DO EXPORTERS CUT THE HEDGE? WHO HEDGES, WHEN & WHY

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ABSTRACT

We use data (including Customs data) derived from the Longitudinal Firm Performance Database (LFPD) to analyse the currency denomination and hedging behaviour of New Zealand merchandise exporters. For instance: In which currencies are New Zealand merchandise exports by country of destination denominated? Do different types of firms (e.g. by size or sector) display different hedging practices? Do forward points make any difference to hedging decisions? Is hedging consistent over the exchange rate cycle or do (some) exporters selectively hedge when the exchange rate reaches historical extremes? Has selective hedging been a profitable strategy for New Zealand exporters? Our results have implications for the capability of exporters to handle exchange rate volatility and for the potential impact of exchange rate volatility on exports.

JEL classifications: D21 (firm behaviour)
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The results of this study are based in part on tax data supplied by Inland Revenue to Statistics New Zealand under the Tax Administration Act. This tax data must be used only for statistical purposes, and no individual information is provided back to Inland Revenue for administrative or regulatory purposes. Any discussion of data limitations or weaknesses is in the context of using the data for statistical purposes, and is not related to the ability of the data to support Inland Revenue's core operational requirements. Careful consideration has been given to the privacy, security and confidentiality issues associated with using tax data in this project. In particular, in the IBULDD dataset, individuals' tax data has been aggregated to the firm-level. Furthermore, only people authorised by the Statistics Act 1975 are allowed to see data about a particular firm.

1. Introduction

We address questions that are central to understanding New Zealand firms' export performance: To what extent are exporters exposed to currency volatility and to which currencies are they most exposed? How do exporters hedge these exposures? Within this question, related questions arise: Do some or all firms hedge? Do different types of firms (e.g. by size or sector) display different hedging practices? Do forward points make any difference to hedging decisions? Is hedging consistent over the exchange rate cycle or do (some) exporters selectively hedge when the exchange rate reaches historical extremes? Has selective hedging been a profitable strategy for New Zealand exporters? We access a unique unit record database – New Zealand Customs data – to address these questions.

Firms face many risks. One set of risks faced by exporters and other firms relates to variability in earnings due to exchange rate changes. A long-standing theorem in finance (Modigliani and Miller, 1958) suggests that hedging these risks adds nothing to firm value; given any positive cost of hedging they should therefore be left unhedged.

In practice, however, many firms do hedge currency exposures. Recent finance literature proposes certain circumstances where costly hedging may constitute optimal behaviour. In these circumstances, certain classes of firm may consistently choose to hedge and others to remain unhedged. Empirical tests confirm the validity of some hypotheses regarding optimal hedging, but not all. Further, there is evidence in some industries internationally of selective hedging – i.e. choosing hedging positions so as to 'time the market'. Hypotheses have been developed to indicate when certain types of firms may choose to selectively hedge, but early results suggest that firms may not behave optimally in this respect, especially in relation to financial market exposures.

The literature concentrates almost exclusively on the hedging behaviour of large (generally listed) firms. Very little is known about behaviour of exporters (or other firms) more widely. Little is also known about the overall currency hedging behaviour of New Zealand firms. Most domestic research has considered the behaviour of listed firms; one study covers a broader sample of firms but is a single snap-shot so one cannot interpret whether the results are representative of behaviour across the cycle.

In contrast to all previous domestic and international studies, we examine the hedging behaviour of a large set of firms, being all New Zealand merchandise exporters. We do so for a continuous ten year period, thereby examining patterns both across time and across specific cycles and events. We use data available on a daily basis for all exporters at the 10-digit commodity level. Further, we are able to link the export and currency hedging behaviour of exporters to the same firms' financial data derived from Statistics New Zealand's newly compiled Longitudinal Firm Performance Database (LFPD).[3]

We use these data sources to compile descriptive statistics of behaviour and to test hypotheses concerning the presence, and impacts, of selective hedging. Future

[3] In its development stage, this database was referred to as IBULDD after the project that created it.

analysis will utilise the longitudinal nature of the data to conduct econometric tests of these hypotheses at the unit record level.

The paper proceeds as follows. In section 2, we review the international theory and evidence relating to hedging behaviour in general, and currency hedging behaviour in particular. Section 3 conducts a similar review in relation to New Zealand evidence. Section 4 discusses our data and sets out hypotheses that we wish to examine. Section 5 presents derived series and comments on their relationships to some of the hypotheses. Section 6 specifically examines the practice of selective hedging, testing for its presence and testing whether, on balance, it has been a profitable strategy. Section 7 summarises our findings and suggests potential future work.

2. Theory and International Evidence

The Modigliani-Miller theorem states that, under certain assumptions, adoption of alternative financial policies cannot affect firm value. Firm value is instead determined by underlying production and related decisions. The irrelevance of financing policies, including hedging policies, reflects the ability of shareholders and debtholders to undertake similar financing activities; hence the financing choice of firms adds nothing to the set of possibilities open to suppliers of finance.

The case of currency hedging is a specific example of an activity that is available to shareholders and debtholders as well as to the firm, so falls into the category of financing activities covered by the Modigliani-Miller theorem. Within Australasia, an example of this irrelevance result is the choice of two large minerals companies - BHP Billiton and Rio Tinto Limited - to choose different functional currencies (USD and AUD respectively), despite both being headquartered in Australia.

Why then do firms hedge risks and, in particular, currency exposures? Evidence that they do so, is obtained both from surveys and from analysis of firms' financial results. Surveys showing that firms hedge at least some currency risks include De Ceuster (2000) for Belgian firms, and Grimes et al (2000) for a broad range of New Zealand firms. For Sweden, Hagelin (2003) finds that firms hedge transactions-based currency exposures but finds no evidence that they hedge translation-based currency exposures. Analytical examinations of hedging behaviour mostly examine whether firm value is affected by (unanticipated) exchange rate changes; studies include Bodnar and Gentry (1993) for United States multinationals, Allayannis and Ofek (2001) for large (mostly S&P-listed) nonfinancial firms,[4] and Sato (2003) for Japanese exporters.

One trouble with many of these studies is that they concentrate almost exclusively on large, often listed, firms whose behaviour may be quite unrepresentative of the broader firm population. Further, most of the studies cover just a single cross-section of firms or at least a very small time series for each firm. Thus issues of dynamic hedging behaviour (e.g. over the cycle) has been mostly ignored in the literature.

[4] Allayannis and Ofek find, in their S&P sample, that firms typically cover 14.5% of their foreign sales by foreign currency derivatives. This 'low' figure may in part be due to US firms' ability to price their foreign sales in USD; firms may also be importers so having a natural hedge in place. They find that foreign currency derivatives are the principal form of hedging instruments used to cover export transactions, and suggest that this may be because of the short term nature of exporting which can require customised short-term contracts (e.g. derivatives) rather than long-term (e.g. debt) contracts.

Longitudinal data covering a wide range of firms is required to investigate more general hedging practices.

2.1 Hedging Rationales and Evidence

Modern finance theory suggests a number of reasons why firms may hedge risks, including currency risks. Many of these reasons relate to potential costs of financial distress (e.g. bankruptcy costs) and to maximisation of investment opportunities; others relate to scale, managerial incentives and governance, country-specific factors (including taxes) and the availability of hedging substitutes (Triki, 2005).

Financial distress costs

Costs associated with bankruptcy or with breaching debt covenants create a reason for firms to hedge variable revenue and expenditure streams (Smith and Stulz, 1985; Nance, 1993). Leverage (the debt-to-equity ratio) is one common measure of exposure to financial distress costs (Berkman & Bradbury. 1996). The market-to-book ratio is also used. Liquidity (e.g. the "quick ratio"[5]) has been used as a related measure, given costs potentially associated with a shortage of working capital; an alternative measure is the interest coverage ratio.[6] Each of these ratios may be expressed relative to the industry median (or mean) to account for sectoral differences. One may also take account of differing likelihoods of entering financial distress that depend on sector or some other characteristic (e.g. through inclusion of sectoral dummy variables).

Evidence for hedging to protect against financial distress costs is found across a range of studies including Smith and Stulz (1985), Geczy et al (1997), and Allayanis and Ofek (2001). Nguyen and Faff (2002) find that distress costs (leverage and liquidity, as well as firm size) are important factors associated with the decisions of large Australian companies to use financial derivatives. Furthermore, once the decision to use derivatives has been made, derivative-based hedging increases as leverage increases. These results extend to the specific use of currency hedging instruments (Nguyen and Faff, 2003).

Underinvestment costs

Differences in costs of internally generated funds and external funds may lead to under-investment. Bessimbinder (1991) finds that shareholders may under-invest in circumstances where gains go mainly to debtholders. Froot, Scharfstein & Stein (1993) demonstrate that hedging can help overcome the underinvestment problem by ensuring a greater, and more dependable, supply of internal funds. Thus, in cases where firms wish to reduce dependence on external funding, hedging should be a positive function of the firm's investment opportunities. The latter may be proxied by the market-to-book ratio or by the ratio of investment to total expenses. Another common proxy, underpinned by an hypothesis that high R&D companies are likely to be fast growth firms, is the ratio of firm R&D expenses to the firm's total expenses. Liquidity ratios may also serve as a proxy for availability of internal relative to external funds. The use of measures (such as liquidity ratios) that proxy for two alternative hypotheses make it difficult to infer the exact mechanisms at work in driving the hedging decision where those proxies are found significant in econometric work.

[5] The quick ratio is obtained by subtracting inventories from current assets and then dividing by current liabilities.

[6] The interest coverage ratio is calculated by dividing a company's earnings before interest and taxes (EBIT) by the company's interest expenses.

Support is forthcoming for the Froot et al hypothesis from the studies of Adam (2002), which finds that firms hedge to reduce their dependence on external capital markets, and Mello and Parson (2000) who demonstrate that hedging is used as a means to increase financial flexibility by improving liquidity. Evidence for greater hedging by firms heavily involved in R&D is obtained by Allayannis and Ofek (2001). However this variable is not significant in several other studies.

Size

Smaller firms may face a greater likelihood of financial distress than larger firms and so may be more likely to hedge. However, if this factor is controlled for, the existence of fixed costs for hedging means that large firms are more likely to hedge (Marsden & Prevost, 2005). Fixed costs, in this context, include development of expertise within the firm to understand the risks associated with the use of hedging products. Related to this rationale, firms that are heavily reliant on exporting as a proportion of their sales are more exposed to currency volatility than firms that have a lesser reliance on exporting. Firms with high absolute value of exports and firms that have high export-to-sale ratios may therefore be expected to be heavier users of currency hedging products (Greczy et al, 1997; Allayannis & Ofek, 2001; Graham & Rogers, 2002; Lel, 2004). Allayanis and Ofek (2001) find a number of variables predict whether a firm will use currency derivatives, but only the exposure factors (foreign sales and foreign trade) explain the degree of currency hedging use. The elasticity of hedging with respect to currency exposure is 0.83 which suggests a hedging rather than a speculative motive in the use of derivatives.

A caution here is that currency of denomination of exports is an important factor to take into account. Where exports are denominated in the domestic currency (i.e. NZD in New Zealand firms' case) it is foreign-currency denominated exports that is the relevant direct exposure variable. Further, if volatility of the domestic currency relative to one currency differs systematically from that of another, the degree of the exposure differs; thus size of export exposure may need to be complemented with the nature of the currency exposure.

Managerial risk aversion, information asymmetry and governance

Managerial risk aversion provides a reason for managers to hedge and so reduce variance in earnings. For instance, CEO tenure may be affected by a single adverse result, promoting hedging against downside possibilities. Managerial incentives can promote adoption of unhedged, and even of speculative, positions. The latter may occur where remuneration is a convex function of firm value (e.g. via stock options). Where datasets are used that do not include managerial compensation variables, other measures, such as the ownership structure of the firm, may be used to proxy managerial risk aversion effects. For instance, owner-managers may face less risk of dismissal than managers of listed firms. Further, there may be a difference in managerial risk aversion and behaviour according to whether the firm is predominantly foreign or domestically owned.

The more volatile that cash flows are, the more difficult it may be for shareholders to monitor manager performance. Breedan & Viswanath (1998) argue that adoption of risk management practices that reduce the noise in earnings also reduces the noise in the learning process concerning the manager's capacities. Corporate hedging may

therefore be adopted by highly qualified managers to signal their superior abilities. The percentage of shares held by institutions, or by other large shareholders, is one potential measure of information asymmetry. Governance approaches may differ between listed and non-listed firms; hence distinguishing between listing status (and possibly also domestic versus foreign) firms may be a useful proxy for information and/or governance differences.

A number of studies find that corporate hedging activity does not increase stock return volatility and so is not considered speculative (Hentschel and Kothari, 2001; Nguyen and Faff, 2002). However, other evidence suggests that management frequently engage in selective hedging (which can be interpreted as tactical or speculative management) of currency and other exposures (De Ceuster et al, 2000). The nature of this behaviour is examined further in section 2.2 and section 6.

Country-specific characteristics
Financial markets differ across countries and across time. Financial expertise within countries also develops over time. Furthermore, corporate reporting standards are country-specific and legal requirements on reporting alter discretely at differing times in different countries. One should expect, therefore, that hedging practices vary both across countries and across time.

Where data relates just to export values, rather than currency of denomination of exports, the degree of currency hedging may also differ across countries. For instance, it is likely that US firms have a greater ability to denominate exports in their domestic currency than do firms from a small country such as New Zealand. Surveys that compare US firm hedging practices with those in other countries indeed find that firms in other countries hedge more than US firms (Lel, 2004; Bartram et al, 2004). Specifically, Bodnar & Gebhardt (1999) find that German firms hedge more than US firms; Bodnar, de Jong and Macrae (2003) find that derivatives usage is more common amongst Dutch than US firms.

Taxes
Another factor affecting hedging that may be country-specific is the nature of the corporate tax system. Where firms face convex tax functions, smoothing income (in the home currency) has a payoff to shareholders (Smith and Stulz, 1985). In a country such as New Zealand, that has a flat company tax schedule (and a flat personal tax schedule above a fairly low threshold), there may still be an argument for corporate hedging behaviour in the presence of corporate tax loss carry-forward situations. In these cases, there is a convex payoff to the firm so firms have an incentive to lock in positive returns in order to use the tax provision.

Alternatives to hedging
Some firms have access to techniques other than derivatives to hedge currency exposures. These techniques take a number of forms including financing activities, such as use of foreign-denominated debt (Allayannis & Ofek, 2001) or importation of raw materials denominated in the exposed currency. Alternatively, firms may denominate their exports in the home currency, although this may still leave an underlying economic exposure to currency movements if the domestic price is linked directly to the foreign price adjusted for the exchange rate. Firms may also consider a strong liquidity buffer as a quasi-hedging tool, so reducing the need to hedge.

Another form of hedge occurs through having flexibility to vary the nature of operating activities. This flexibility may reflect diversification of a firm's activities (e.g. diversity of products with differing market exposures) and/or flexibility in production processes that include an ability to substitute capital for labour over short time horizons. Multinational firms may diversify production locations across different countries (Carter et al, 2003). In addition, firms with some market power may 'price to market' and adopt hedge strategies accordingly (Sato, 2003, for Japanese exporters).

2.2 Selective Hedging

The explanations considered in the previous section relate to optimal hedging practices designed to maximise firm value by relaxing other constraints faced by the firm. These theories are predicated on the basis of consistent behaviour by firms that are subject to the particular constraint. Thus if firm j has characteristics z and is liquidity-constrained to degree c in period t it will hedge to degree h; then if firm j has the same characteristics z, with the same liquidity constraints c in period t+1 it will again hedge to degree h.

A small number of studies have tested whether firms indeed behave consistently in this manner. In order to do so, considerable detail is required on each of the firms under scrutiny; for this reason, most such studies have examined the hedging practices of a small number of firms in a single industry. Examples are Brown et al (2006)[7] for the gold industry, and Meredith (2006) for the oil and gas industry.[8]

Support for the presence of selective hedging goes back at least to Working (1962) who argued that selective hedging can be used to avoid loss by hedging when prices are expected to decline. Taking this idea further, Stulz (1996) posited that firms with a comparative advantage relative to other firms in a market can selectively hedge on the basis of their market views so as to minimise downside outcomes while preserving the upside. An important qualification in his approach is the requirement for firms to possess a comparative advantage in market knowledge for selective hedging to be appropriate to maximise firm value. Firms that specialise in producing specific commodities may possess such knowledge; hence selective hedging theories have been tested for firms in specific commodity markets.

