements. Efficient markets theory, and prior empirical evidence, suggests that the latter strategy – ie, selective hedging – is not commonly profitable for firms. However, recent studies suggest that this behaviour is nevertheless observed.

This study is the first to examine both optimal and selective currency hedging behaviour by exporters across a comprehensive longitudinal panel

[20] Full regression results are not reported in this paper, but are available from the authors on request.

of exporting firms. Our access to administrative (official statistical, taxation and trade) data for almost all private sector firms in the economy enables us to control for selection effects as well as to track each individual firm's currency hedging choices over 81 months (July 2000 – March 2007). We focus on the hedging decisions of New Zealand exporters exposed to NZD/AUD risk through the denomination of their exports to Australia in AUD. Our panel contains over 38,000 firm-month observations on exporters' currency hedging choices drawn from over 600,000 firm-month observations on exporting and non-exporting firms' activities.

Over our observation period, firms hedge an average of 9.4 percent of their AUD exposure back to NZD. However, this ratio varies over time from a monthly average of 4.3 percent to one of 22.4 percent. Figure 4 indicates that the propensity to hedge falls as the NZD/AUD rises relative to its lagged three year average (AUD3), indicative of some degree of selective hedging. The pervasiveness of selective hedging behaviour is confirmed in our estimates. Even after controlling for a large range of factors that may influence optimal hedging decisions, the proportion of exporters' AUD exposures that is hedged is influenced significantly by the level of AUD3. Consistent with prior studies on selective hedging, we therefore find that firms – with no apparent comparative advantage in the currency markets – nevertheless seek to 'time the market'. This result is robust across all subsets of firms that we have tested. The only case where different classes of firm have a significant difference in selective hedging behaviour is the finding that high export intensity firms hedge more consistently than do low export intensity firms; even here, however, significant selective hedging behaviour is observed across both groups.

Our optimal hedging results shed light on some hitherto curious findings in the literature. Perhaps most significant is that we do not find a firm scale effect once controls are included for other relevant firm characteristics that may influence optimal hedging choices. In particular, once we control for firms' prior hedging experience, firm size has no effect on the hedging propensity; however, when experience is omitted, firm size is statistically significant. Prior studies that have found firm size effects on hedging behaviour, even amongst listed S&P and Fortune 500 firms, may therefore suffer from a lack of controls for hedging expertise and experience that may be positively correlated with firm size. Our results in this respect appear to make more sense than the competing conjecture that some Fortune 500 firm have insufficient scale to undertake currency hedging activity.

Other key optimal hedging results indicate that firms with high growth prospects (proxied by a high ratio of intangible to total assets) hedge more intensively as do firms in tax-loss situations. There is tentative evidence that firms with high leverage also hedge more intensively. Each of these findings is consistent with prior theory. Firms that have well diversified trade and currency transactions tend to undertake less intensive explicit hedging of AUD exposures, consistent with the existence of natural hedges.

The strong – and largely expected – optimal hedging results, obtained within a comprehensive longitudinal dataset on virtually all private sector firms involved in New Zealand's most economically important trade relationship, mean that the selective hedging results are unlikely to be a product of omitted variable bias. Rather, our ability to track the same firms over 81 months presents the opportunity to detect deviations of firms' hedging activities from levels implied by the optimal hedging determinants.

We cannot fully explain why firms deviate from their optimal strategies when they have no comparative advantage in the currency markets. Part of the explanation appears to be that firms for which exporting is relatively unimportant (low export intensity) display less consistency in their hedging decisions. This may be because they have not developed explicit internal policies within the firm to deal with this situation. However, this cannot be the full explanation since even high export intensity firms still tend to engage in selective hedging behaviour. Future work may fruitfully explore whether differing managerial characteristics help explain this observed behaviour and/or whether firms respond to external hedging strategy advice (eg, from banks or specialist advisers). Whatever the explanations turn out to be, our results indicate that selective hedging behaviour exists and appears to be ubiquitous across many classes of firm.

