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Exporters' Optimal and Selective Hedging Choices

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Abstract

How do exporting firms manage currency exposures? We examine this issue at the individual firm level using data from the prototype Longitudinal Business Database (LBD) recently developed by Statistics New Zealand. The LBD covers virtually all New Zealand firms. To this has been linked survey & administrative data enabling construction of a wide range of firm-level financial variables. We also have daily Customs merchandise trade shipment data linked to firms. This is our source for currency exposures and hedging decisions, with 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 use these data to test both optimal and selective hedging theories. Optimal hedging theory hypothesises that firms' hedging choices depend on: probability and cost of financial distress, underinvestment risks, scale, managerial risk aversion, information asymmetry, governance, ownership structures and tax rules. We construct numerical proxies for these variables longitudinally at the firm level. Recent literature also suggests that some exporters vary currency hedging positions relative to their optimal position in a *selective* attempt to 'beat the market'. We examine whether New Zealand exporters to Australia hedge their currency exposures (a) by hedging exports denominated in Australian dollars (AUD) into NZD, and/or (b) by denominating exports in NZD. 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 AUD/NZD is perceived to be 'high' or 'low' relative to an historical average. Estimation is over July 2000 to March 2007 (monthly) – a period during which the AUD/NZD varied substantially, making this a particularly pertinent period to test exporters' currency risk management behaviours.

JEL Codes: D21; F31; G15

Keywords: hedging behaviour; exporting; exchange rates

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DISCLAIMER

This research was undertaken while Richard Fabling was on secondment to Statistics New Zealand. The opinions, findings, recommendations and conclusions expressed in this report are those of the authors. Statistics NZ, 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.

Access to the data used in this study was provided by Statistics NZ in accordance with security and confidentiality provisions of the Statistics Act 1975. Only people authorised by the Statistics Act 1975 are allowed to see data about a particular business or organization. The results in this paper have been confidentialised to protect individual businesses from identification.

The results are based in part on tax data supplied by Inland Revenue to Statistics NZ 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.

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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 (i.e. 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 includes taxation data pertaining to a firm's annual accounts as well as its 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. It 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 do 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 (e.g. 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. The study did, however, 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% 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' AUD exposures; aggregate hedge ratios were consistently negatively related to the value of the AUD/NZD cross rate, consistent with exporters locking in perceived low exchange rates. Despite this observed behaviour, statistical tests found no evidence that selective hedging behaviour is positive 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 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) having examined whether selective hedging occurs for commodities in the gold and the oil/gas industries respectively. Firms may profitably hedge selectively if they possess a comparative advantage relative to other firms in a market with respect to future price trends (e.g. 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.

The use of selective hedging in interest rate and currency markets appears to be much more widespread than can be explained solely by firms using comparative advantage about a specific market (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. (For some implied New Zealand evidence on this view, see Brookes et al, 2000.[3]) It is, however, possible that actions which appear to represent selective hedging behaviour (e.g. 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. The latter, in particular, is an alternative that we explore in our empirical work.

In order to model selective hedging behaviour, one must first be able to 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*, out of 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.

[3] Brookes et al (2000) report that corporates consider forward rate contracts have advantages 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 (i.e. on perceived mean-reverting exchange rate behaviour) is practiced by a sizeable portion of exporters.

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 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 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), so also 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 cited studies. 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 sub-sets 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 (e.g. 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, including selection issues. In particular, we are careful to delineate two separate approaches to dealing with potential selection biases. 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 and to 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.

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% and 43.3% respectively (Fabling and Grimes, 2008). A small proportion was denominated in other currencies, chiefly USD, but these are not our focus for the remainder of the paper. The share of AUD-denominated exports hedged back to NZD varied between 20% and 32% 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 (e.g. by forward contracts).[4] 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.

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,[5] 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

[4] Brooks et al (2000) find that forward contracts are the predominant form of currency hedging used by New Zealand exporters.
[5] Value calculations for this variable use AUD as numeraire.

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).

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

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:

$$\begin{aligned} H_{it} &= H^*_{it} \text{ if } Z^*_{it} > 0; \; H_{it} \text{ unobserved otherwise} \\ Z_{it} &= 1 \quad \text{ if } Z^*_{it} > 0; \; Z_{it} = 0 \text{ otherwise} \end{aligned} \tag{2}$$

To deal with these selection and truncation issues we use Heckman's two-step (Heckit) method involving a selection equation plus an equation that estimates the parameters of interest.[6] 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 ν_{it}.