Meredith examines whether oil and gas production companies selectively (speculatively) hedge their projected output. He tests whether companies attempt to lock in high prices by hedging a higher proportion of output when prices are perceived to be high than when they are perceived to be low. Many firms in his sample do not hedge; however, amongst those that do, some have variable hedge ratios. He argues that selective hedging in the oil market may arise because oil prices are widely believed to be mean-reverting (unlike gas prices); further, oil firm managers have expertise in the markets in which they produce.

[7] Tufano (1996) also examined hedging behaviour of gold mining firms (1990-1993) but did not specifically examine selective hedging hypotheses. He found a significant positive relationship between hedging and leverage, but little support for use of hedging to reduce financial distress costs or taxes. He found strong support for managerial characteristics and incentives affecting hedging behaviour documenting a negative relationship between hedging and managerial stock ownership and with the stock option holdings of officers and directors.

[8] Haushalter (2000) also examined hedging behaviour in the oil and gas industry, but concentrated on consistent hedging practices rather than on selective hedging.

Meredith computes the proportion of the next year's firm-specific production of oil and gas that is hedged, and tests whether these ratios vary according to (a) the price of oil (gas); (b) a dummy variable measuring whether oil (gas) prices are above or below their ten-year mean (4 year mean for gas); and (c) the stock of oil (gas) inventories. Given the perceived mean reversion of oil prices, he hypothesises that oil hedging may be a positive function of oil prices and a negative function of oil inventories. He controls for factors relevant for traditional hedging theories, including proxies for financial distress costs, commodity price volatility and size.

His descriptive statistics indicate selective hedging of oil; the proportion of oil output that is hedged in high oil price environments is more than double the hedging rate in low oil price environments. Tobit estimates indicate that all three selective hedging measures are highly significant for oil hedging ratios, but not for gas.[9] He indicates that companies appear to have improved operating performance through selective hedging of crude oil, but not of natural gas. These findings are consistent with mean reversion of oil prices, but not of gas prices, coupled with some comparative advantage within the industry.

Brown et al (2006) analyse hedging behaviour of 44 gold-mining firms. They also find evidence that firms tend to increase hedging as prices move in their favour. While this is inconsistent with conventional risk management theory, it is consistent with selective hedging (market timing). However, their evidence does not suggest that selective hedging leads to superior operating or financial performance.

The use of selective hedging appears to be much more widespread than can be explained solely by firms using their comparative advantage about a specific market. Dolde's (1993) survey of Fortune 500 firms found that, of firms using derivatives, almost 90% reported they took a view of the market. In a survey by Bodnar, Hayt and Marston (1998), 60% of firms using foreign currency derivatives stated that their market views frequently or sometimes affected the size and timing of their hedging position. Faulkender (2005) finds that interest rate exposures (and hedging behaviour) are associated with the slope of the yield curve at the time debt is issued, indicating that risk management practices are primarily driven by speculation or myopia, not by standard risk management considerations.

Firm governance practices may be associated with the adoption of selective hedging. For instance, Beber and Fabbri (2006) find that managerial characteristics and incentives explain a large share of the time-variation of foreign exchange derivatives use by US non-financial firms. Use of selective hedging is affected by the management compensation scheme, is less frequent among female managers and among managers with longer tenure. Firms where the CEO holds an MBA degree, is male, younger, and has less previous work experience, speculate more.

Glaum (2000) finds that German firms follow heterogeneous risk management practices. Some firms do not manage their open currency positions; others hedge their positions immediately on arising. However, the majority of firms follow a selective hedging strategy, hedging positions for which they expect a currency loss

[9] Meredith finds that his control variables proxying standard hedging theories are not significant; this is possibly because the companies within the sample are quite homogeneous.

while leaving open positions for which they expect a currency gain. Interpreting this evidence, Glaum (2002) argues that such a strategy is based on forecasts of future exchange rate changes, implying that many corporate financial managers believe that they can 'beat the market'. This is contrary to efficient markets theory and to traditional theories of hedging. It is also contrary to Stulz's proposition that selective hedging may be undertaken where the firm has a comparative advantage in market-specific knowledge.[10]

Glaum sets out a number of theories of selective hedging, and tests them using a survey of 74 large German firms. He begins with the three logical possibilities explaining why firms may engage in selective (speculative) hedging:

(i) Firms are indeed able to beat the market (i.e. to earn risk-adjusted profits on their bets).[11]

(ii) Firms are not able to beat the market but managers/directors erroneously believe that they can do so.[12]

(iii) Firms are not able to beat the market and managers are aware of this, but take bets anyway.[13]

In Glaum's sample, 90% of firms use derivative financial instruments, with forward foreign exchange contracts being the most popular; 88% of those who use derivatives claim they use them only for hedging purposes. However this figure includes selective hedgers (54%), i.e. firms that, contrary to their reported policy on the use of derivatives, actively adjust their hedges in response to perceived market opportunities. He tests nine hypotheses concerning selective hedging decisions. These hypotheses are based principally on observation rather than being derived from an optimising model; indeed some may represent sub-optimal behaviour (at least for the firm). The nine hypotheses, each with an expected positive effect on the probability of a firm undertaking selective hedging, can be summarised briefly as:

Hypothesis	**Nature of Issue**	**Proxy Variable**
H1:	Financial distress	Interest coverage
H2:	Leverage	Equity/Total capital
H3:	Growth opportunities	Book-to-market ratio
H4:	Size	Firm value
H5:	Diversification	Diversified firm (y/n)
H6:	Multinationality	Foreign sales/Total sales
H7:	Profitability	Return on equity
H8:	Agency/governance	Bank ownership (y/n)
H9:	Hedging substitutes	Convertible debt or preference stock (y/n)

In his multivariate logit regressions, Glaum finds significant results (with the expected sign) for leverage and, to a lesser extent, for nature of bank ownership and firm size (firms that engage in selective hedging tend to be much larger than those that do not

[10] Braas and Bralver (1999) show that even banks tend not to make money from taking speculative positions in financial markets.

[11] This is unlikely for non-financial firms in the foreign exchange market.

[12] This explanation may be related to poor accountability systems.

[13] This could be value-maximising for a firm in financial distress (Stulz, 1996). Alternatively it might be related to managerial incentives especially if managerial remuneration is linked positively to upside results but not to losses or to profits below budget.

selectively hedge). Profitability has the wrong sign, possibly reflecting reverse causation (i.e. firms that selectively hedge reduce profitability by doing so, or have other poorly performing policies). It could also reflect Stulz's hypothesis that management returns are convex if firms are in financial distress. The firm size result may indicate that firms with large treasury functions employ managers who believe either that they can beat the currency markets, or who have incentive packages that reward upside returns more than downside losses relative to some benchmark.

Glaum's three 'logical possibilities' and nine hypotheses provide a useful basis for studies designed to test selective hedging behaviours. We use them as a foundation for our study of hedging behaviour across New Zealand exporting firms.

3 Prior New Zealand Evidence

A number of New Zealand studies have examined the hedging behaviour of listed New Zealand corporates using information that these firms have been required to disclose since the early 1990s. Some detailed survey evidence is also available.

Berkman and Bradbury (1996) use data from New Zealand Stock Exchange (NZSE, now NZX) listed firms (excluding foreign firms and financial firms) on the fair value and the contract value of off- and on-balance sheet financial instruments. None of the 116 firms in the sample indicate that derivative financial instruments are used for speculative purposes.[14] They test standard theories of firms' hedging choices, estimating a Tobit model (using fair value and contract value respectively as dependent variables), with a wide range of independent variables: firm market value; interest cover; leverage; tax loss; earnings-price ratio; asset growth/cash flow; managerial share ownership; liquidity; dividend payout; alternative capital instruments; and proportion of overseas assets.

Their results support the view that firms use derivatives to reduce costs of financial distress and to increase the present value of tax losses; a high proportion of liquid assets and a low dividend payout ratio reduce the use of derivatives. Ownership may affect derivative usage, with managers who are part-owners of the firm using derivatives to reduce the variability of firm value. When fair value is used as the measure of hedging activity, Berkman and Bradbury find support for the hypothesis that derivative use is positively related to the value of a firm's growth options.

Berkman et al (1997) report a survey of NZSE listed firms,[15] finding that 53% of firms use derivatives (compared with 48% in Berkman and Bradbury). The use of derivatives is strongly correlated with size: 100% of firms with market value of equity greater than US$250 million use derivatives (compared with 65% in the United States; Bodnar et al, 1995); 70% between $50-$250 million use derivatives; 36% with less than $50 million of equity use derivatives (compared with 12% in the United States). Thus New Zealand listed corporate derivative use increases with firm size, and New Zealand corporates use derivatives considerably more than do US firms. The latter result may possibly be due to greater currency exposures for New Zealand compared with US firms. Derivative usage amongst the surveyed New Zealand corporates also varied considerably by sector with usage rates of: 29% for

[14] However recall Glaum's finding that almost all German firms claim the same lack of speculative use while a majority acknowledge that they undertake selective hedging.
[15] The survey had a 64% response rate (79/124 firms).

commodity-based firms; 82% for non-durables manufacturing firms; 86% for durables manufacturing firms; 73% for transport & utility firms; 86% for retail & wholesale firms; and 32% for services firms.[16]

Of the firms that use derivatives, approximately 80% use forward contracts to hedge foreign currency exposures. Firms reported that their main currency exposures were to the US dollar (68.6%) and the Australian dollar (28.5%); the next highest was 2.9% for the Japanese yen. Firms further claimed that derivatives are mainly used to reduce funding costs (69%),[17] to hedge contractual commitments (79%); and to reduce fluctuations in earnings (62%).[18] None claimed to be using derivatives for speculating. If these claims are accurate, we would not expect to observe selective hedging amongst New Zealand corporates over this period.

Reynolds and Boyle (2006) undertook similar analysis to that of Berkman and Bradbury using 1999 data for 105 domestic non-financial NZSE listed firms. They relate these data to results for sectoral use of currency derivatives from earlier surveys by Marsden and Prevost. The sectoral proportions of firms that use currency derivatives in 1994, 1997, 1999 are: primary sector: 33%, 33%, 50%; other goods sectors: 44%, 50%, 86%; and services/property/IT sectors: 30%, 21%, 36%. This evidence indicates quite different usage rates across years even after controlling for sector. This may indicate either selective hedging or learning behaviour (with a strongly increasing usage rate for the other goods sector and, to a lesser extent, for the primary sector).

Reynolds and Boyle use Tobit analysis to estimate the level of derivative use given that a firm chooses to use derivatives, and logit analysis to evaluate the binary decision to use derivatives. Dependent variables are fair value and contract value of derivative contracts scaled by market value of the firm. Explanatory variables include: Tobin's Q; asset growth; existence of tax-loss carry-forwards; interest cover ratio; leverage; firm value; ownership characteristics; alternative capital instruments; liquidity; dividend payout ratio; overseas assets; and sector dummies. They consider inclusion of R&D expenditures to represent a firm's investment opportunities but are unable to do so since there is no requirement for New Zealand firms to publicly report R&D expenditure. Contrary to the hypothesis of Froot et al (1993), but consistent with prior New Zealand evidence, they find that higher growth firms are less likely to use derivative contracts. Consistent with a wide body of evidence, leverage is positively related to derivative usage, and larger firms are more likely to use derivatives; sectoral effects are also important. Reynolds and Boyle find that tax-loss carry-

[16] Comparable US sectoral usage rates were 49%, 42%, 39%, 32%, 29% and 14% respectively. A recent New Zealand survey (Marsden and Prevost, 2005) finds that New Zealand goods-producing firms are more likely to be derivatives users than are firms in other sectors. This is consistent with the high proportion of derivatives use amongst manufacturers in the Berkman et al survey. Marsden and Prevost also find that companies with higher growth opportunities and a greater proportion of outside directors were less likely to use financial derivatives following the introduction of the 1993 Companies Act (which raised expectations of directors' fiduciary responsibilities).

[17] Given that New Zealand short term interest rates have consistently been above Australian, and especially United States, short rates, this may reflect a perceived forward rate pick-up argument, implying that firms are discounting any offsetting costs due to potential currency depreciation.

[18] A more recent survey of 175 New Zealand firms (Prevost, Rose and Millar, 2000) shows that 47% of firms indicate that the single most important reason they hedge with derivatives is to minimise fluctuations in real cash flows.

forwards do not explain the extent of derivative usage; while liquidity (contrary to theory) is related positively to derivative usage.

A larger scale survey (Grimes et al, 2000) sheds more detailed light on the nature of New Zealand firms' currency hedging practices related to transactions with Australia (New Zealand's single largest trading partner). The authors conducted a survey of New Zealand firms, as a special part of the November 1999 National Bank of New Zealand Business Outlook Survey, with questions relating to currency denomination of exports to Australia and currency hedging practices. Unlike prior studies, this survey covered a wide range of firms, being sent to approximately 1,500 firms with responses from 409 firms. Of the respondents, 117 firms had 0-5 employees, 81 had 6-10, 70 had 11-20, 68 had 21-50, and 68 had over 50 employees (5 did not indicate size); the predominance of smaller firms reflects the size distribution of New Zealand firms. The survey included 100 manufacturing firms, 64 agriculture firms, 194 services firms, and 51 'other' firms; 64 firms had exports of at least 50% of total sales, while 53 firms had exports to Australia comprising at least 10% of total sales.

The survey included 138 exporters to Australia that reported the currency denomination of their Australian exports. These comprised New Zealand dollars (NZD, 46%), Australian dollars (AUD, 46%), US dollars (USD, 2%), 'Other' (0%) and 'Mixed' (5%).[19] Currency denomination varied considerably by sector with Manufacturing (31% NZD, 66% AUD, 3% USD/Mixed); Agriculture (69% NZD, 15% AUD, 15% USD/Mixed); Services (62% NZD, 29% AUD, 10% USD/Mixed); Other Sectors (50% NZD, 38% AUD, 13% USD/Mixed).[20]

Within the survey, 173 firms indicated their hedging practices with respect to AUD exposures: 61% hedged none of these exposures, 9% hedged all exposures, while 30% hedged some exposures. In addition, 172 firms indicated their hedging practices with respect to non-AUD currency exposures: 52% hedged none of these exposures; 8% hedged all exposures; while 41% hedged some exposures. Firms did not generally consider hedging costs to be high: 81% of firms answered that AUD hedging costs were low or very low (on a five point scale); 72% answered that non-AUD hedging costs were low or very low. A higher proportion of smaller firms (less than 50 employees) found AUD hedging costs to be high than did larger firms.[21]

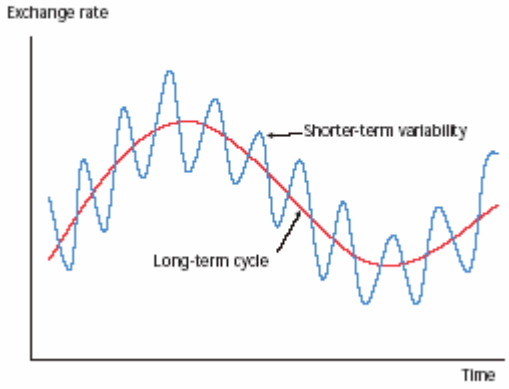
Finally, the study analysed actual hedging practices of firms that exported at least 10% of their sales to Australia. This revealed strongly divergent hedging practices between small and large firms. Of small firms (<25 employees) 80% hedged none of their AUD exposures (and 82% hedged none of their non-AUD exposures) compared with 7% and 10% respectively for large firms (>50 employees); mid-sized firms sat between these extremes. None of the small firms hedged all of their AUD or non-AUD exposures compared with 36% (AUD) and 19% (non-AUD) for large firms. This

[19] The largest two currencies in Mixed were again AUD and NZD.
[20] The survey also asked about currency denomination of imports from Australia, finding that 58% of importing firms had Australian imports denominated solely in AUD, 22% in NZD, 2% USD, 1% 'Other', and 18% 'Mixed' (of which 52% were predominantly in AUD).
[21] However this pattern was not repeated for non-AUD hedging costs.

evidence is consistent with prior findings that firm size if positively correlated with currency hedging.[22]

In a paper in the Reserve Bank of New Zealand *Bulletin*, Brookes et al (2000) discuss corporate use of currency hedging instruments. They differentiate between short run volatility of "up to an annual frequency" and longer cycles "that last a year or more" (see their Fig 1, p.23, reproduced below). The figure, and the concept of an exchange rate "cycle", implies that the exchange rate exhibits mean reversion of the type considered relevant for oil price hedging by Meredith (2006).