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Appendix
Table A.1
Variables, Data Sources, Description, Expected Sign (tobit)

Variable	Sub	Source	Description	E(sign,tobit)
Dependent Variables: Specification 1 (Currency is Exogenous)				
XAUD	it	Customs	**1st stage:** Firm exports in AUD in t (=1 if so; 0 otherwise)	
H1	it	Customs	**2nd stage:** Proportion of firm i's AUD exports in t that are hedged, calc in AUD (0≤H1≤1), H1=(AUD exports hedged)/(total AUD exports)	
Dependent Variables: Specification 2 (Cover/Currency are Joint Decisions)				
XAU2	it	Customs	**1st stage:** Firm exports to Australia in AUD or NZD in t (=1 if so; 0 otherwise)	
H2	it	Customs	**2nd stage:** Proportion of firm i's XAU2-defined exports that are hedged, calc in NZD (0≤H2≤1), H2=(total XAU2 exports - unhedged AUD OZ exports)/(total XAU2 exports)	
Independent Variables			**[py means "previous year" defined by the firm's financial reporting dates]**	
ZHK	it	Customs	Dummy=1 if firm has hedged any export before	+
MHK	it	Customs	1/(No. months since firm last hedged any export); 0 if never	+
MHK_x	it	Customs	Alternate specification for ZHK,MHK: x≤1yr, 1<x≤3yrs, x>3yrs. Dummy=1 if firm most recently hedged during period x but not earlier	+
DER	it	IR10/AES	Debt to equity ratio: Debt/(Debt+Equity) [py]	+
ICR	it	IR10/AES	Interest coverage ratio: Interest expenses/(Earnings before interest & tax) [py]	+
LSAL	it	IR10/AES	Natural log of real total sales [py]	+
FXNS	it	Customs; IR10/AES	NZD denominated exports excluding reexports (calc in NZD)/total sales [py]	-

Table A.1 (continued from previous page)

Variable	Sub	Source	Description	E(sign,tobit)
FXNRS	it	Customs; IR10/AES	NZD denominated reexports (calc in NZD)/total sales [py]	?
FXAS	it	Customs; IR10/AES	AUD denominated exports excluding reexports (calc in NZD)/total sales [py]	+
FXARS	it	Customs; IR10/AES	AUD denominated reexports (calc in NZD)/total sales [py]	?
FXOS	it	Customs; IR10/AES	Other fx denominated exports excluding reexports (calc in NZD)/total sales [py]	?
FXORS	it	Customs; IR10/AES	Other fx denominated reexports (calc in NZD)/total sales [py]	?
FMAS	it	Customs; IR10/AES	Australian imports (calc in NZD)/total sales [py]	-
FMOS	it	Customs; IR10/AES	Other country imports (calc in NZD)/total sales [py]	?
DTE	it	IR10/AES	Depreciation to expenses ratio: Depreciation/total expenses [py]	+
ITA	it	IR10/AES	Intangible asset ratio: Intangible assets/total assets [py]	+
DTP	it	IR10/AES	Dividends to profit ratio: Dividends paid/Profit [py]	-
ZBT_x	it	LBF	Business_type dummies: Sole proprietor, Partnership, State-owned Enterprise; (Company is omitted)	?
ZBT_FOR	it	LBF/IR4	Dummy=1 for known foreign-owned firm (0 otherwise)	-
ZTX	it	IR4	Company carrying a tax loss forward to current year	+
DPC	it	Customs	No. of HS10 products exported over past 12 months (running)	-
DMC	it	Customs	No. of markets exported to over past 12 months (running)	-
DCC	it	Customs	No. of currencies exported in over past 12 months (running)	-
DIC	it	Customs	No. of countries imported from over past 12 months (running)	-
PCA	it	Customs	The first principal component of DPC, DMC, DCC & DIC	-
AUD3	t	RBNZ	Deviation of AUD from 3 year moving average	-

Table A.1 (continued from previous page)

Variable	Sub	Source	Description	E(sign,tobit)
AUD3dx	t	RBNZ	Monthly change in deviation of AUD from 3 year moving average (x=1…12)	?
IMR	it	Probit	Inverse Mills ratio from probit equation	?
IMR_decx	it	Probit	Dummy = 1 if inverse Mills ratio in decile x (x=2…10) (decile 1 is omitted)	?
HS_k	i	Customs	Dummy=1 if 2-digit HS good (k=1,…,97) ever exported by firm over August 1997 to March 2007	?
Extra independent variables for 1st stage (probit)				
*_ind	it	Customs	Industry averaged variable	
FEX	it	Customs	Dummy =1 if firm has ever exported before	
FEA	it	Customs	Dummy =1 if firm has ever exported to Australia before	
FAU	it	Customs	Dummy =1 if firm has ever exported in AUD before	
MEX	it	Customs	1/(No. months since firm last exported); 0 if never	
MEA	it	Customs	1/(No. months since firm last exported to Australia); 0 if never	
MAU	it	Customs	1/(No. months since firm last exported in AUD); 0 if never	
XAU	it	Customs	Firm exports to Australia in t (=1 if so; 0 otherwise)	
ZMk	t		Month dummies k=1-11 (Jan-Nov)	