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

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

[6] Full information maximum likelihood (FIML) provides an alternative estimation method. However, 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.

where the inverse Mills ratio (using $\mathbf{W}_{it}$ and the estimated $\boldsymbol{\gamma}$ from the probit equation) is used to proxy ν_{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 $\rho=0$. However, 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.

Under our first approach (where we assume 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; $XAUD_{it} = 0$ otherwise.[7] 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 = 0 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.

[7] I.e. $XAUD_{it}$ takes the role of Z_{it}; i and t subscripts are henceforth suppressed in the text where the meaning is clear.

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 (i.e. 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,[8] consistent with a hypothesis that hedging is 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_1 YR, MHK_3YR and MHK_>3YR respectively.[9]

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 hypothesised to be positive).[10] 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, and so has the incentive to lock in a tranche of tax-free profits. The variable, ZTX, is a binary variable 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 (e.g.

[8] Here and elsewhere, we describe the alternative hypothesis against the null of zero.
[9] Corresponding variables are included for our second approach, with hedging experience defined also to include prior exports denominated in NZD.
[10] 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.

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[11] 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 currencies used to import 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 therefore can also, in part, 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 exports (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 AUD/NZD and so choose to hedge a greater proportion of its AUD denominated exports (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

[11] Defined at the HS10 (harmonised system 10-digit) level.

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 hedge risks more comprehensively (positive coefficient). Conversely, companies that have a high dividend to profit ratio (DTP) may be signalling 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 also 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 LBF 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 do 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 =1 if the firm has ever exported the good (between 1997 and 2007) and 0 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 (i.e. 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.

Furthermore, for the probit equation, we replace ZHK_{it} and MHK_{it} (i.e. variables included in the tobit indicating whether the firm has hedged before, and time since hedging) with their respective industry 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 AUD/NZD exchange rate from its three-year lagged moving average, AUD3:

$$AUD3_t = \frac{AUD/NZD_t}{\sum_{i=1}^{36} AUD/NZD_{t-i}/36}$$

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 AUD/NZD from an historical average reference point since the descriptive and/or anecdotal evidence (e.g. Brookes et al, 2000) indicates that at least some exporters do make hedging decisions based on backward-looking benchmarks of 'normal' exchange rate levels; i.e. they assume at least some degree of mean reversion in the AUD/NZD 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 of 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.

3 Sample and Data Sources

Our comprehensive sample comprises all New Zealand-based firms meeting minimum threshold requirements that ever exported to Australia between July 2000 and March 2007; this period (81 months) constitutes our estimation period.[12] The estimation period is determined by availability of lagged financial data, noting that we use previous financial year data to minimise any endogeneity issues.[13] The threshold requirements for a firm to be included in the sample is that the firm is ever "economically active" over two consecutive years from 2000-2007. (Thus 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,[14] 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 reliability of the data. 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 for some data 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;[15] this increases the sample sizes in the two equations to 948,120 and 53,868 respectively.

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[12] 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 sample, 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.

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

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

[15] The imputed data is supplied by Statistics New Zealand and uses a mix of historical, donor & linear interpolation.

The size distribution of firms included in our study is shown in the kernel density graph, Figure 1, for LSAL (logarithm of real sales).[16] The distribution of LSAL is remarkably symmetric and covers a very broad range of firm size extending from approximately NZD5,000 p.a. to around NZD180,000,000 p.a. The distribution of firms' financial states also varies considerably across the sample. Figure 2 plots the kernel density of DER [debt/(debt+equity)]. This plot excludes firms with DER=0 (17.7% of firms) and firms with DER=1 (15.2% of firms).[17] Slightly fewer than half of firms have debt: total liabilities less than 0.5; overall there is strong diversity of balance sheet strength across the sample. By contrast, Figure 3 shows that ITA (intangible assets/total assets) is heavily skewed towards zero; 73.6% of firms have ITA=0 (these firms are omitted from the kernel density graph but are included in our estimates). For the large bulk of firms, intangible assets comprise less than 10% of total assets.[18]

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 sample it ranges mostly between 15% and 20%, then drops to between 5% and 10% over the final five years. The drop coincided with a sharp rise in AUD3 (deviation of AUD/NZD 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.

[16] The kernel density is calculated excluding the top 1% and bottom 1% of the distribution due to confidentiality restrictions.
[17] The drops depicted in Figure 2 at either end of the distribution are artificial, being generated by the smoothing algorithm for the kernel density. Note that our econometric estimates in section 4 include firms with DER=0 and DER=1.
[18] Means and standard deviations of all variables are available from the authors on request.