Figure 1: Exchange rate fluctuations: short-term and long-term cycles



Source: Brookes et al (2000), p.23.

Brookes et al base their discussion of currency hedging practices in part on interviews with New Zealand firms. They consider that the forward points component of forward exchange rates (reflecting interest rate differentials) influences New Zealand firms' perceptions of the cost of forward contracts, and hence their willingness to use them. As an example, they note that NZD interest rates have consistently been above most trading partner interest rates, meaning that forward selling rates for foreign currencies against the NZD rate were generally below the spot rate. This was perceived as an inducement for exporters to hedge, and for importers not to. They explain, however, that if forward points are part of an arbitrage condition, they are not an added cost or benefit, and to consider them as such represents a mis-perception on the part of firms.[23]

Reflecting the survey findings of Grimes et al (2000), Brookes et al note that forward contracts are virtually costless to the user. They provide an excellent hedge against short-term exchange rate exposures (e.g. for near-term, contracted export sales); however, hedging for longer-term exchange rate cycles is more problematic. This is

[22] The survey asked about attitudes to currency union with Australia. Support was inverted U-shaped by firm size with strongest support coming from firms with 11-20 employees. The authors surmised (p.106) "that many firms of this size have reached the stage where exporting is becoming viable and important to enable expansion, with Australia being the most likely initial export market. However, the firm may not have the staff resources and/or experience to manage exchange rate exposures, or at least may prefer to devote rare staff resources to other tasks."

[23] The same perception underlies the 'carry trade' in the currency markets.

especially the case when export sales are uncertain, in which case a forward contract can lead to firms taking an unintended currency position if the expected export sale does not eventuate.[24]

While forward contracts do not result in material direct costs, they do impose an indirect cost by utilising credit lines, with the size of the credit allocation increasing as the length of the forward contract increases. Small and/or highly leveraged firms are most likely to be affected by this crowding out of access to credit, and so may make less use of forwards than do large firms. Accounting requirements may also affect use of forwards for longer term hedges which are not be tied to an explicit transaction, so creating reported earnings volatility.

Currency hedges other than forward contracts are also available, including options, balance sheet hedging and natural hedges. Use of foreign currency loans may be an avenue that is available to larger corporates; thus hedging using forwards could conceivably be more prevalent for smaller firms (contrary to the usual scale argument). Invoicing exports in local currency is another method of hedging. However the authors note that this does not automatically represent an economic hedge, especially where the local currency price varies in a spot fashion to reflect exchange rate changes.

Brookes et al argue that forwards have advantages for short-term 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). To the extent that this comment is a reflection of firms’ views, it indicates that selective hedging, based on prospective exchange rate views, is an approach adopted by some New Zealand firms. This comment is consistent also with the notion (reflected in Figure 1) that the NZD exhibits longer term mean reversion properties.

The authors conclude that New Zealand firms tend to limit currency hedging to relatively short horizons and to ‘ride out’ longer-term cycles, with long-term hedging perceived to be risky. They perceive a general pattern of substantial hedging of known trade receipts and payments out to six months, with less cover for flows expected between six and twelve months ahead, and a rapid fall-off in the extent of cover for transactions expected to occur beyond twelve months.

4 Data and Hypotheses

Our data are obtained from Statistics New Zealand’s Longitudinal Firm Performance Database (LFPD). This longitudinal database (described more fully in Fabling et al, 2007) collates a number of official surveys of, and administrative and tax data on, the universe of New Zealand firms. The Longitudinal Business Frame provides a basis for linking the data sources. Tax data are available relating to GST, IR4 and IR10 returns. Data from LEED (Linked Employee-Employer Database, that utilises PAYE and employer tax data) aggregated to the firm level are linked into LFPD. These financial data are supplemented by data from Statistics New Zealand’s Annual Enterprise Survey and other Statistics New Zealand surveys (sampled from the Business Frame).

[24] They note that a number of firms that had hedged expected sales suffered this experience in 1997/98 when, because of the Asian crisis, they suffered an unexpected downturn in export sales.

One further administrative data source that forms part of LFPD is the Customs New Zealand database on merchandise exports and imports. As described in Fabling and Sanderson (2007), this source provides detail on individual firms' exports and imports by country and by commodity (detailed Harmonised System [HS] codes) on a daily basis. Firms must also detail the currency of denomination of the export. Thus we can ascertain currency of denomination by country of export. Further, where the currency of denomination is not NZD, firms must record whether they have hedged the currency exposure into NZD. If they have done so, they must record the hedged currency rate which is used to record the NZD value of merchandise trade.[25]

Less complete data are available for firm imports. For each firm, we can ascertain country, currency of trade, and commodity of imports, but not hedging practices. Nevertheless, the import data can be used to ascertain whether firms that import follow the same currency hedging practices for their exports as do non-importers, so testing whether imports play a role as a natural hedge.

The data are available longitudinally for all New Zealand merchandise exporters. In (calendar) 2005, for instance, the number of firms that were reported as merchandise exporters totalled 10,541. This represented roughly 2% of firms considered economically active that year.[26] We aggregate the Customs data to monthly frequency and utilise data from August 1997 to February 2007, being the full period for which we can obtain comparable data.

Our goal in this research programme is to model hedging decisions at the individual exporter (unit record) level. We aim to use the unit record data to test a range of hypotheses, derived from the surveyed literature, regarding both optimal hedging and selective hedging behaviour. The current paper is a precursor to that analysis. We present a range of descriptive statistics, derived from various aggregations of the individual firm data, that shed light on a number of aspects of hedging behaviour. The empirical section of the paper further examines the practice of selective hedging by New Zealand exporters.

Questions regarding hedging behaviour that we address in this paper are as follows:

Q1. What are the shares of exports (over time) of alternative currencies of denomination? We address this question both for shares of the number of individual transactions (termed 'lines' in the Customs data) and for shares of total fob export value. Further, we split the currency denomination shares by country of destination.

Q2. What percentage of total foreign currency exports, Australian dollar (AUD) exports and United States dollar (USD) exports are hedged (over time)?[27]

Q3. What is the relationship between the hedged rates of exchange (for AUD and USD) to the current spot exchange rates at the time of export? What does this imply about the likely hedging term that is observed?

[25] If they have not hedged, Customs New Zealand records an appropriate NZD value based on current exchange rates.
[26] Bearing in mind that the denominator in this calculation contains firms that would not be expected to export goods. For example, Fabling & Sanderson (2007) naturally find a much higher proportion of merchandise exporters when the population is restricted to manufacturers, wholesale traders & agriculture, forestry & fishing firms (using ANZSIC divisions from the Longitudinal Business Frame).
[27] AUD and USD are the most common foreign currency denominations for exports.

Q4. How does hedging behaviour vary by sector?

Q5. How does hedging behaviour vary by firm size?

Q6. How does hedging behaviour vary by export intensity of the firm?

Q7. How does hedging behaviour change over time in relation to levels of (a) the exchange rate, and (b) forward points (represented by the interest rate differential between short term New Zealand dollar interest rates and the short rates of the other currency)? Specifically we address the hypotheses that: (a) the hedge ratio for a currency exposure increases when the NZD is low relative to historical norms against that currency; and (b) the hedge ratio for a currency exposure increases when the forward points relative to that currency increases (i.e. when New Zealand short rates increase relative to the rates in that country).

Questions 1-4 are primarily descriptive of hedging practices while questions 5 and 6 relate to hypotheses derived from optimal hedging theory; each of these questions is addressed in section 5. Question 7 relates primarily to theories of selective hedging. This issue is examined in detail in section 6.

5. Hedging Patterns

Currency of Denomination

Figure 1 graphs the shares of total fob exports (by value) that are denominated in foreign currencies. Figure 2 graphs the shares of total export transactions denominated in foreign currencies. In each case, we split currencies into USD, AUD and Other; all remaining transactions are denominated in NZD.

The most striking aspect of these graphs is the very small proportion of exports (both by fob value and by transactions) denominated in foreign currency at the outset of the period, with a strong upward trend in the shares over time. Recall that we are measuring the currency denomination of exports, not necessarily the economic exposure of exporters to currency movements. For instance, as discussed by Brookes et al (2000), wool exports tend to be denominated in NZD but producers are exposed to currency movements since the spot price of wool varies almost directly with the spot exchange rate.

A second aspect that is apparent from the graphs is the importance of transactions in USD and AUD as proportions of foreign currency transactions (and values). In 1998,[28] of foreign currency denominated export transactions, on average 33% and 52% were in USD and AUD respectively. In 2006, these proportions were 51% and 28% respectively, indicating a strong upward shift in the USD share and a strong downward shift in the AUD share. The proportions of export values expressed in USD and AUD were 61% and 32% respectively in 1998, and 69% and 12% respectively in 2006. These show the same direction of changes in shares as the transactions data.

A third feature of Figures 1 and 2 is that the upward path in the foreign currency proportion does not follow a smooth trend. The proportions increased sharply during a period of weakness in the NZD over 2000-2001 but then reverted back to the

[28] All years are calendar years unless otherwise specified.

underlying trend. The proportions then increased sharply again in mid-2003. These results suggest a prima facie case for the existence of selective hedging.

Very little has hitherto been known about the currency of denomination of New Zealand exports by country of destination. Figure 3 summarises the currency denomination shares of exports to New Zealand's five largest export markets across the full sample.

Over half (63%) of exports (by value) to Australia are denominated in NZD with a further 36% denominated in AUD; just 1% are denominated in USD, and even less in 'Other'. These figures compare with the surveyed shares (for 1999) in Grimes et al (2000) that showed 46% of exports to Australia denominated in each of NZD and AUD, with 2% in USD and 0% in 'Other'. The figures are in the same ballpark as one another, albeit with an increased share in NZD relative to AUD in the full sample Customs data relative to the 1999 surveyed data.

In each of the US and UK markets, 57% of exports are denominated in NZD, with USD being the other dominant currency for US exports, and 'Other' (predominantly Sterling and Euro) being the other predominant currencies for exports to the UK. Japan has a significant USD share (18%) as well as a significant 'Other' share (13%, predominantly Yen). Yen denomination is notably absent in exports apart from Japan.

Exports to China follow a different currency denomination pattern. Of the five major markets, China is the only country for which NZD denomination is outweighed by foreign currencies. Furthermore, the predominant foreign currency is the USD not the Yuan (the Chinese currency); 54% of exports to China are denominated in USD.

Overall, the currency denomination patterns show that approximately 80% of New Zealand's exports by value are now denominated in foreign currencies, with the major currency exposure being to the USD and with a smaller exposure to the AUD. Other currencies are less important than the AUD in terms of direct currency exposures.

Hedging Proportions

Figure 4 graphs the proportion of non-NZD transactions ('lines') that are hedged. Additionally, it graphs the proportion of non-NZD fob export values that are hedged. Both measures indicate similar behaviours but with a stronger upward trend in the value-based measure than in the transactions-based figure. In each case, the hedging ratio increased temporarily in 1998 and again in 2000-2001. Subsequently we investigate whether this behaviour was associated with exchange rate movements. The hedge ratio increased to a more stable plateau (on both measures) from 2004 onwards.

At the end of the sample (early 2007), approximately 65% of non-NZD exposures by value were hedged, with a smaller proportion (approximately 55%) by transactions. An implication of the higher value figure is that larger firms (or at least larger exporters) tend to hedge more fully than do smaller firms (or exporters). This is investigated more formally below.

Figure 5 charts the proportion of foreign currency transactions by currency exposure for exports denominated in AUD, USD and 'Other'. One notable feature of the graph is the relatively low proportion (around 30%) of AUD transactions that are hedged. In 1999, approximately 25% of export transactions were hedged, leaving 75% unhedged. In the Grimes et al survey covering the same year, 61% of firms answered that none of their AUD exposures were hedged and a further 30% had hedged only some of their AUD exposures. These responses are broadly (and reassuringly) similar to the findings from the Customs data.

The share of 'Other' exposures that are hedged plateaus at around 60% after 2004, but with considerable variability prior to then. Considerable variability is also observed in the share of USD exposures that are hedged prior to 2004, with much greater stability (between 60% and 70%) thereafter.

Relationship of Hedged Rates to Spot Rates
Figure 6 presents the monthly AUD/NZD exchange rate together with data for the rate observed on hedged currency transactions as at time of export. In order to present a measure of dispersion of these latter rates, we present the 25th and 75th percentiles of the distribution. Figure 7 presents comparable data for the USD/NZD exchange rate.

It is apparent, from both graphs, that the reported hedged rate closely mirrors the spot rate and that the dispersion around the spot rate is very small. We examine the lag relationship between the two. Specifically, if the hedge has been taken out prior to the export transaction we would expect a higher correlation between the median hedged rate and a lag of the spot rate than with the current spot rate. Table 1 presents the correlation coefficients of the median hedged rate with the current and up to three (monthly) lags of the spot rate, for each of the AUD/NZD and the USD/NZD.

Table 1: Correlation of Median Hedged Rate (t) With Currrent and Lagged Spot Rate (1998:1 – 2007:2, monthly data)

	AUD/NZD	**USD/NZD**
Spot (t)	0.982	0.993
Spot (t-1)	0.982	0.997
Spot (t-2)	0.919	0.984
Spot (t-3)	0.861	0.965

The correlations indicate that hedges are very short term for both the AUD and USD. The one month lag relationship is fractionally stronger than the contemporaneous relationship for the USD, whereas the two relationships are virtually identical for the AUD. The correlations drop off sharply for the second and third monthly lags.

These results do not necessarily indicate, however, that firms fail to hedge expected transactions more than one month out. It is possible that (some) firms adopt rolling one month hedges to retain flexibility. This behaviour could be related to opportunities for selective hedging (rolling monthly hedges enable regular choices of whether to conduct or renew a hedge on a monthly basis), or it could be related to

uncertainties over export transactions. Without pinpointing the reason, we infer that the hedges we observe principally reflect short term decisions, with a modal horizon of one month.

Sectoral Hedging Patterns

Figure 8 depicts hedging rates for merchandise export transactions disaggregated by export sector (2-digit HS code).[29] Different hedging patterns are apparent across sectors and across time. All sectors show considerable variability in hedge ratios across time, although all four ratios tend to be much more stable from 2004 onwards.

At the start of our sample (1997:8), Agriculture and Mining had low hedge rates (19% and 0% respectively) whereas Manufacturing and Forestry were each higher (30% and 52% respectively). These ratios compare with Berkman et al's (1997) survey findings for listed New Zealand corporates that found hedging usage rates of 29% for commodity-based firms and 82%-86% for manufacturing firms. The difference especially in the hedging ratios for Manufacturing firms between the two studies may be attributable to the fact that Berkman et al cover only listed firms, whereas our study covers all exporters. Listed firms are, on average, both larger than the median firm in the economy and may face different accountabilities and incentives.

Table 2 presents the correlation coefficients between the hedge ratios of each of the sectors over the full period (1997:8 – 2007:02). Two groups of industries emerge. First, the two biologically-based industries – Agriculture and Forestry – have a moderate positive correlation (0.345). Second, Mining and Manufacturing have a strong positive correlation (0.655). Both correlations are significant at the 1% level. Remaining correlations are close to zero.

Pending multivariate analysis using the unit record data, we cannot ascribe specific reasons to these correlation patterns. Possible underlying reasons may relate to currency of export denomination, firm size, or other firm characteristics (such as leverage, liquidity, R&D intensity, etc). In future analysis, once we control for the wide range of factors potentially relevant to optimal hedging choices, we will examine whether sector retains any significant explanatory power.