Table A.2
Probit and tobit regression results

	1	2	3	4	5	6	7	8	9	10	11
	Probit	Tobit	tobit	tobit	tobit	tobit	tobit	tobit	tobit	Probit	tobit
	Main	Main	No ICR	PCA	No IMR	IMR dec's	Fin only	Fin & hedge	alt. MHK	incl imp.	incl imp.
ZHK_ind	0.233									0.516***	
	[0.160]									[0.000]	
MHK_ind	0.352									0.701*	
	[0.442]									[0.061]	
ZHK		1.005***	1.008***	0.989***	0.825***	0.990***		0.977***			1.169***
		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]		[0.000]			[0.000]
MHK		5.186***	5.190***	5.218***	5.055***	5.267***		5.203***			5.632***
		[0.000]	[0.000]	[0.000]	[0.000]	[0.000]		[0.000]			[0.000]
MHK_1yr									4.767***		
									[0.000]		
MHK_3yr									0.652***		
									[0.000]		
MHK_>3yr									0.176		
									[0.188]		
DER	-0.016	0.150**	0.113	0.151**	0.216***	0.149**	0.266***	0.138*	0.211**	-0.041***	0.127*
	[0.272]	[0.040]	[0.116]	[0.039]	[0.004]	[0.041]	[0.006]	[0.058]	[0.012]	[0.000]	[0.054]
ICR	0.009	-0.162**		-0.160**	-0.179***	-0.165**	-0.364***	-0.195***	-0.114	0.024**	-0.152***
	[0.469]	[0.012]		[0.013]	[0.006]	[0.010]	[0.000]	[0.003]	[0.122]	[0.015]	[0.007]

Table A.2 (continued from previous page)

	1	2	3	4	5	6	7	8	9	10	11
LSAL	0.018***	0.025	0.026	0.004	-0.016	0.035*	0.356***	-0.028	0.089***	0.013***	-0.027
	[0.000]	[0.226]	[0.214]	[0.849]	[0.448]	[0.087]	[0.000]	[0.124]	[0.000]	[0.000]	[0.123]
FXNS	-0.366***	-0.187	-0.215	-0.067	-0.059	-0.107			0.066	-0.381***	-0.391***
	[0.000]	[0.250]	[0.184]	[0.675]	[0.722]	[0.517]			[0.723]	[0.000]	[0.000]
FXNRS	-0.647***	-1.161	-1.198	-1.022	0.398	-0.668			-0.484	-0.171***	-0.154
	[0.000]	[0.159]	[0.146]	[0.213]	[0.612]	[0.407]			[0.625]	[0.000]	[0.528]
FXAS	2.423***	-0.286	-0.299	-0.229	-1.854***	-0.321			-0.236	1.140***	-0.125
	[0.000]	[0.150]	[0.132]	[0.248]	[0.000]	[0.340]			[0.283]	[0.000]	[0.285]
FXARS	1.983***	-2.994***	-2.985***	-2.765***	-5.741***	-2.623**			-7.137***	0.482***	-0.328
	[0.000]	[0.005]	[0.005]	[0.009]	[0.000]	[0.014]			[0.000]	[0.000]	[0.261]
FXOS	0.483***	0.685***	0.676***	0.810***	0.382**	0.624***			1.151***	0.129***	0.138
	[0.000]	[0.000]	[0.000]	[0.000]	[0.044]	[0.001]			[0.000]	[0.000]	[0.289]
FXORS	-0.414**	-11.512***	-11.689***	-11.563***	-11.618***	-11.820***			-13.565***	-0.224***	-0.857***
	[0.016]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]			[0.000]	[0.000]	[0.007]
FMAS	0.063	0.218	0.231	0.165	0.382*	0.142			0.108	0.073***	0.159
	[0.126]	[0.329]	[0.300]	[0.462]	[0.091]	[0.522]			[0.689]	[0.002]	[0.229]
FMOS	-0.096***	0.521***	0.515***	0.287**	0.757***	0.392***			0.822***	-0.120***	0.219**
	[0.000]	[0.000]	[0.000]	[0.021]	[0.000]	[0.003]			[0.000]	[0.000]	[0.023]
DTE	0.375***	0.407	0.310	0.396	-0.347	0.588	1.490*	0.226	-0.512	0.107*	0.492
	[0.000]	[0.521]	[0.625]	[0.534]	[0.593]	[0.349]	[0.080]	[0.722]	[0.484]	[0.087]	[0.129]