4 Results

4.1 Estimated Equations

In reporting results, we concentrate on those using our first approach to defining hedging (i.e. taking the currency of denomination as exogenous to the firm) and using only unimputed data. Subsequently, we report results that also incorporate imputed data and report on results from using our second approach to defining hedging (including NZD exports as hedged exports). Our reporting focuses primarily on the tobit results (rather than the probit results) since our focus is on the currency hedging decision rather than the prior export decision. We report both the optimal hedging findings and the selective hedging results. 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 our sample make our results with respect to selective hedging particularly rigorous compared with prior exploratory studies.[19]

Table 1 presents our results using our first hedging definition. All columns, other than the final two, report results for the sample that uses only imputed data. Column 1 presents the probit equation used to predict whether firm i exports to Australia in AUD in month t (p-values using robust standard errors are shown in square parentheses for each coefficient). We are able to predict the exporting choice with a high degree of precision (pseudo-R^2=0.682). We calculate the inverse Mills ratio from the probit regression for inclusion in the second stage tobit equation, but otherwise do not focus on interpreting the probit coefficients.

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 indicating the importance of estimating the selection equation. Note, however, that when we omit this ratio (column 5) the results do not change markedly. One potential criticism of including the inverse Mills ratio in its raw form, as in our main estimate, is that the implied linearity assumption may not be appropriate. To test sensitivity of the

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

results to an alternative specification, we include a set of binary dummy variables indicating whether the observation is in the second to tenth deciles of the inverse Mills ratio (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% level have the hypothesised sign. The hedging experience variables (ZHK and MHK) are both highly significant (p=0.000) indicating that firms have an increased potential to hedge in month t if they have past hedging experience.

Natural hedging opportunities affect the propensity to hedge AUD exports. We find that firms which 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 in the regression. One reason for this is that these four variables are highly correlated with one another (the six bi-variate correlation coefficients range between 0.31 and 0.68). We form the first principal component of the four variables (PCA) and include this variable in place of them in column 4. The principal component is highly significant and negative as expected if natural hedge opportunities affect explicit hedging behaviour; other results are not materially affected.

The hypothesis that firms facing under-investment risks are likely to hedge more intensively is supported by our results. Specifically, firms with high intangible asset ratios (ITA) tend to hedge a higher proportion of their AUD exposures. We stress that this result holds even with the inclusion of extensive sector controls in the equation. The result is robust across all specifications including when imputed data is used (column 11), although coefficient size and significance fall to some extent 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 intuitively appealing proxy for such firms, but has not generally been available comprehensively to past researchers in this field, and imputation techniques are not likely to be able to replicate such a variable with high precision. The drop in size and significance of ITA in the larger sample 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 firms in this situation 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%, 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. Overall, with respect to the financial variables there appears to be some limited support that firms with more fragile balance sheets (and especially firms that wish to lock in tax loss benefits) tend to increase their hedging of AUD exposures.

One important finding relates to firm size. Our firm scale variable (LSAL) is not significant (even at the 20% 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 also across the specifications without ICR, with PCA, and without the inverse Mills ratio (columns 3-5), albeit with some limited significance (p=0.087) with the alternative specification of the inverse Mills ratio.

One reason that prior studies may have reported a (possibly non-existent) firm scale effect for hedging is if a positive correlation exists between firm size and other firm characteristics that had been omitted in those studies. To test this possibility, column 7 presents results for an equation that omits the hedging experience and diversification (plus related) variables.[20] These variables have moderate to high positive correlations with firm size. The results in column 7 now suggest a sizeable and significant firm scale effect (p=0.000 for LSAL) with these variables 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 interpretation of, the firm scale effects found in prior studies.

Firm size is found to be significant (albeit with a much smaller coefficient than in column 7) when we include an alternative definition of the hedging experience variables. 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 recent (less than three year) variables significant. These results accord with the hypothesis that prior (but not distant prior) hedging experience is an important determinant of current hedging choices. However the explanatory power of this variant of the equation is not as high as for the main equation (which also emphasises the importance of recent hedging experience), so the main equation is preferred.

4.3 Selective Hedging

Turning to the issue of selective hedging, we find no evidence that the decision to export to Australia in AUD is driven by the level of the AUD/NZD relative to its past three year average (AUD3). This result, from the probit equation, is consistent across both samples (i.e. without and with imputed data) with $p \approx 0.45$ on AUD3 in columns 1 and 10. This

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

finding implies that our first approach to defining hedging is appropriate since currency of export denomination does not appear to be affected by actual exchange rate levels.