Table 2: Correlation of Hedge Ratios Across Sectors (1997:8 – 2007:2, monthly data)

	Agriculture	***Forestry***	***Manufacturing***	***Mining***
Agriculture	1			
Forestry	0.345	1		
Manufacturing	-0.066	0.096	1	
Mining	0.030	0.057	0.655	1

Firm Size

We examine whether hedging practices differ by firm size. While theory suggests that firm size may be positively or negatively related to hedging decisions, most

[29] We group all items related to agriculture and processed agricultural products (e.g. casein) together as Agriculture; similarly we group forestry and processed forestry products (e.g. pulp and paper) together as Forestry. Mining is a stand-alone group; all other items are included as Manufacturing (given that we are dealing only with merchandise exports). In part, these groupings are chosen to meet confidentiality requirements. Agriculture here comprises just over 50% of exports.

international and domestic evidence indicates that large firms hedge currency exposures more comprehensively than do small firms.

Figure 9 presents the average hedge ratio for all firms (i.e. proportion of all foreign currency transactions that are hedged) together with the ratios for large and small firms. Large firms here are the largest quarter of firms by sales (BAI Sales).[30] Small firms are the smallest quarter of firms by sales. In each case, we take the ratio of all transactions that are hedged aggregated across all the relevant firms. Our sales data extends to the 2005/06 year; thus we present the information through to 2006:1.

Over the full sample, the average proportion of foreign currency export transactions hedged across all firms is 39%. Small firms, by comparison, hedged an average of 33% of their transactions, while large firms hedged an average of 49%. These results are consistent with the international evidence, cited earlier, that small firms on average hedge a smaller proportion of their exposed currency transactions than do large firms. Surprisingly, however, second and third quartile firms hedge even less than do small firms. The average hedging ratios for second and third quartile firms across the period are 21% and 22% respectively.

The findings for the second and third quartile firms raise doubts that shortages of resources or high fixed costs are the reasons behind the smaller than average level of hedging by small firms. Possibly the relationship is non-linear. Our theories indicate that hedging involves fixed costs and that this favours hedging by larger firms relative to smaller firms. Theory also suggests that costs and probability of financial distress raise the likelihood of hedging; small firms are generally considered to be more risky than are larger (often longer established and better diversified) firms. Our results may be reflecting both sets of factors. Again, once controls for a range of factors are introduced at unit record level in future analysis, the contributions of these alternative explanations may be uncovered.

Table 3: Correlation of Hedge Ratios Across Firm Size Quartiles (1997:8 – 2006:1, monthly data)

	Quartile 1	***Quartile 2***	***Quartile 3***	***Quartile 4***
Quartile 1	1			
Quartile 2	0.366	1		
Quartile 3	0.424	0.202	1	
Quartile 4	0.437	0.090	0.430	1

While average hedging behaviour differs across quartiles, the dynamics of hedging choices are positively correlated across firms in the four size quartiles. (Quartile 2 firms, however, have low correlations with quartile 3 and, especially, 4 firms.) Furthermore, the standard deviation of hedge ratios over the sample for each of the four quartiles is similar (14%, 10%, 12% and 10% respectively). These results suggest, to the extent that firms engage in selective hedging, this behaviour is reflected across firms of all sizes, and does not just reflect behaviour by firms in certain size classes.

[30] BAI refers to the Business Activity Indicator, derived from GST sales data.

Export Intensity

Figure 10 presents information on whether export intensity (zero-rates sales/total sales)[31] is related to firms' hedging decisions. The figure is drawn in an analogous fashion to Figure 9. Firms in the highest export intensity quartile hedge considerably more than the average across all firms, while those with low export intensity hedge less. This is consistent with rationales relating to costs of financial distress, since firms with high export intensity face greater balance sheet risks arising from currency fluctuations than do firms with low export intensity (controlling for other factors).

Firms in the lowest export intensity quartile on average hedge just 11% of their export transactions. This contrasts with 34%, 35% and 52% respectively for quartiles 2, 3 and 4. In this case, therefore, the hedging ratio increases monotonically with the relevant quartile. Perhaps surprisingly, the second quartile of firms have the highest standard deviation of hedging ratio (at 18%, compared with 9%, 13% and 14% for quartile 1, 3 and 4 firms respectively). The reason for this result is unclear and is left to future work to investigate.

Table 4: Correlation of Hedge Ratios Across Export Intensity Quartiles (1997:8 – 2006:1, monthly data)

	Quartile 1	***Quartile 2***	***Quartile 3***	***Quartile 4***
Quartile 1	1			
Quartile 2	0.186	1		
Quartile 3	0.393	0.150	1	
Quartile 4	-0.335	-0.488	-0.065	1

Table 4 examines how the dynamic behaviour of hedging choices varies by export intensity quartile. Firms in the lowest three quartiles exhibit small to moderate positive correlation of behaviour. However, firms with high export intensity behave in an opposite manner to other firms, and especially to quartile 1 and 2 firms. The difference in behaviour between quartile 1 and 4 firms can be seen from Figure 10. Over the first half of the sample, high export intensity firms appeared to take larger and more consistent positions relative to their normal behaviour, although both sets of firms showed volatile hedging behaviour. Over the second half of the sample, low export intensity firms have hedged only a small (below 10%) and relatively stable proportion of their export transactions; in contrast, high export intensity firms have moved to a hedge ratio of around 65%, with considerable volatility remaining in their hedging choices.

It is possible that this dichotomy in behaviour reflects a stronger penchant for selective hedging by high export intensity firms, possibly because of actual or imagined expertise within those firms with respect to currency markets. We investigate some aspects of this issue in the next section; in future, we will use the unit record data directly to examine this question in more detail.

6. Selective Hedging

We analyse two features that may be relevant to selective hedging choices. The two features relate to exchange rates relative to perceived fundamentals and the level of forward points (i.e. short term interest rate differentials).

[31] Zero-rated sales are sales on which firms do not pay GST, which includes export sales.

First, we examine whether the hedging ratio for a particular currency exposure increases at times when the NZD is low relative to that currency. Such behaviour may reflect management having an unhedged benchmark, but choosing to lock in what is perceived to be a favourable exchange rate on an opportunistic basis. Alternatively, management may have a hedged benchmark but choose to take hedges off at times when the NZD is perceived to be high.

Figure 11 plots the hedge ratio for all USD-exposed transactions together with the USD/NZD exchange rate. Signs of selective hedging, especially in the first half of the sample, are apparent. For instance, the USD/NZD rose over the first half of 1999 and the hedge ratio fell from 36% to 24%; over 2000-2001, the USD/NZD fell sharply and the proportion of USD transaction exposures rose markedly. Later in the sample, the trends in each of the series is, by contrast, strongly positively correlated although there are times when short run changes remain in the opposite direction (e.g. in early-mid 2004, when the hedge ratio rose from around 65% to 70% at a time when the USD/NZD rate had slipped from 0.692 to 0.616 over three months).

Figure 12 depicts comparable information for the AUD, while Figure 13 presents information for 'Other' currencies, plotted against the Trade-Weighted Exchange Rate Index (TWI). Similar examples of short term selective behaviour are apparent in both graphs. So too is the longer run positive correlation between hedging ratios and currency movements. These results suggest that selective hedging behaviour, if based on perceptions of currency 'opportunities', may be affected as much by short term currency changes as by longer term currency levels.

Figure 14 plots the hedge ratio for all USD-exposed transactions together with the short-term (30 day) interest rate differential (forward points) between New Zealand and the United States (FPNZUS). Figure 15 plots the comparable information for AUD-exposed transactions, where FPNZAU is the forward points against the AUD. In both cases, a normalised series for each variable is used to make the relationship scale-neutral.

A small positive relationship is apparent in each case. This relationship is consistent with New Zealand exporters increasing their hedging when forward points move further in their favour.(noting that, for most of the sample, the forward points have consistently been positive for New Zealand exporters). The correlation in the USD case is 0.39, and in the AUD case is 0.44.

VAR Modelling

We investigate the presence (or otherwise) of selective hedging more formally using unrestricted vector autoregressions (VARs). Specifically, we examine the relationship between hedge ratios (for both values and transactions) and exchange rates, subsequently adding the influence of forward points. We concentrate specifically on USD and AUD exposures.

Prior to formulating the VAR specification, we test the variables for their time series properties. Table 5 reports p-values for Augmented Dickey-Fuller (ADF) tests, with the null of a unit root, for each of the variables of interest. We treat a variable as stationary where $p<0.05$.

On these tests, both the USDNZD and AUDNZD are non-stationary, as are the USD hedge ratios. The AUD hedge ratios, by contrast, are stationary.[32] It is important only to include stationary variables in the VAR (unless a cointegration relation is present). To ensure we use stationary variables, we consider that each variable may vary around a stochastic trend that can be approximated by a Hodrick-Prescott filter[33] passed through the series. We take the cycle series (i.e. the raw series minus the HP trend series) as our measure in the VAR (each detrended series, labelled with the suffix, _CYC, is stationary). For consistency, we use the HP-filtered series for the AUD hedge ratios as well as for the non-stationary variables. It makes little difference to our results whether we use the raw or filtered series for the AUD hedge ratios.[34]

Table 5: Unit Root Tests
(1997:8 – 2006:1, monthly data)

Variable	ADF (no trend) [p-value]
usdnzd	0.798
audnzd	0.249
audhr_tra	0.000
audhr_val	0.001
usdhr_tra	0.226
usdhr_val	0.087
fpnzau	0.042
fpnzus	0.416

Definitions:
usdnzd is the USD/NZD exchange rate;
audnzd is the AUD/NZD exchange rate;
audhr_tra is the transactions-based hedge ratio for AUD exposures;
audhr_val is the value-based hedge ratio for AUD exposures;
usdhr_tra is the transactions-based hedge ratio for USD exposures;
usdhr_val is the value-based hedge ratio for ASD exposures;
fpnzau are the forward points for the NZD relative to the AUD;
fpnzus are the forward points for the NZD relative to the USD.
A variable with a _cyc suffix in subsequent analysis is the detrended series (using an HP filter).

Prior to estimating and presenting the VAR results, we outline what we may expect to find. First, in the two variable (hedge ratio and exchange rate) VAR, selective hedging will be indicated where there is a significant negative response of the hedge ratio to the exchange rate. This result would indicate exporters locking in perceived low exchange rates for their exports, while remaining unexposed when the exchange rate is perceived to be abnormally high.

Second, we test the relationships using both the transactions-based and value-based hedging ratios. The value-based ratios weight large (relative to small) exporters more heavily than in the transactions-based measure. Thus differences in large versus small exporter behaviour may be inferred from different reactions of the two hedge

[32] Forward points relative to Australia are stationary, but those relative to the US are non-stationary.
[33] The HP filter uses the standard smoothing parameter for monthly data of 14,400.
[34] Reflecting the stationarity of these series the correlation of the raw and HP-filtered series for AUDHR_TRA and AUDHR_VAL are 0.827 and 0.832 respectively.

ratio measures to exchange rates. For instance, if the value-based measure shows a stronger reaction to exchange rates than does the transactions-based measure we can infer that large exporters are more likely to engage in selective hedging behaviour.

Third, after estimating the two variable VAR, we add in forward points as a third variable. We would anticipate a positive relationship between the hedge ratios and forward points (if there is a relationship). Again the relationship may differ between the transactions-based and value based measures, indicating different behaviour of large versus small exporters.

Each VAR is estimated using three lags of each variable.[35] Once estimated, impulse response functions (IRFs) are calculated, based on each of the estimated systems.

Appendix 1 presents graphs of the effect of a one standard deviation change in the (detrended) exchange rate on the relevant hedge ratio. In each graph, the solid line depicts the estimated response; the dashed lines indicate two standard error bands (calculated analytically). We treat any relationship as 'significant' where zero sits outside the confidence bands for at least one month.

Initially we conduct the analysis for the full period, being 1997:11 – 2007:02 (we lose the initial three months due to the lag structure of the VAR). We also split the sample at the mid-point (after 2002:06) to test for changes in the relationship over time; the full period contains 112 observations, with 56 observations in each sub-period.

Figure A1 in the Appendix indicates that for the full period, the value-based hedging ratio for AUD exposures (*audhr_val_cyc*) responds significantly to the AUDNZD exchange rate (*audnzd_cyc*). The maximum response occurs three months following an exchange rate change, possibly reflecting the hedging horizon of exporters; i.e. hedging decisions are made three months prior to the export transaction (which appears intuitively reasonable).

When transactions are used as the measure (Figure A2), a similar relationship, albeit shallower and with longer lags (and not quite significant) is obtained. The differences between the two suggest that larger exporters are both quicker at responding to perceived exchange rate misalignments (between the NZD and AUD) and respond more aggressively than do smaller exporters.

Figures A3 and A4 plot the corresponding IRFs for USD exposures. The value-based measure shows a similar, but insignificant, pattern to the AUD results, but the transactions-based measure shows no clear direction of response (at least over the initial months). The descriptive graphs suggest that hedging behaviour, especially for USD exposures, may have changed between the first and second halves of the sample. We examine this possibility by presenting the results for the value-based hedging measure for the two sample halves.[36]

[35] Initial testing showed longer lags were not significant in the equations, but up to three lags on the dependent variable were, at times, significant. No concurrent terms are included as explanatory variables.

[36] Transactions-based measures are omitted for brevity; they are consistent with the value based measures, but, as with the full sample, are less significant.

The first half-sample results for AUD and USD exposures are presented as Figures A5 and A6 respectively. Figures A7 and A8 present the second half-sample IRFs. Over the first half of the sample, both the AUD and USD responses are significantly negative, with both responses peaking three months after the exchange rate change. In the second half of the sample, the AUD response is again significant (peaking after two months), but the USD response (which is now slightly positive) is well within the confidence bounds around zero. Together, these results indicate that exporters with AUD exposures continue to adopt selective hedging positions, but those with USD exposures no longer do so in a material fashion.

One possible criticism of our exchange rate measure is that the HP filter uses actual future values of the rate in calculating the trend and cycle series. We test the robustness of our results by calculating backward looking measures of exchange rate misalignment. Specifically we subtract from each exchange rate the lagged one year mean, three year mean, five year mean and ten year mean respectively of that exchange rate. These rates are denoted *aud1, aud3, aud5*, *aud10, usd1, usd3, usd5* and *usd10*. For instance, in period 2003:1, *aud1* equals AUD/NZD in 2003:1 less the mean value of AUD/NZD over the twelve months from 2002:1 to 2002:12.

The previous results are robust to using these backward-looking measures. Figures A9 - A12 present the IRFs for AUD value-based hedge ratios to AUDNZD shocks, using each of the four backward-looking measures for the full period. The significance and shape of the responses is very similar throughout. The strongest relationship is obtained using the three year lag. Figures A13 – A16 present the IRFs for the USD value-based hedge ratios to shocks to USDNZD shocks, using each of the four backward-looking measures. We present these results just for the first half-sample consistent with the prior finding that USD selective hedging was not apparent in the second half-sample. The significance and shape of the responses is again very similar throughout. The strongest relationships in this case are obtained using the longer lags (five and ten years).[37]

The difference in backward-looking lag structure between the AUD and USD may reflect the differing time series properties of the two exchange rates. As shown in Figures 11 and 12, deviations of USDNZD from its sample mean are much larger and longer than is the case with AUDNZD. (This is reflected also in Table 5, where the unit root is rejected at p=0.249 for AUDNZD compared with p=0.798 for USDNZD.) Selective hedgers may therefore consider that if cycles are mean-reverting, the adjustment is much faster for the AUDNZD than for the USDNZD.

Hitherto, we have not considered forward points explicitly in the analysis. We have experimented with including the forward points measures in the VAR specifications (with alternative exchange rate measures). However in no case (whether expressed as raw or filtered data) is the forward points effect remotely significant for either currency. This is despite the moderate univariate positive correlations reported above. For instance, Figure A17 presents the full period response of the AUD value-based hedge ratio to forward points (*fpnzau*). The lack of response to forward points

[37] Results for other samples in all cases reflect the HP filtered results and so are not reproduced here.

implies that any forward points effect on hedging is correlated with, and swamped by, the effect of the exchange rate cycle on exporters' behaviour.