Table A.2 (continued from previous page)

	1	2	3	4	5	6	7	8	9	10	11
ITA	0.052	0.689***	0.694***	0.653***	0.558**	0.710***	1.206***	0.662***	0.918***	0.024	0.489**
	[0.268]	[0.003]	[0.003]	[0.005]	[0.019]	[0.002]	[0.000]	[0.004]	[0.001]	[0.518]	[0.017]
DTP	-0.012	0.108	0.118	0.097	0.118	0.108	0.122	0.119	-0.010	-0.011	-0.023
	[0.485]	[0.198]	[0.161]	[0.251]	[0.164]	[0.196]	[0.279]	[0.161]	[0.918]	[0.433]	[0.756]
ZBT_SP	-0.097*	0.240	0.285	0.168	0.422	0.200	0.383	0.145	0.485	-0.019	-0.078
	[0.066]	[0.500]	[0.422]	[0.640]	[0.236]	[0.571]	[0.452]	[0.684]	[0.259]	[0.585]	[0.762]
ZBT_PART	-0.107***	0.702***	0.724***	0.704***	0.889***	0.696***	0.916***	0.650***	1.037***	-0.114***	0.372**
	[0.006]	[0.002]	[0.002]	[0.002]	[0.000]	[0.002]	[0.005]	[0.005]	[0.000]	[0.000]	[0.035]
ZBT_SOE	-0.132	-0.540	-0.514	-0.377	-0.570	-0.706	0.071	-0.644	0.054	-0.022	0.196
	[0.130]	[0.216]	[0.239]	[0.378]	[0.208]	[0.104]	[0.904]	[0.145]	[0.910]	[0.717]	[0.529]
ZBT_FOR	-0.045***	-0.066	-0.050	-0.100	-0.011	-0.065	-0.898***	-0.081	-0.149*	-0.056***	-0.022
	[0.001]	[0.352]	[0.472]	[0.155]	[0.878]	[0.355]	[0.000]	[0.229]	[0.066]	[0.000]	[0.728]
ZTX	-0.019	0.169***	0.115*	0.156**	0.169***	0.171***	0.714***	0.178***	0.195***	-0.003	0.150***
	[0.146]	[0.009]	[0.059]	[0.016]	[0.010]	[0.008]	[0.000]	[0.006]	[0.009]	[0.733]	[0.009]
DPC	0.000	-0.001	-0.001		-0.002	-0.001			-0.003**	0.000	-0.003**
	[0.568]	[0.478]	[0.465]		[0.164]	[0.547]			[0.035]	[0.960]	[0.019]
DMC	-0.001	0.003	0.003		0.007	0.003			0.028***	0.001	0.012***
	[0.278]	[0.554]	[0.567]		[0.166]	[0.566]			[0.000]	[0.587]	[0.004]
DCC	0.127***	-0.188***	-0.188***		-0.274***	-0.185***			-0.215***	0.133***	-0.233***
	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]			[0.000]	[0.000]	[0.000]

Table A.2 (continued from previous page)