In the tobit equations, by contrast, we find consistent evidence that AUD3 affects the proportion of AUD exposures that are hedged. All specifications, and both samples, have a negative coefficient on AUD3 with a high degree of significance (p=0.000). Furthermore, the coefficient on this variable 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 suggests that there is an interplay between hedging experience and the propensity to hedge selectively. (Future work will examine the characteristics of firms most prone to adopting selective hedging practices.)

Our estimates imply that a 1% rise in AUD/NZD_t 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 are hedged) from a mean level of 9.4% to 8.1%.[21] This confirms that the selective hedging effect is of a material economic magnitude as well as being statistically significant.

The analysis to date has been conducted using our first approach to defining hedging. The probit results reported above imply that this approach is appropriate. Nevertheless, we have also estimated the models using our second hedging definition, i.e. broadening the definition also to include NZD-denominated exports to Australia as hedged transactions. Concentrating on the selective hedging results (which are likely to be most affected by this change in definition), we find, as before, no impact of AUD3 within the probit equation (p=0.566).[22] However we again 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 exporting to Australia have the ability to choose

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[21] 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 AUD/NZD (and hence of AUD3) which we do not model here.

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

their currency of denomination, their hedging decision remains responsive to the level of the AUD/NZD 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 and 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 market movements, especially those in the currency. Efficient markets theory, and prior empirical evidence, suggests that the latter strategy – i.e. selective hedging – is not commonly profitable for firms. However, some recent studies suggest that this behaviour is nevertheless observed.

Our study is the first internationally to examine both optimal and selective currency hedging behaviour by exporters across a comprehensive longitudinal sample of exporting firms. Our access to administrative (official statistics and taxation) data for almost all firms in the economy enables us to control for selection effects as well as to track each individual firm's currency hedging choices on a monthly basis over 81 months. We focus on the hedging decisions of New Zealand exporters exposed to AUD/NZD risk through the denomination of their exports to Australia in AUD. Our sample 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.

On average, over our sample, 9.4% of firms with AUD exposures hedge that exposure back to NZD. However, this ratio varies over the sample period (July 2000 – March 2007) from a monthly average of 4.3% to one of 22.4%. Figure 4 indicates that the propensity to hedge falls as the AUD/NZD rises relative to its lagged three year average (AUD3), indicative of some measure of selective hedging occurring. The incidence of selective hedging is confirmed in our estimates. Even after controlling for a large range of factors that may influence optimal hedging decisions, we find that the proportion of exporters' AUD exposures that are hedged is influenced significantly by the level of AUD3. Consistent with prior preliminary studies on selective hedging, we therefore find that firms – with no apparent comparative advantage in the currency markets – nevertheless seek to 'time the market'.

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 we include controls 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 – which may well be positively correlated with firm size. Certainly, our results in this respect 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 obtained here are 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 fragile balance sheets (high debt to equity ratios) 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 explicit hedging of AUD export exposures less intensively, consistent with the existence of natural hedges.

The strong – and largely expected – optimal hedging results, obtained within a comprehensive and rich 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 monthly over 81 months has given us the opportunity to detect deviations of firms' hedging activities from the levels implied by the optimal hedging determinants. What we cannot explain, at present, is why firms deviate from their optimal strategies when they have no comparative advantage in the currency markets. Nor have we explained whether particular firm characteristics are associated with the propensity to hedge selectively. These latter questions are the subject of ongoing research using this extraordinarily detailed longitudinal dataset.

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Figure 1: Distribution of logarithm of Real Sales (LSAL)