Does Selective Hedging Work?
Finally, we examine whether selective hedging reflects an ability on the part of exporters who adopt the practice to predict exchange rate movements. Specifically we examine whether variations in the hedge ratio from its trend value "predicts" future exchange rate changes. To do so, we estimate the following regression for each hedge ratio and currency, for the full sample and for each split-sample period:

$$\Delta\log(ER_t) = \beta_0 + \beta_1 * HEDGE_{t-1} + \beta_2 * HEDGE_{t-2} + \beta_3 * HEDGE_{t-3} + \varepsilon_t \quad (1)$$

where ER is variously AUDNZD and USDNZD; and HEDGE is variously *audhr_tra_cyc, audhr_val_cyc, usdhr_tra_cyc, usdhr_val_cyc.*

For each regression, we test the joint significance of β_1, β_2 and β_3 (using the equation F-statistic with the null hypothesis: $\beta_1=\beta_2=\beta_3=0$). Note, that unlike the VAR specification or a Granger causality test, we do not include lagged exchange rates in (1). The reason is that we are testing whether exporters benefit by selective hedging, not whether the hedge ratio predicts future exchange rate changes over and above what can be explained by past changes. Indeed, if past exchange rate changes help to predict future exchange rate changes, selective hedging may be a profitable strategy.

Table 6: Tests of Selective Hedging Success

Variables & Sample	**Sign of Σβ**	**p-values**				**Adj. R^2**
		β_1	**β_2**	**β_3**	**F**	
Full Period						
AUD						
audhr_tra_cyc	+	0.909	0.186	0.942	0.278	0.008
audhr_val_cyc	+	0.593	0.305	0.910	0.291	0.007
USD						
usdhr_tra_cyc	-	0.877	0.088	0.386	0.101	0.030
usdhr_val_cyc	-	0.889	0.023	0.077	0.036	0.050
1st Half						
AUD						
audhr_tra_cyc	+	0.787	0.135	0.755	0.265	0.019
audhr_val_cyc	+	0.716	0.297	0.852	0.408	-0.001
USD						
usdhr_tra_cyc	-	0.963	0.223	0.475	0.345	0.007
usdhr_val_cyc	-	0.912	0.037	0.078	0.073	0.074
2nd Half						
AUD						
audhr_tra_cyc	+	0.444	0.996	0.847	0.770	-0.035
audhr_val_cyc	+	0.631	0.815	0.855	0.766	-0.035
USD						
usdhr_tra_cyc	-	0.361	0.111	0.452	0.243	0.023
usdhr_val_cyc	-	0.704	0.502	0.899	0.796	-0.037

Table 6 presents the sign of the sum of the β coefficients which should be positive if selective hedging is a profitable strategy. We also present the p-values for the t-tests on the individual β coefficients and for the F-test for the combined effect of the βs; the Adjusted R^2 is presented as a measure of explanatory power of the hedge ratio for future exchange rate changes. Results are presented for the full sample and for the two sample halves.

The results in Table 6 indicate unambiguously that selective hedging has not been successfully practiced by New Zealand exporters as a whole. The only significant t-statistics and F-statistics have the wrong sign for the variables in question. In these cases, on average, hedging has risen (fallen) just prior to an exchange rate fall (rise). In all other cases, no significant relationship is obtained. Explanatory power of the equation (Adj. R^2) is uniformally low (and often negative), with the highest value for an equation having the correctly signed variables being 0.019. These results are robust across samples, across hedge ratio measures and across currencies.

7. Conclusions

Modern approaches to hedging indicate that, contrary to the Modigliani-Miller theorem, hedging may be optimal for a firm faced with one or more market imperfections. These include costs of financial distress, underinvestment risks due to differences in cost and availability of internal versus external finance, economies of scale, taxation convexities, managerial risk aversion, information asymmetry and governance and managerial incentive-related factors. A considerable body of evidence exists to test these rationales for optimal hedging activity. Some evidence relates to use of hedging instruments in general, and some is specific to the hedging of particular exposures, including currency exposures.

Another, mostly recent, body of literature addresses the issue of selective hedging. This occurs when firms choose to hedge a certain class of exposure at some times but not others, with the hedging decision being based on perceptions of future price movements. Selective hedging may be a profitable strategy in cases where the firm has superior information relative to the market in the relevant field. Examples that have been examined internationally include firms operating in specific commodity markets such as gold and oil/gas.

Other recent studies (Glaum, 2000, 2002; Brookes et al, 2000) suggest that non-financial firms also undertake selective hedging in deeply-traded financial markets, including currency and interest rate markets. It is not apparent that such firms have any information comparative advantage in these markets. However existing evidence on these activities is sparse at best. Furthermore, almost all evidence on both optimal and selective hedging exists only for large, generally listed, firms. In every country, these are a minority of firms.

Our study uses a unique information source to address these and a range of related issues. Our primary data source is the New Zealand Customs database for merchandise trade. The data cover all exports on a daily basis diaggregated by commodity, currency and destination for all merchandise exporters. Furthermore, we can link the firms in this dataset directly to information derived from taxation and

official survey data. All such data have been obtained on a confidentialised basis so that we are not aware of the identity of any firm.

For this study, we have aggregated all data derived from the Customs database to monthly frequency and have aggregated across exporters, again to ensure confidentiality. We present a number of descriptive statistics obtained from the data. These include statistics relating to currency of denomination of New Zealand exports, both overall and to certain markets.

A majority of exports are denominated in NZD. Of the foreign currency transactions, the largest proportion is denominated in USD with AUD being the next largest currency of denomination. The proportion of non-NZD transactions that is hedged changes over time. The proportion is both variable over short time-spans and, especially in the case of USD exposures, has increased over time. Hedging appears to be for short periods, although we cannot ascertain whether this reflects roll-overs in hedging positions.

Considerable differences emerge in hedging behaviour across different sectors. In a dynamic sense, we find that the Agriculture and Forestry sectors have positively correlated hedge ratios, as do Mining and Manufacturing firms. We do not have a theory to explain why these particular patterns exist. Large (upper quartile) firms hedge to the greatest degree but, perhaps surprisingly, small (lower quartile) firms are the next most comprehensive hedgers. Intermediate-sized firms (by sales) hedge a lower proportion of currency exposures than either large or small firms. This may reflect a non-linearity in the underlying forces affecting optimal hedging behaviour including scale (favouring hedging by large firms) and costs of financial distress (potentially favouring hedging by small firms). The relationship between hedging and export intensity is, however, monotonic, with hedging ratios increasing as export intensity increases.

We find strong evidence of selective hedging, particularly for AUD exposures. Hedge ratios are consistently negatively related throughout the sample to the value of the AUDNZD, consistent with exporters locking in perceived low exchange rates across the whole sample (1997 – 2007) for AUD exposures. The same behaviour is observed over the first half of the sample for USD exposures, but not over the second half of the sample (2002 onwards). Our results imply that selective hedging is more pronounced for large exporters than small exporters. The difference in selective hedging between AUD and USD exposures over the latter half of the sample may reflect the behaviour of the two exchange rates. The AUDNZD has moved within a much smaller band, and with a greater reversion to the mean, than has the USDNZD. This may have encouraged firms to believe that they can predict future movements of the NZDAUD with some accuracy whereas this is not the case with the more volatile USDNZD.

The other factor that we hypothesise may have driven selective hedging decisions, are the forward points (i.e. differences in short-term interest rates between New Zealand and the other respective country). However we find no evidence that changes in forward points alter hedging decisions.

We test whether selective hedging is a positive feature of firms' exchange rate management by testing whether hedging ratios anticipate future currency movements. We find no evidence that such behaviour is positive for firms. Specifically there is no explanatory power of hedging practices for future exchange rate changes, whether in the AUDNZD or USDNZD. This result is robust across sample periods and across alternative measures of hedging that weight small and large exporters differently.

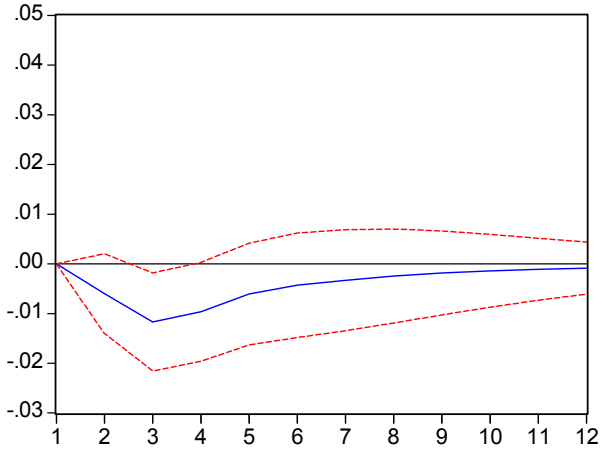
Overall, our selective hedging results are consistent with those of Brown et al (2006) for the gold industry; i.e. that firms engage in selective hedging but such behaviour does not add to their performance. What is unique about our results compared with others is that we cover the universe of merchandise exporting firms for a country. Thus we include the behaviour of both large and small firms across the entire range of goods-producing sectors.

Our findings on the lack of selective hedging success fit with those of Glaum (2002) and relate to the theory of speculative hedging advanced by Stulz (1996). Exporters are not successful in improving their results through the practice of selective currency hedging since they do not have superior knowledge of future currency movements relative to the market as a whole. This leaves open the question of why firms undertake selective hedging in the currency market, given that costs must be increased by having to make tactical currency hedging decisions. We leave analysis of this as an open question that may be addressed with reference to the unit record data available in the new longitudinal LFPD dataset.

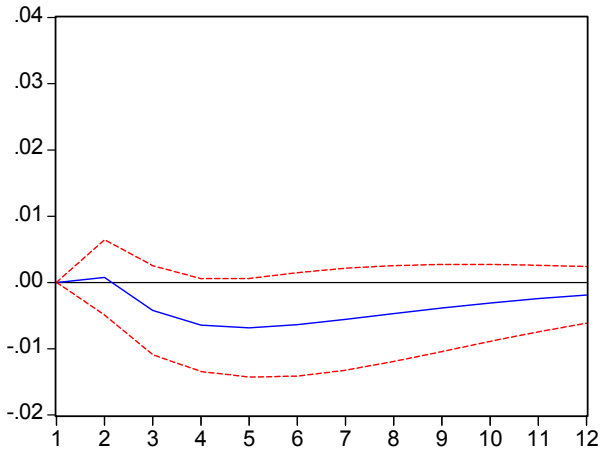
APPENDIX 1: VAR Impulse Response Functions (to 1 Std Dev Shocks)

Full period (1997:11-2007:02)

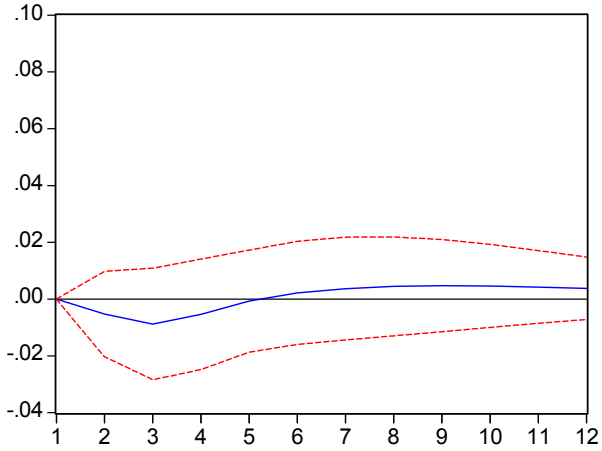
A1. audhr_val_cyc to audnzd_cyc



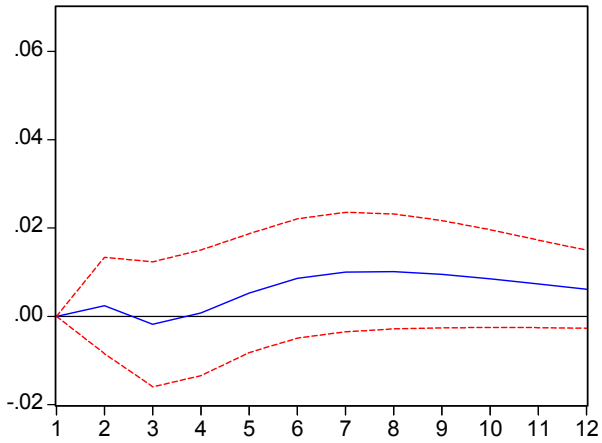
A2. Reaction of audhr_tra_cyc to audnzd_cyc



A3. Reaction of usdhr_val_cyc to usdnzd_cyc

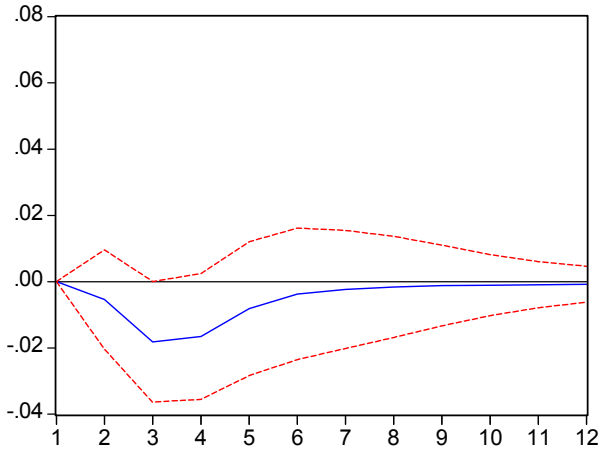


A4. Reaction of usdhr_tra_cyc to usdnzd_cyc

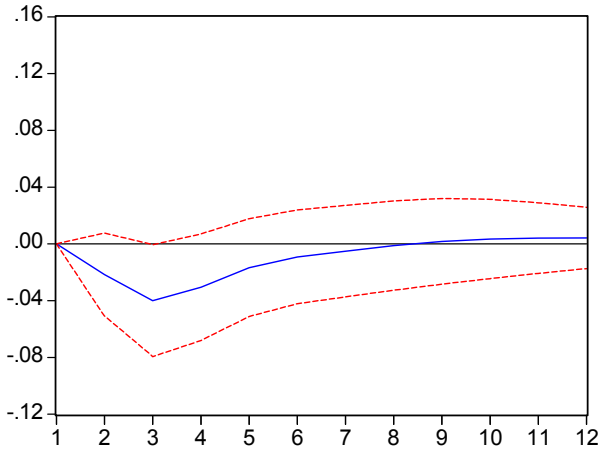


First half period (1997:11 – 2002:06)

A5. Response of audhr_val_cyc to audnzd_cyc

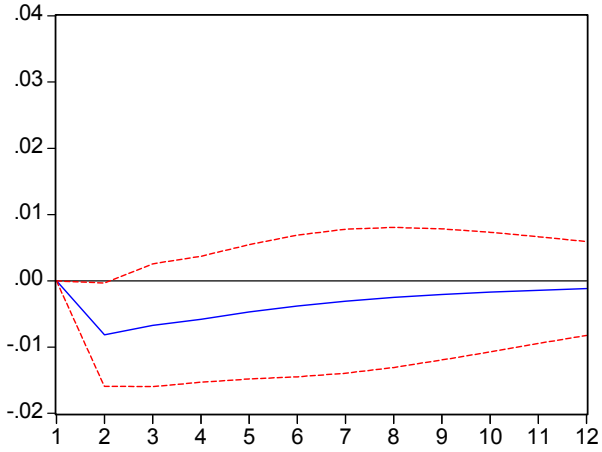


A6. Response of usdhr_val_cyc to usdnzd_cyc

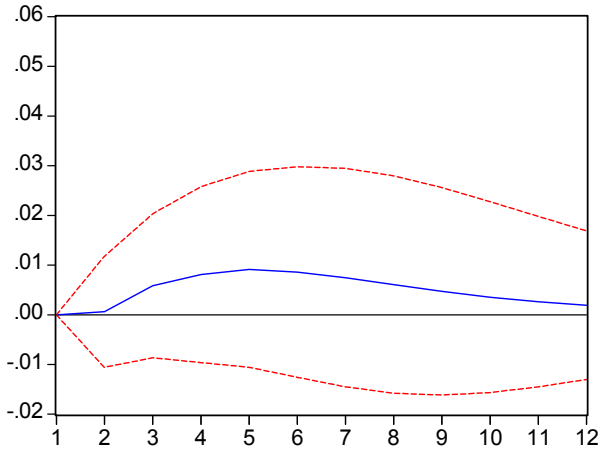


Second half period (2002:07 – 2007:02)