	1	2	3	4	5	6	7	8	9	10	11
DIC	-0.005***	-0.031***	-0.031***		-0.029***	-0.031***			-0.050***	-0.007***	-0.026***
	[0.000]	[0.000]	[0.000]		[0.000]	[0.000]			[0.000]	[0.000]	[0.000]
PCA				-0.103***							
				[0.000]							
AUD3	0.109	-7.220***	-7.122***	-7.231***	-7.745***	-7.112***	-15.650***	-7.523***	-9.271***	0.089	-8.322***
	[0.453]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.457]	[0.000]
AUD3d1	-0.704*	5.995***	5.855***	5.947***	6.902***	5.794***	17.740***	6.389***	7.780***	-0.644**	7.072***
	[0.051]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.031]	[0.000]
AUD3d2	-0.659*	3.016*	2.961*	2.965*	3.116*	2.873*	9.749***	3.238**	3.935**	-0.467	3.408**
	[0.074]	[0.059]	[0.064]	[0.064]	[0.054]	[0.071]	[0.000]	[0.044]	[0.032]	[0.127]	[0.023]
AUD3d3	-0.385	9.000***	8.905***	9.029***	9.367***	8.810***	18.180***	9.412***	9.439***	-0.386	9.770***
	[0.293]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.202]	[0.000]
AUD3d4	-0.511	6.766***	6.757***	6.875***	7.042***	6.759***	15.086***	7.125***	8.055***	0.208	7.857***
	[0.152]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.481]	[0.000]
AUD3d5	0.094	7.675***	7.582***	7.679***	8.350***	7.646***	19.470***	8.123***	10.188***	-0.329	8.607***
	[0.794]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.270]	[0.000]
AUD3d6	-0.688*	5.958***	5.887***	6.028***	6.710***	5.634***	15.710***	6.564***	6.873***	-0.547*	6.334***
	[0.057]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.067]	[0.000]
AUD3d7	-0.751**	4.700***	4.633***	4.617***	5.168***	4.737***	13.635***	5.118***	6.369***	-0.621**	6.177***
	[0.039]	[0.003]	[0.003]	[0.004]	[0.001]	[0.003]	[0.000]	[0.001]	[0.000]	[0.039]	[0.000]

Table A.2 (continued from previous page)

	1	2	3	4	5	6	7	8	9	10	11
AUD3d8	0.220	8.073***	8.035***	8.113***	8.482***	7.781***	16.823***	8.598***	9.310***	-0.157	7.870***
	[0.547]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.604]	[0.000]
AUD3d9	0.071	8.113***	8.068***	8.167***	8.667***	8.087***	16.787***	8.621***	9.642***	0.319	10.474***
	[0.838]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.269]	[0.000]
AUD3d10	0.073	7.301***	7.236***	7.270***	7.445***	7.379***	16.781***	7.866***	9.639***	-0.208	5.994***
	[0.835]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.475]	[0.000]
AUD3d11	-0.637*	2.822*	2.750*	2.822*	3.133**	2.652*	10.538***	3.239**	4.817***	-0.372	4.845***
	[0.064]	[0.073]	[0.080]	[0.073]	[0.049]	[0.091]	[0.000]	[0.041]	[0.007]	[0.192]	[0.001]
AUD3d12	0.032	7.647***	7.552***	7.592***	7.930***	7.518***	17.145***	8.266***	9.374***	-0.113	8.645***
	[0.925]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.685]	[0.000]
IMR		0.930***	0.931***	0.944***			-0.269***	0.997***	0.670***		0.991***
		[0.000]	[0.000]	[0.000]			[0.000]	[0.000]	[0.000]		[0.000]
IMR_dec2						0.063					
						[0.604]					
IMR_dec3						-0.045					
						[0.756]					
IMR_dec4						-0.180					
						[0.265]					
IMR_dec5						-0.129					
						[0.467]					

Table A.2 (continued from previous page)

	1	2	3	4	5	6	7	8	9	10	11
IMR_dec6						0.201					
						[0.276]					
IMR_dec7						0.517***					
						[0.004]					
IMR_dec8						0.987***					
						[0.000]					
IMR_dec9						1.505***					
						[0.000]					
IMR_dec10						1.854***					
						[0.000]					
FEX	-0.077*									-0.030	
	[0.099]									[0.437]	
FEA	-0.061									-0.100***	
	[0.130]									[0.003]	
FAU	0.464***									0.472***	
	[0.000]									[0.000]	
MEX	-0.102***									-0.076***	
	[0.000]									[0.000]	
MEA	-0.754***									-0.761***	
	[0.000]									[0.000]	
MAU	2.162***									2.192***	
	[0.000]									[0.000]	

Table A.2 (continued from previous page)											
	1	2	3	4	5	6	7	8	9	10	11
XAU	2.651***									2.598***	
	[0.000]									[0.000]	
Obs.	647,952	38,892	38,892	38,892	38,892	38,892	38,892	38,892	38,892	948,120	53,868
Pseudo R2	0.682	0.374	0.374	0.373	0.361	0.378	0.074	0.369	0.296	0.672	0.375

p-values in brackets; *significant at 10%; **significant at 5%; ***significant at 1%. Constant & sector dummies included in all equations; month dummies included in probits.