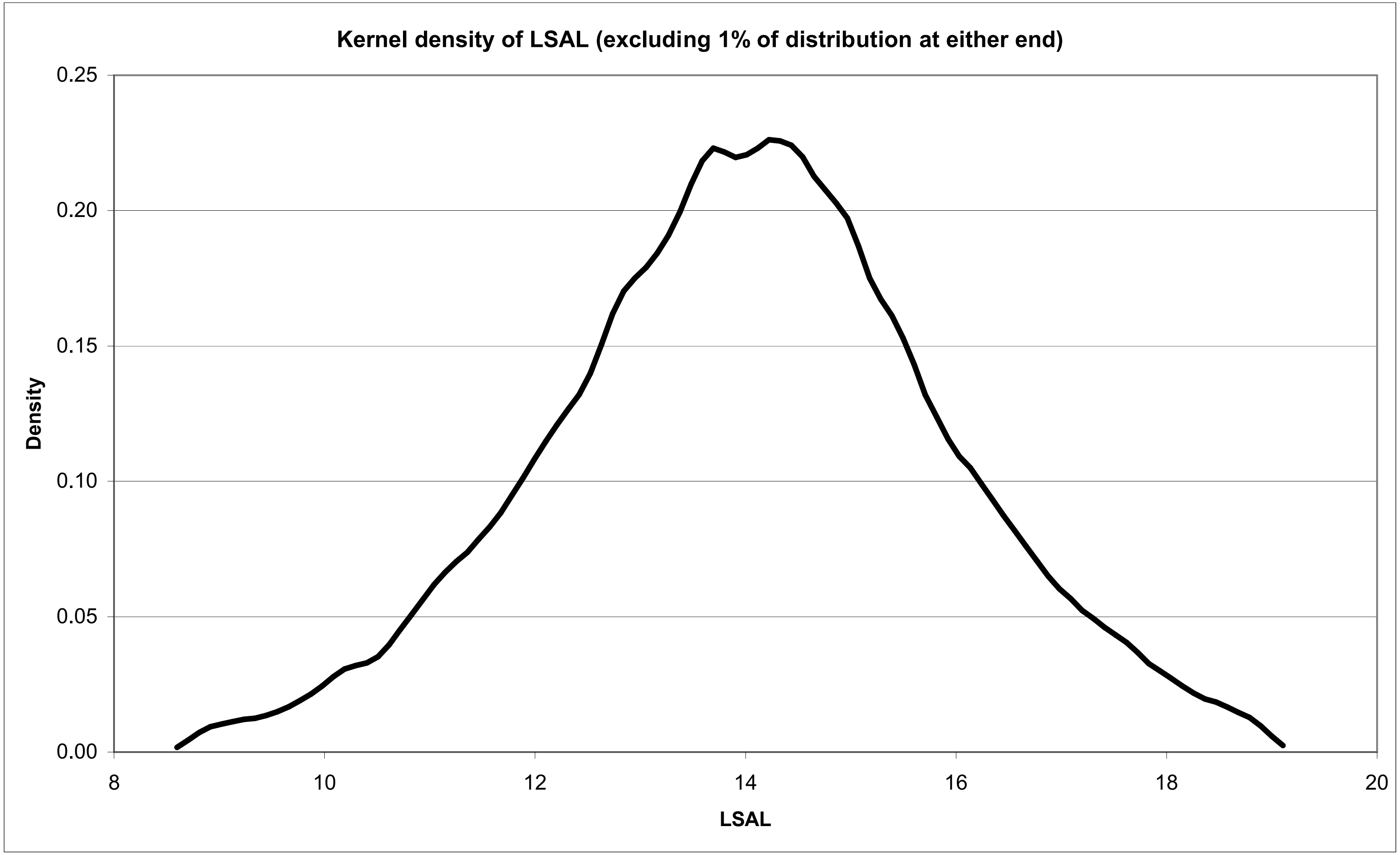

Figure 2: Distribution of [Debt/(Debt+Equity)] (DER)