A7. Response of audhr_val_cyc to audnzd_cyc

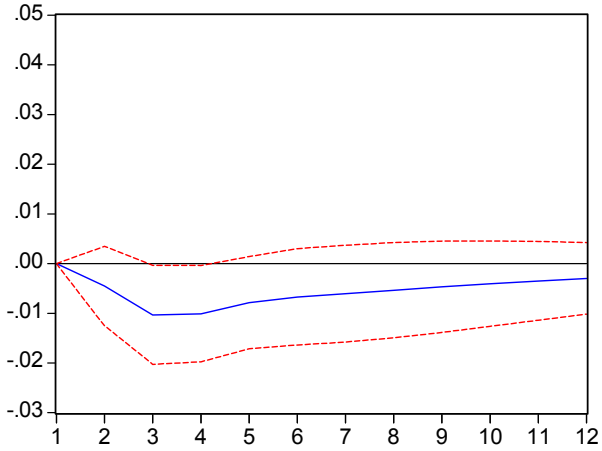


A8. Response of usdhr_val_cyc to usdnzd_cyc

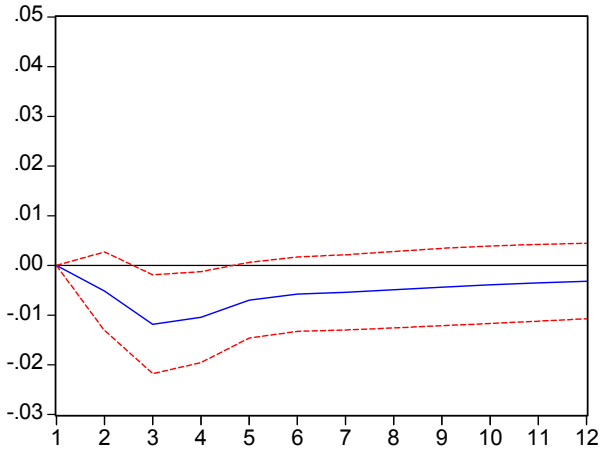


Full period (1997:11-2007:02) Alternative Exchange Rate Measures

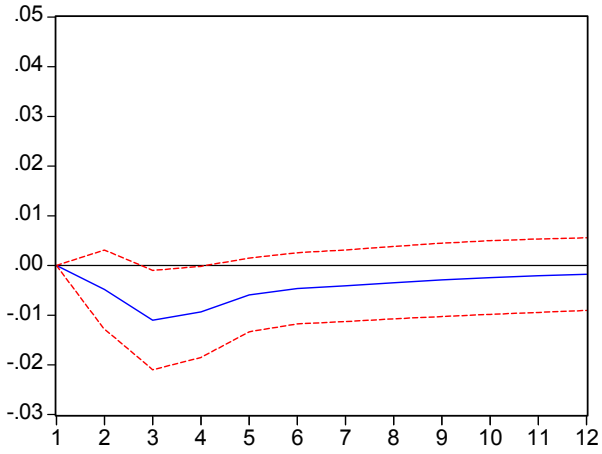
A9. Response of audhr_val_cyc to aud1



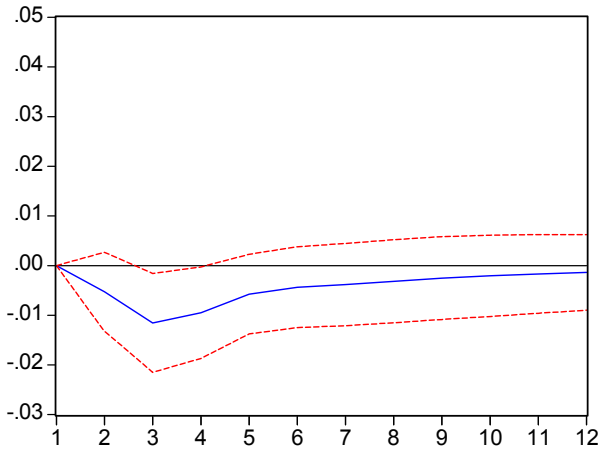
A10. Response of audhr_val_cyc to aud3



A11. Response of audhr_val_cyc to aud5

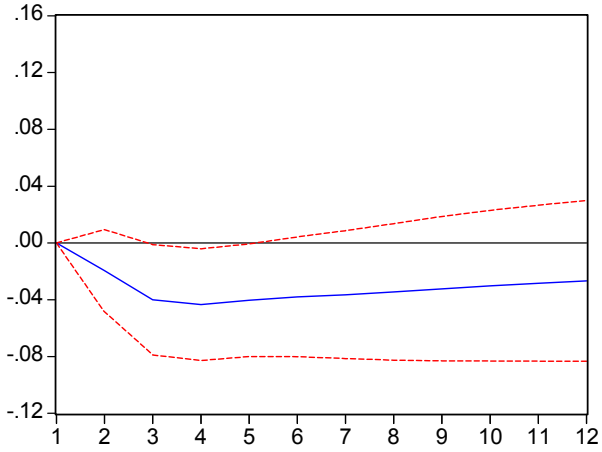


A12. Response of audhr_val_cyc to aud10

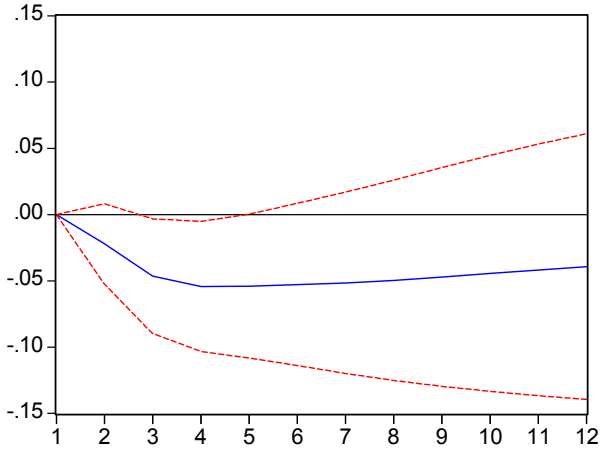


First half period (1997:11 – 2002:06)

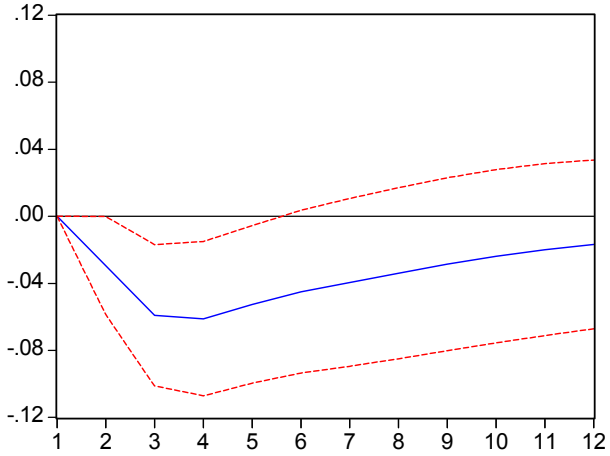
A13. Response of usdhr_val_cyc to usd1



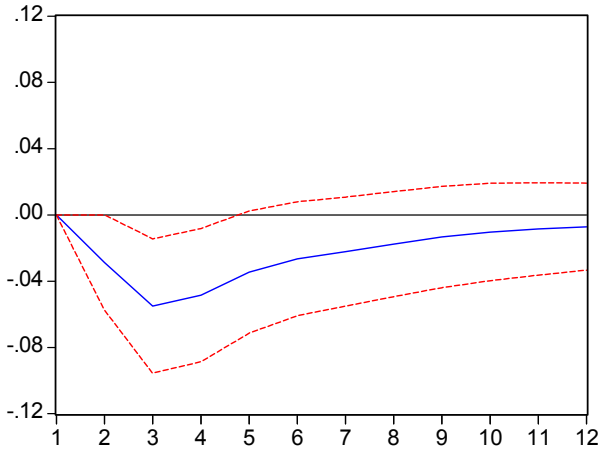
A14. Response of usdhr_val_cyc to usd3



A15. Response of usdhr_val_cyc to usd5



A16. Response of usdhr_val_cyc to usd10



Full period (1997:11-2007:02) Forward Points Effect

A17. Response of audhr_val_cyc to fpnzau

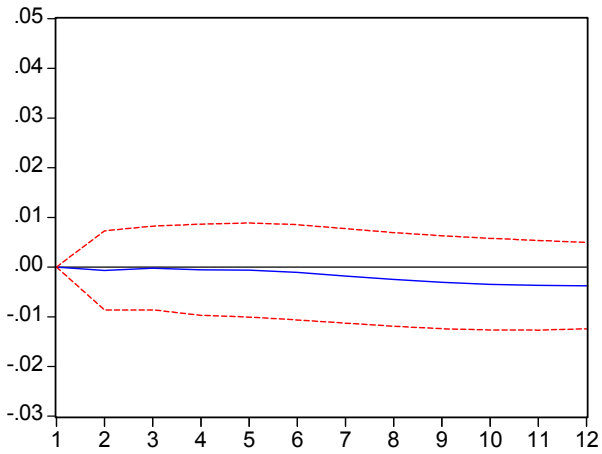


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Figure 1

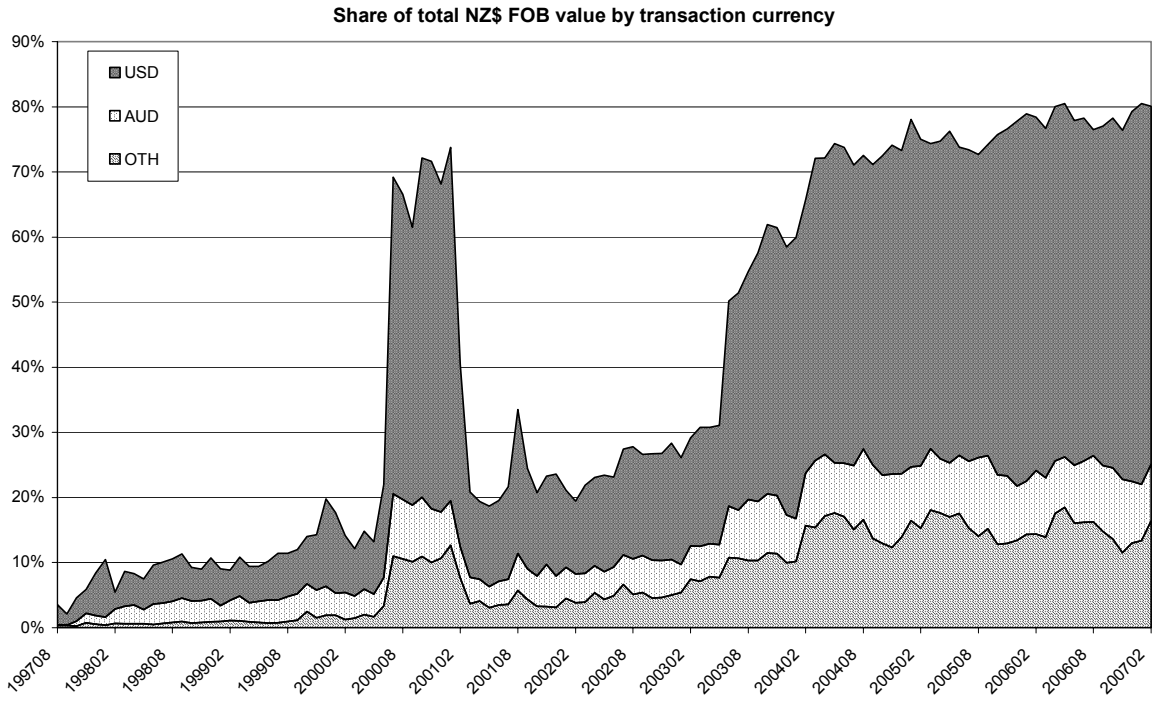


Figure 2

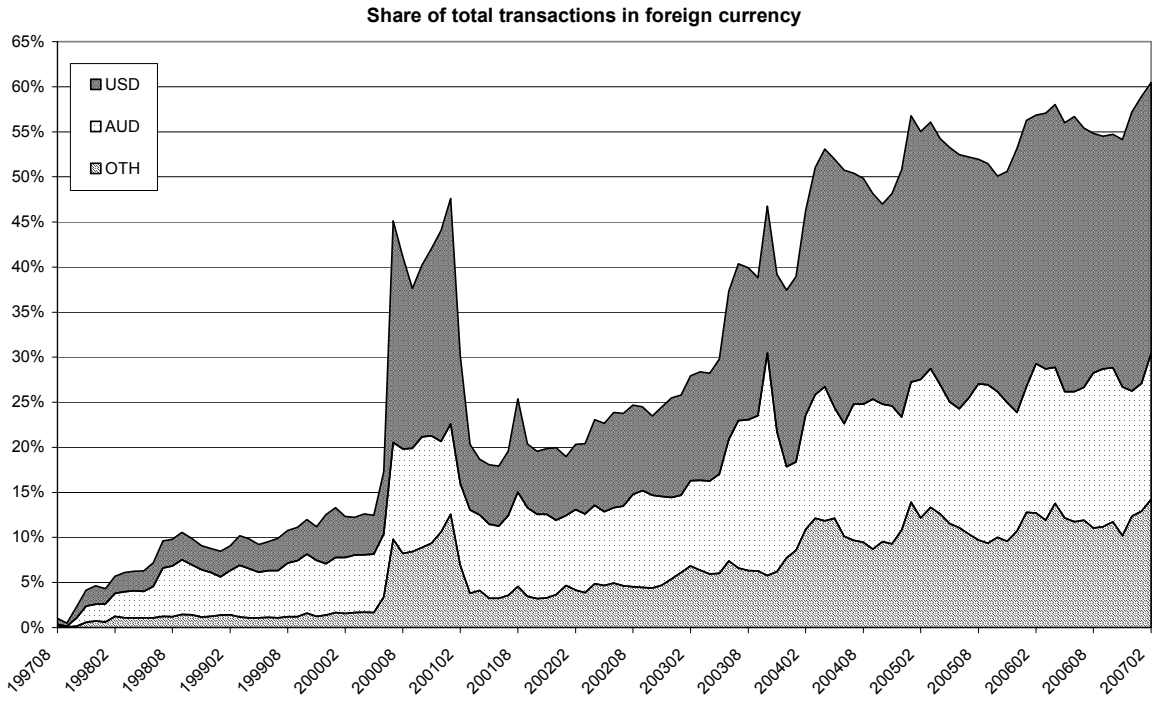


Figure 3: Currency of Denomination by Destination (Sample Average)

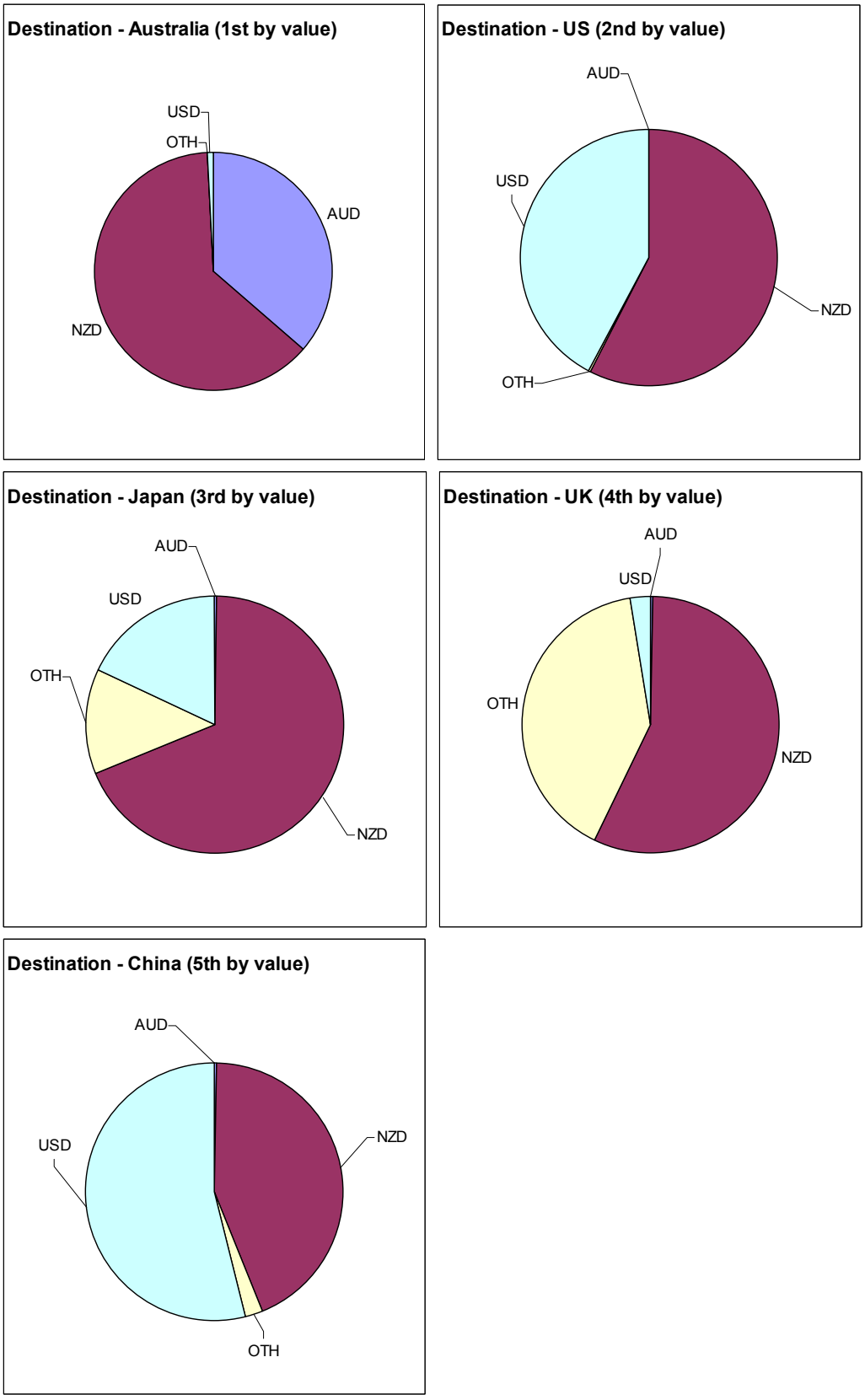


Figure 4

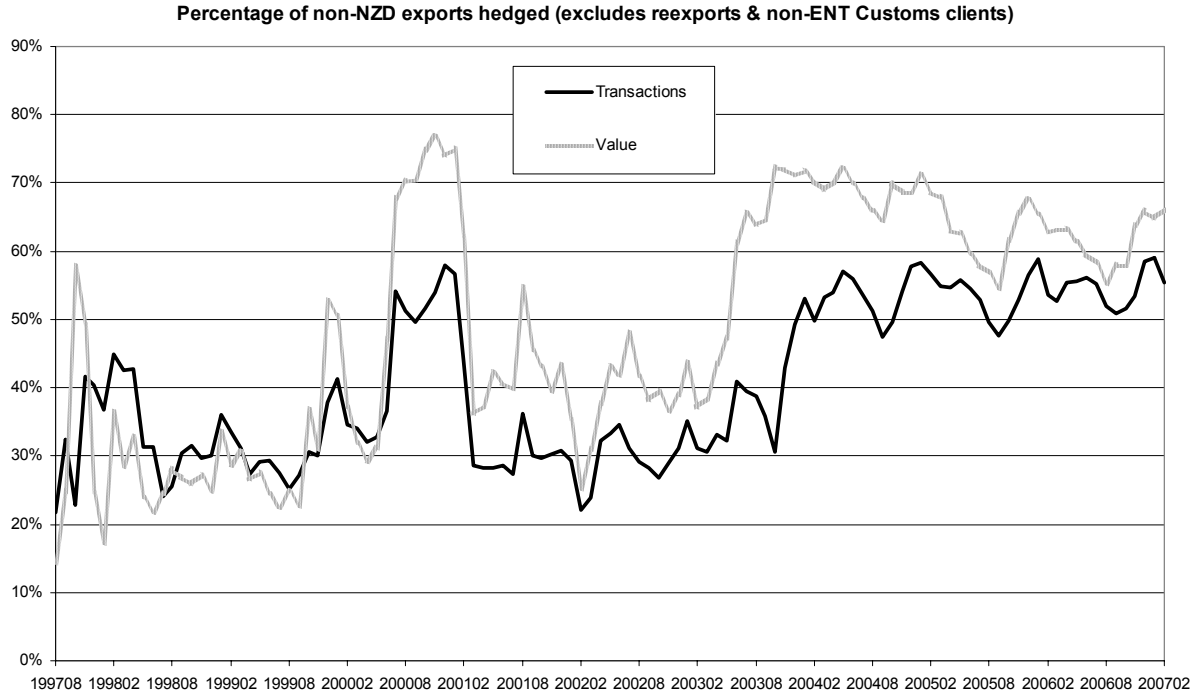


Figure 5

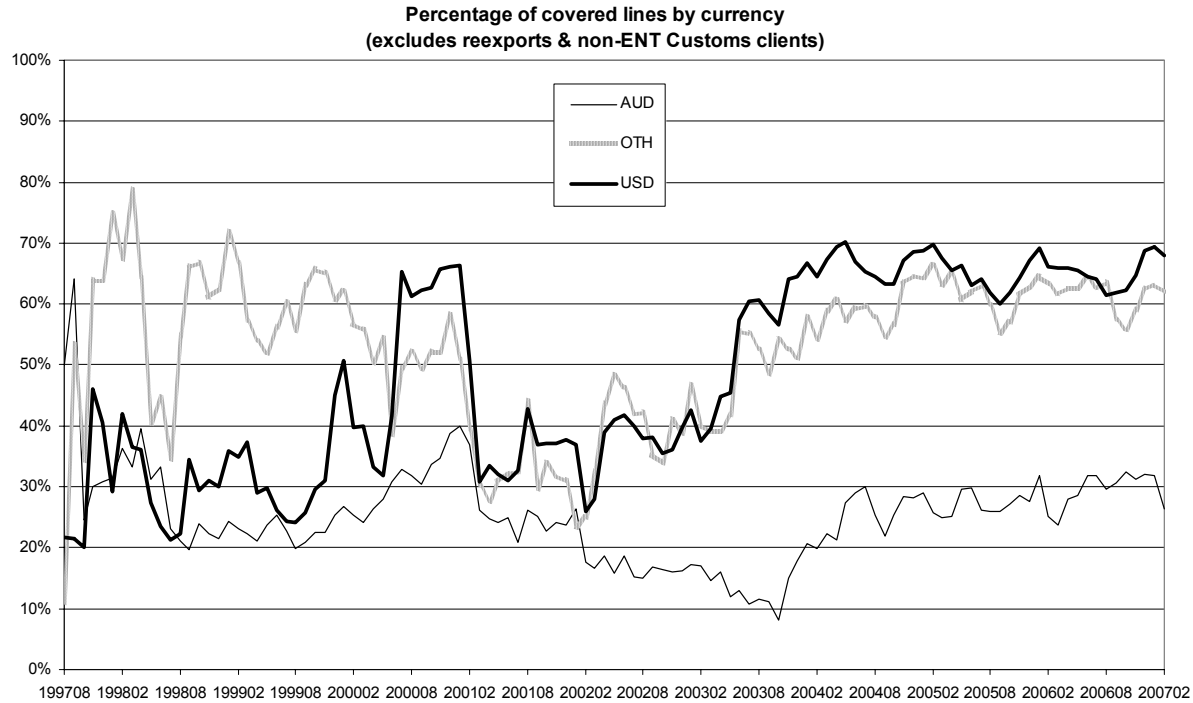
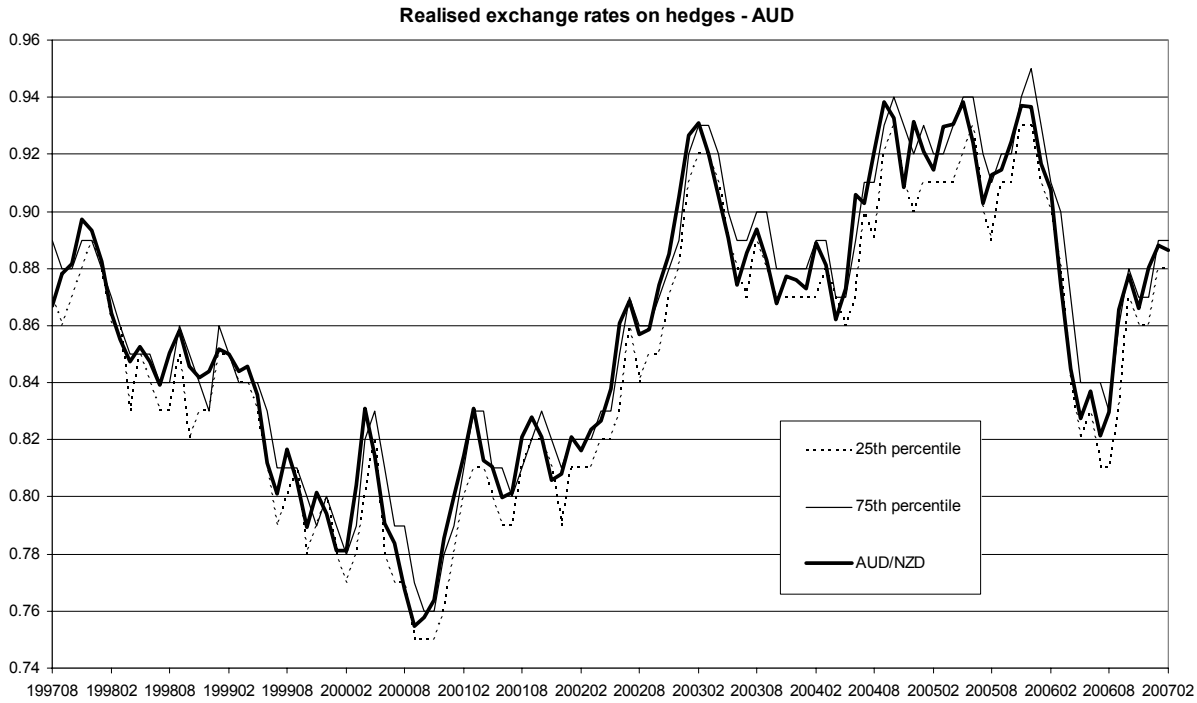


Figure 6



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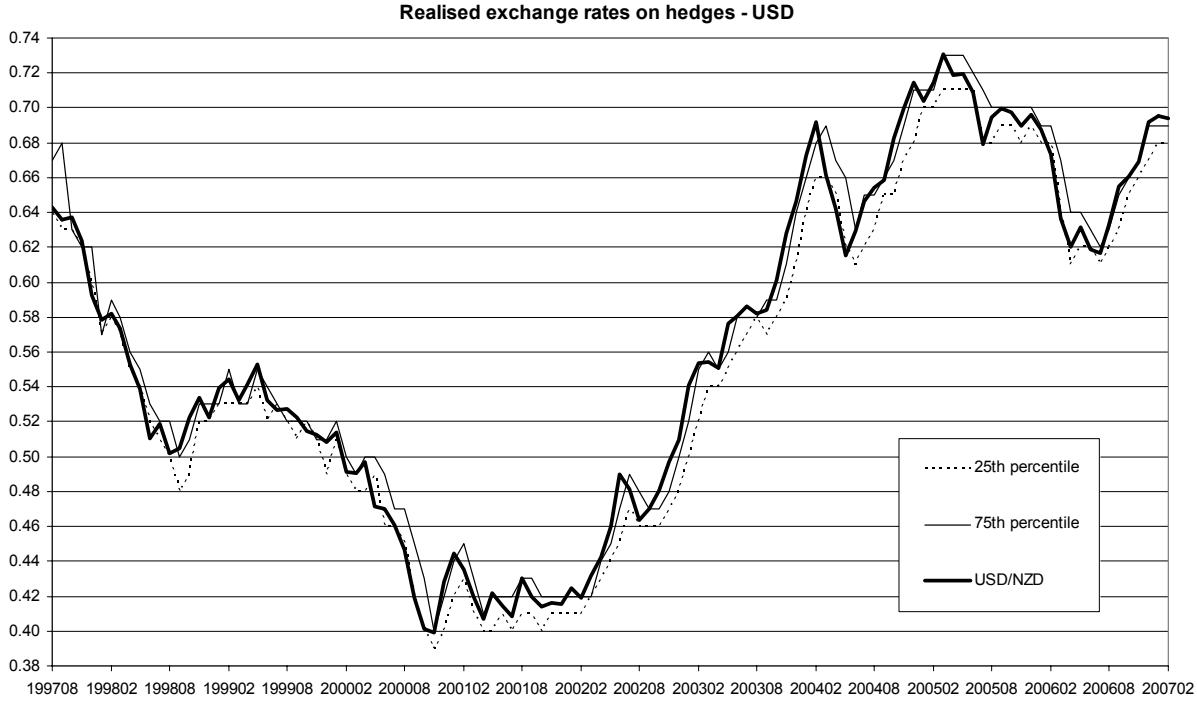

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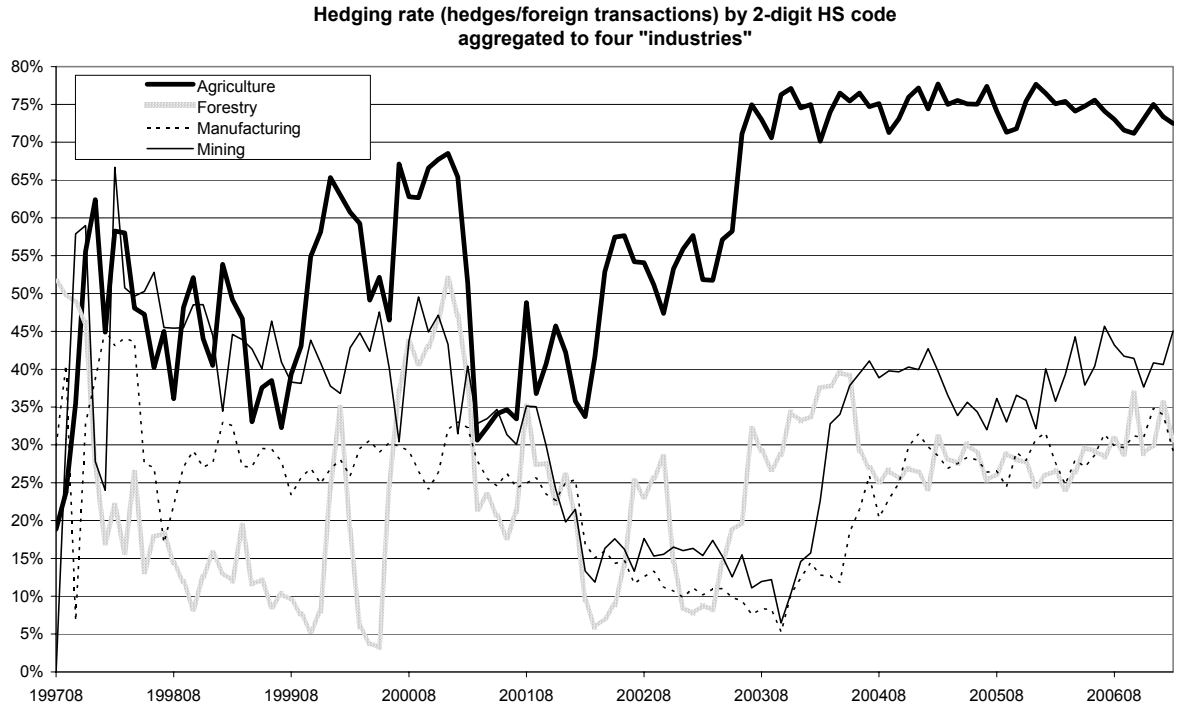