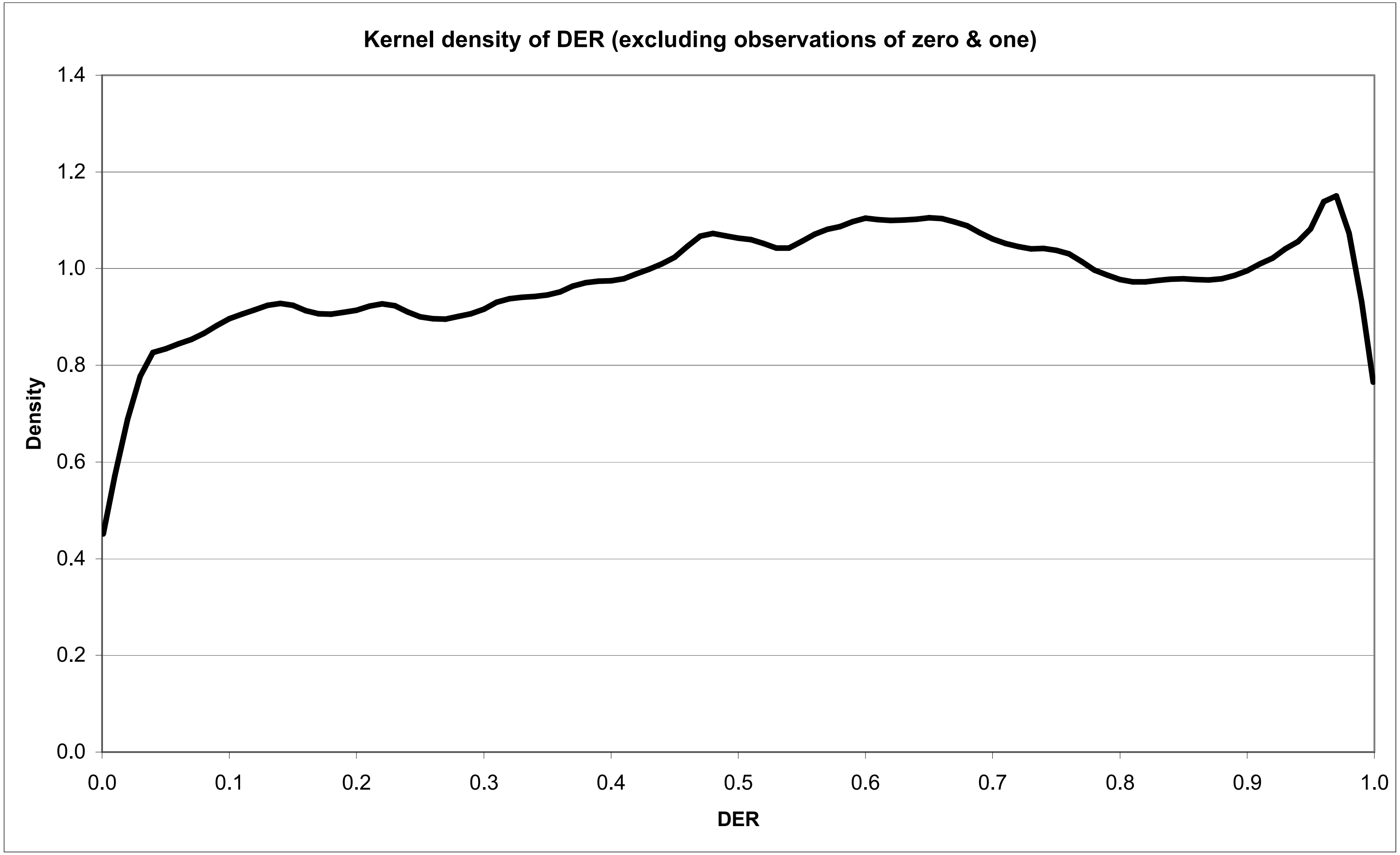

Figure 3: Distribution of Intangible Assets/Total Assets (ITA)