Figure 9

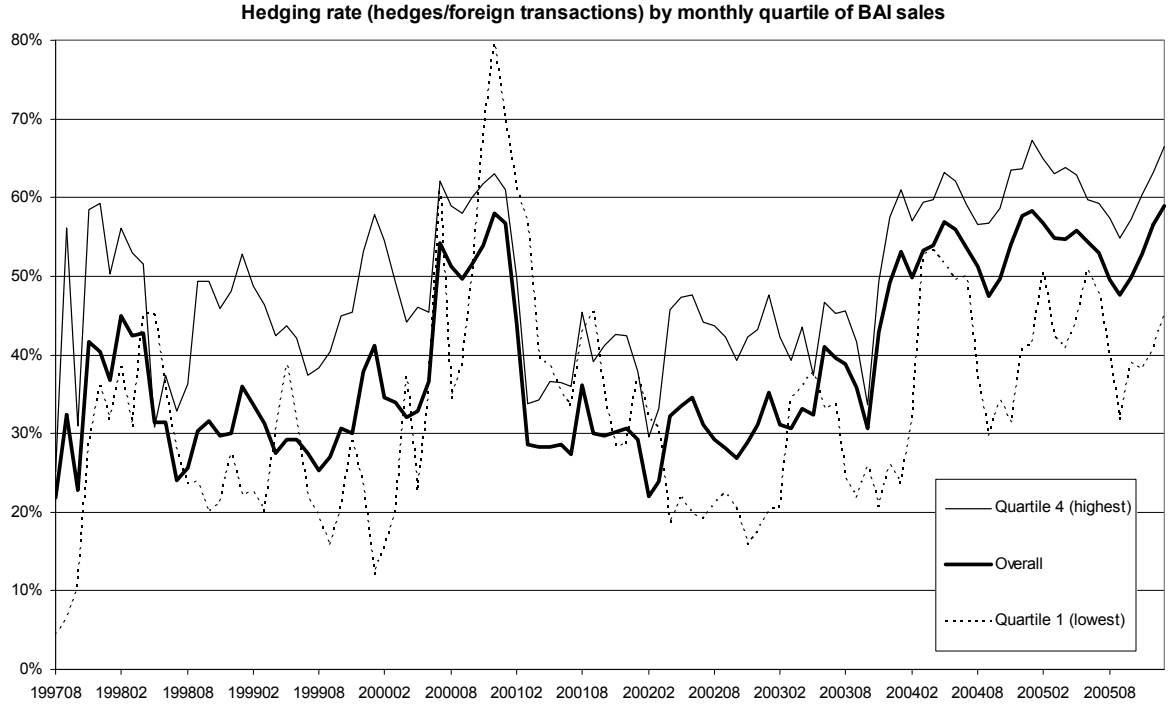
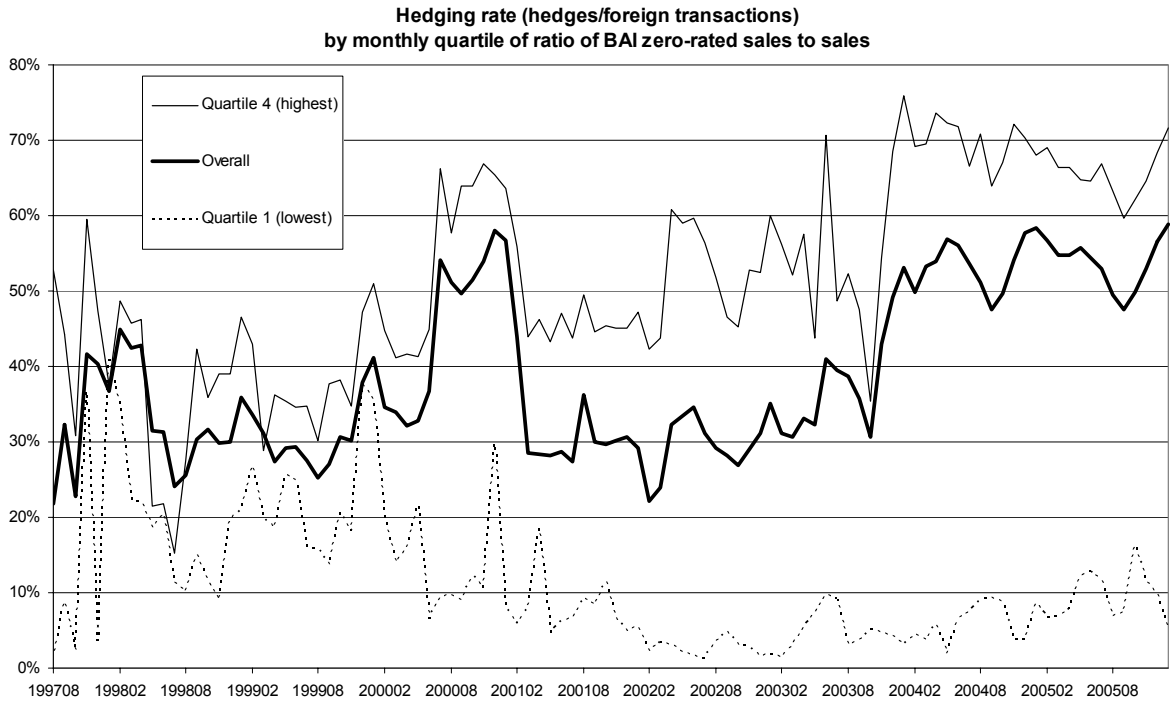


Figure 10



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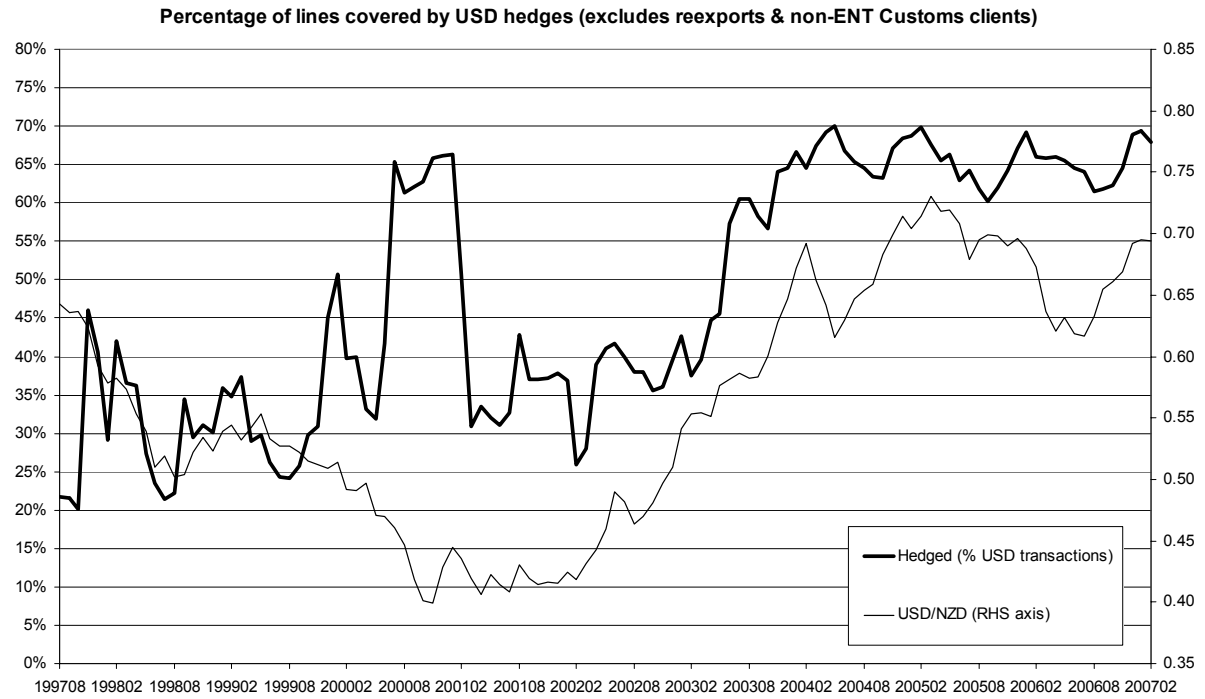

Figure 12

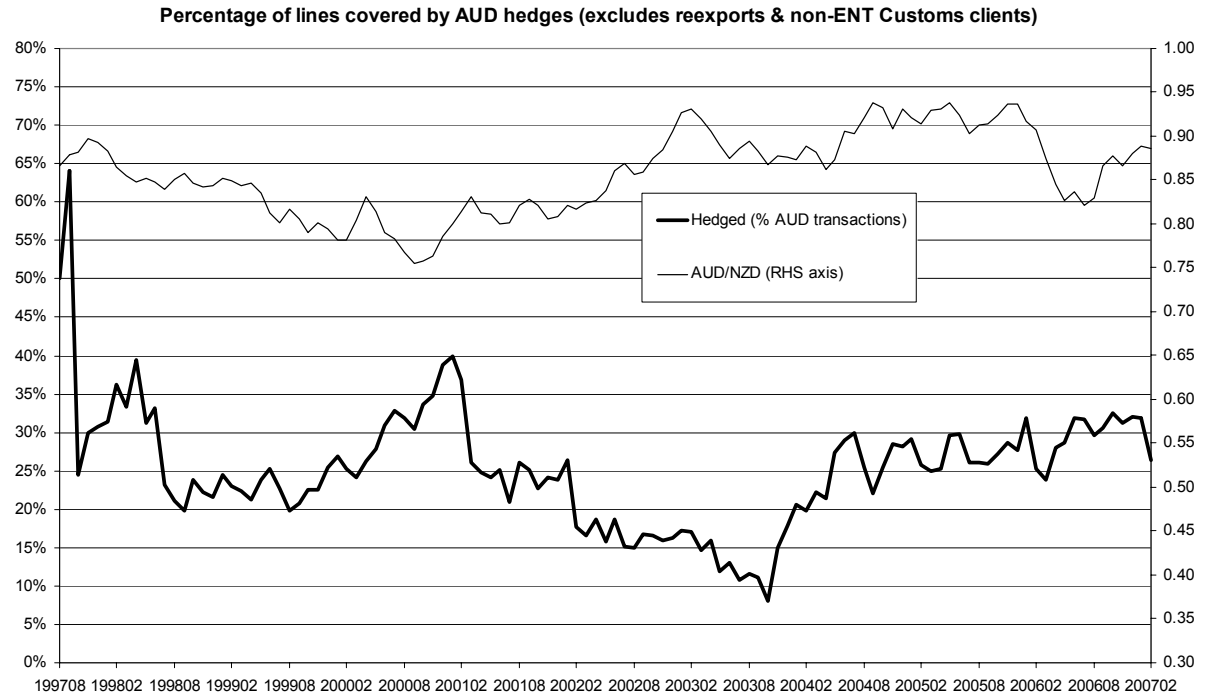

Figure 13

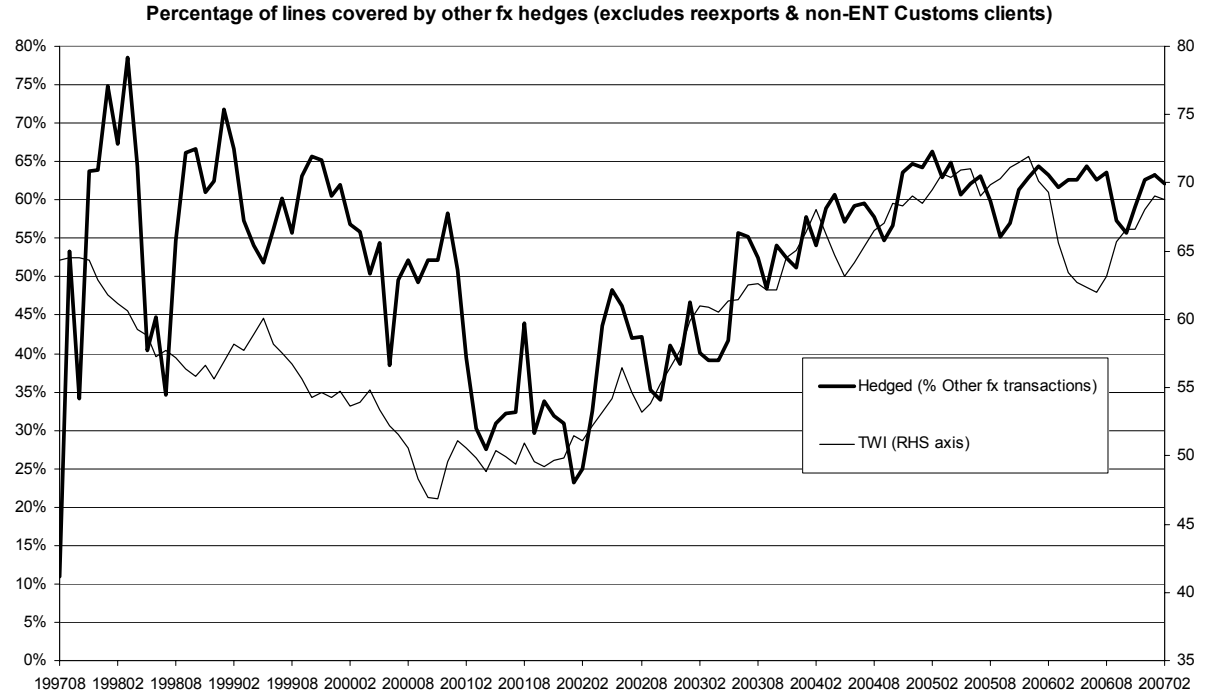

Figure 14

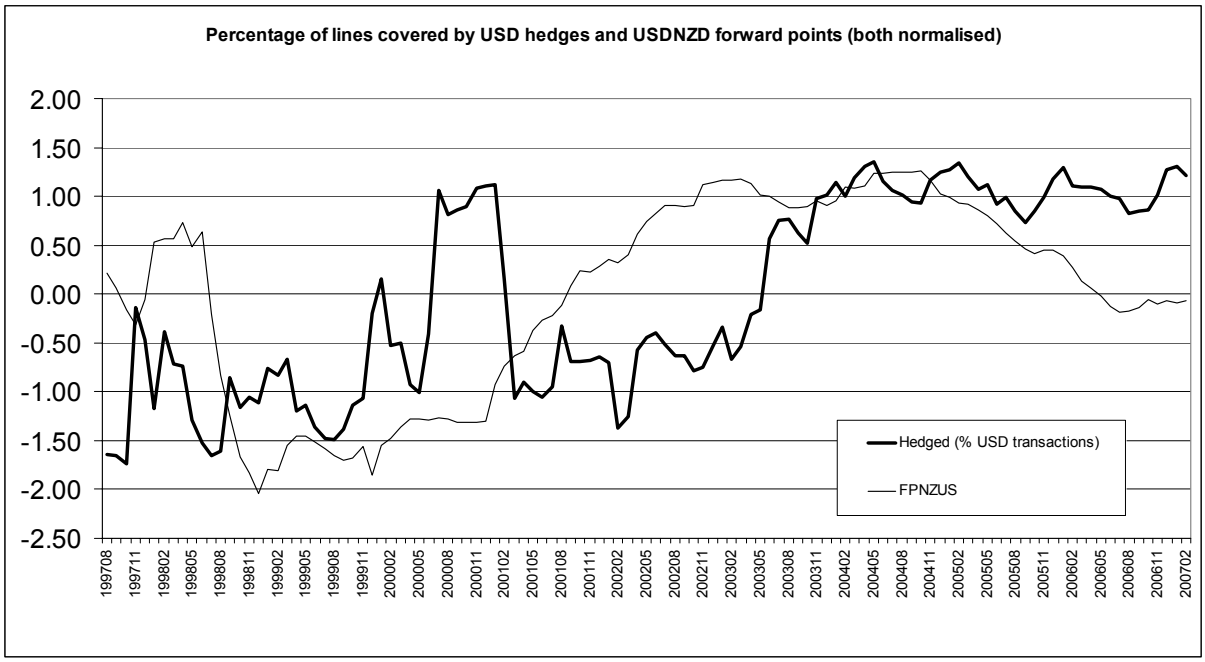

Figure 15