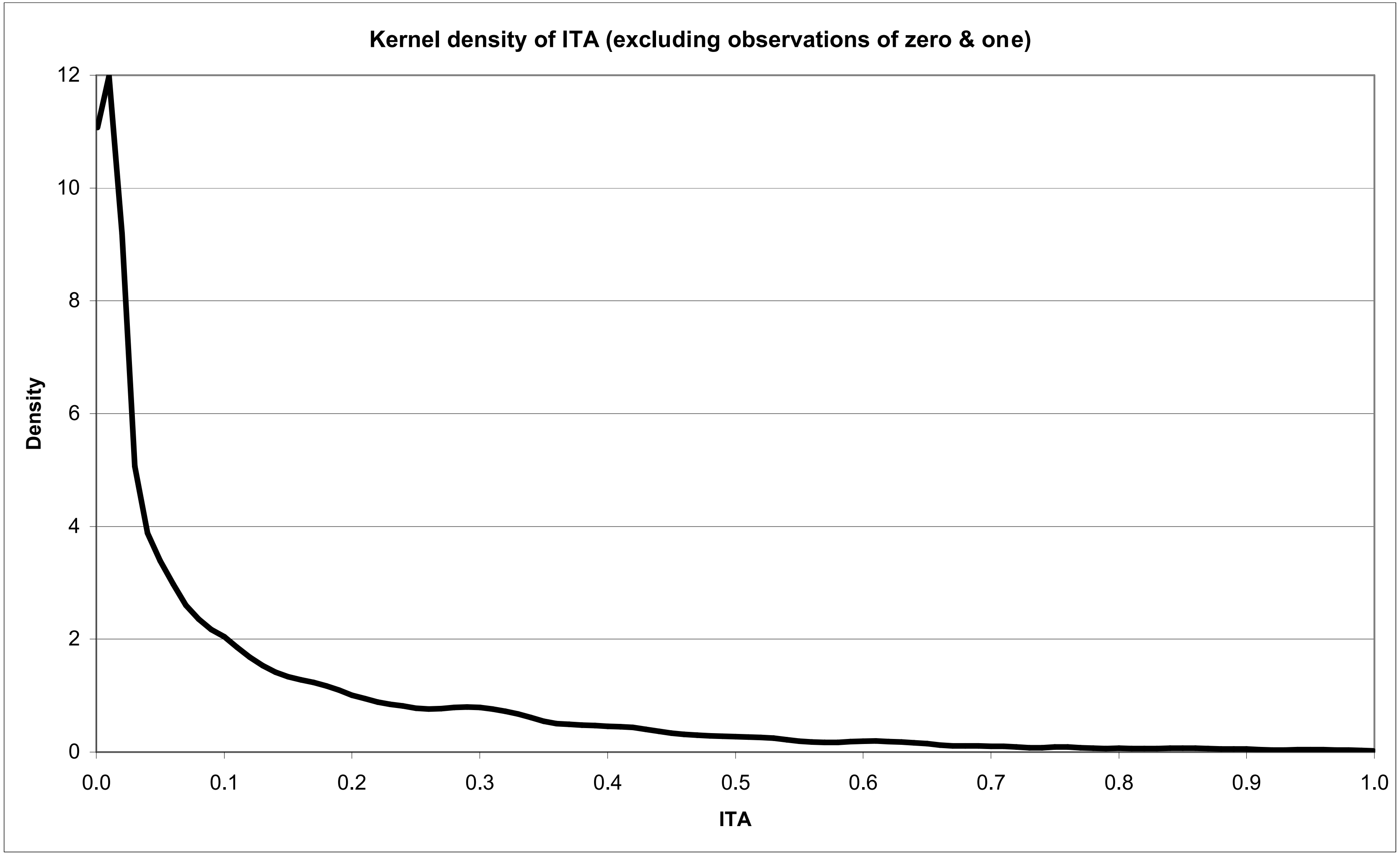

Figure 4: Mean Monthly Value of H1 (AUD Hedging Proportion) & AUD3 (AUD/NZD deviation from lagged 3 year average)

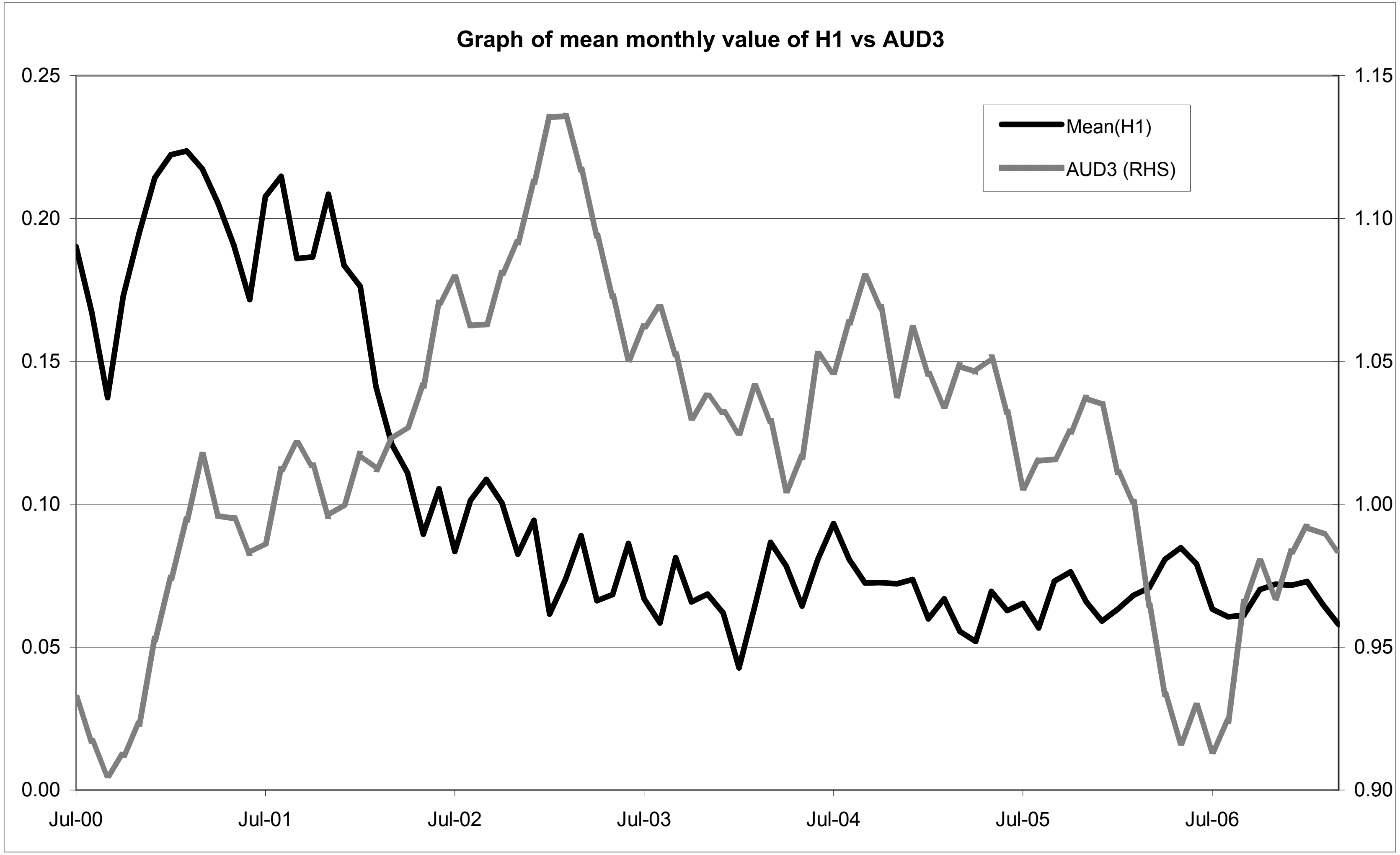

Table 1: Probit and Tobit Regression Results

	1	2	3	4	5	6	7	8	9	10	11
	Probit Main	Tobit Main	Tobit No ICR	Tobit PCA	Tobit No IMR	Tobit IMR dec's	Tobit Fin only	Tobit Fin & hedge	Tobit alt. MHK	Probit incl imp.	Tobit 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]
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

	1	2	3	4	5	6	7	8	9	10	11
	[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	0.31	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]
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	-0.01	-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*	0.24	0.285	0.168	0.422	0.2	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	-0.54	-0.514	-0.377	-0.57	-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	-0.05	-0.1	-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	-0.001	-0.001		-0.002	-0.001			-0.003**	0	-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]
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***							

	1	2	3	4	5	6	7	8	9	10	11
				[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]
AUD3d8	0.22	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					

	1	2	3	4	5	6	7	8	9	10	11
						[0.756]					
IMR_dec4						-0.18					
						[0.265]					
IMR_dec5						-0.129					
						[0.467]					
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*									-0.03	
	[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]	
XAU	2.651***									2.598***	
	[0.000]									[0.000]	
Obs.	647952	38892	38892	38892	38892	38892	38892	38892	38892	948120	53868
Pseudo R2	0.682	0.374	0.374	0.373	0.361	0.378	0.074	0.369	0.296	0.672	0.375

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

Appendix: Variables, Data Sources, Description, Expected Sign (2^{nd} Stage)

Variable	Sub	Source	Description	
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]**	**E(sign,Tobit)**
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 has 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	ln(real total sales) [py]	+
FXNS	it	Cust; IR10/AES	NZD denominated exports excluding reexports (calc in NZD)/total sales [py]	-
FXNRS	it	Cust; IR10/AES	NZD denominated reexports (calc in NZD)/total sales [py]	?
FXAS	it	Cust; IR10/AES	AUD denominated exports excluding reexports (calc in NZD)/total sales [py]	+
FXARS	it	Cust; IR10/AES	AUD denominated reexports (calc in NZD)/total sales [py]	?
FXOS	it	Cust; IR10/AES	Other fx denominated exports excluding reexports (calc in NZD)/total sales [py]	?
FXORS	it	Cust; IR10/AES	Other fx denominated reexports (calc in NZD)/total sales [py]	?
FMAS	it	Cust; IR10/AES	Australian imports (calc in NZD)/total sales [py]	-
FMOS	it	Cust; 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, SOE	?
ZBT_FOR	it	LBF/IR4	Dummy=1 for known foreign-owned firm	-
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	-
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	Inverse Mills ratio in decile X (X=2…10)	?
HS_k	i	Customs	Dummy=1 if 2-digit HS good (k=97) ever exported by firm during August 97-March 07	?
Extra independent variables for 1st-stage				
*_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)	