



Exchange rate exposures of US banks: A cash flow-based methodology

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Abstract

Using a cash flow-based framework, we decompose exchange rate exposure into short-term and long-term elements for 105 individual US banks over 1988–1998. We show that significant long-term exposure is more prevalent than significant short-term exposure, reflecting the difficulty in recognizing, modeling, and managing the longer-term effects of exchange rate risk. Our analyses reveal that 72% of internationally oriented and 88% of domestically oriented banks in the sample have significant exposure to at least one of five currency pairs. This result supports the theory that domestic banks are exposed and should be concerned about the indirect impact of exchange rate risk. Furthermore, we provide some evidence that economies of scale may exist for institutions with extensive international operations.

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1. Introduction

Understanding the dimensions of risk is an inherent part of banking, and an area of the highest importance to bankers, regulators, and policy makers. This emphasis was underscored by the adoption of the Basle Accord in 1988, which linked the capital requirements of banks to asset risk categories and to off-balance-sheet

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obligations. The 1997 Market Risk Amendment to the Accord allows banks to use internally developed risk management systems; banks tailor such systems to their specific business structure and strategies. Risk management systems are now in place in most large US banks (e.g., Hendricks and Hirtle, 1997; Crouhy et al., 2000).

Complementing these developments over the past 10 years has been an academic literature in finance, which has sought to identify the sources of risk for banks. Among the risk sources examined, exchange rate risk is one of the most prominent. Most authors have assessed the impact of foreign exchange risk on bank stock returns using multifactor models (e.g., Choi et al., 1992; Wetmore and Brick, 1994; Chamberlain et al., 1997; Choi and Elyasiani, 1997; Elyasiani and Mansur, 1999). The approaches in these studies broaden the CAPM-based market model by including an exchange rate factor to examine whether returns are sensitive to the exchange rate risk dimension.

In contrast to previous work, we follow a methodology that focuses on the cash flow impact of the exchange rate risk of US banks. This methodology identifies banks that have exposures to exchange rates against the US dollar and allows for an assessment of the existence and relative importance of short-term and long-term exposures. Understanding the nature of the exposure of cash flows is important since hedging strategies and risk management models are likely to differ for each bank, depending on specific bank exposures. We find that this methodology is useful in understanding bank exchange rate exposures. The cash flow concept we use in this paper is operating income before depreciation and exchange rate gains and losses. Operating income is an indicator of bank credit standing or “soundness”. This in turn has bank management implications across such issue areas as liquidity and funds sourcing, as indicated by the CAMELS system currently used by bank examiners. Within this framework, we find that long-term exposure is more prevalent than short-term exposure among the US banks in the study, reflecting the difficulty in identifying and managing the longer-term effects of exchange rate risk. The pervasiveness of longer-term currency exposures may indicate the need to increase the focus on modeling these exposures within risk management systems.

Based on the potential direct and indirect effects of exchange rate risk on cash flows (e.g., Chamberlain et al., 1997), we argue that not only international but also domestic banks may be significantly exposed. Our analyses reveal that 72% of the internationally oriented banks in the sample have significant exposure to at least one of five major currency pairs, while 88% of domestically oriented banks have significant exposure to at least one of the currencies. These rather high proportions suggest that even domestic banks should adapt their risk management systems to better understand the cash flow consequences of their indirect currency exposures.

Previous studies have examined the exchange rate exposure of money center, super-regional and regional banks (e.g., Wetmore and Brick, 1994; Choi and Elyasiani, 1997), but none have explicitly categorized banks according to the extent of international banking activities. To investigate the possibility of economies of scale in exposure management, we classify the banks according to the extent of international banking activities and according to asset size. The classification based on the extent of international banking activities appears to be useful. We find that the frequency of

exposure for internationally oriented banks in the sample is significantly less than the frequency of exposure for the domestically oriented banks for some currency pairs. This result is consistent with the belief that economies of scale or scope occur in foreign exchange exposure management. Institutions with the greatest extent of international activity are likely to be more aware of the potential for such exposures and are likely to have greater experience in foreign exchange risk management.

The organization of the remainder of this paper is as follows. In the next section, we discuss the effects of exchange rate risk with emphasis on possible sources of direct and indirect effects, short-term and long-term effects, and economies of scale in managing the exposures. Based on these perspectives, we develop our testable hypotheses. Subsequently, we describe the sample, data, and methodology used in this study. We then present the empirical results and conclude the paper with a summary.

2. Perspectives on exchange rate exposure of banks

2.1. Direct and indirect exposures

The impact of exchange rate risk on cash flows of banks is directly influenced by foreign currency-denominated asset and liability structures, off-balance sheet exposures, and non-asset-based services. In addition, a less obvious source of exposure arises when exchange rate movements *indirectly* affect the cash flows of banks by directly affecting the cash flows of bank customers, competitors, and funds suppliers. Chamberlain et al. (1997) also recognize that banks may experience such indirect effects.

Banks are generally regarded as domestic if they do not have direct foreign currency involvement. Yet, domestic banks as well as international banks might have exposure indirectly through the exposures of their customers, competitors, and funds suppliers. Many articles theoretically present (e.g., Hodder, 1982; Choi, 1986) and conceptually acknowledge (e.g., Wentz, 1979; Jacque, 1981; Lessard and Lightstone, 1986; Jorion, 1990) the exposure of domestic firms. International finance textbooks also routinely discuss the exposure of domestic firms (e.g., Eiteman et al., 1998; Eng et al., 1998; Madura, 2000). For example, Madura (2000, p. 276) states, “Since creditors could experience large loan losses if the MNCs that were granted loans experienced financial problems, they may prefer that the MNCs maintain low exposure to exchange rate risk”. Furthermore, domestic banks are frequently less aware of the importance of currency exposures and less prepared organizationally to take steps to measure and manage these exposures. As a result, domestic banks can have significant exchange rate exposures.

2.2. Long-term and short-term exposures

From direct and indirect sources, exposures can generate both longer-term and short-term impacts. Direct long-term exposures may occur in the following areas: Bank lending and leasing portfolios; held-to-maturity investments; and off-balance

sheet obligations, such as medium-term lines of credit and long dated swap obligations. Most indirect exposures have a longer-term orientation. As currency movements influence the economic circumstances of customers, competitors, and funds suppliers, the cash flows of the bank are subsequently affected.

Short-term exposures, which are typically direct, can arise from cash flows from non-asset-based sources, such as transaction-related services and loan origination fees. Other examples of short-term exposures may arise from: Trading activities; mark-to-market investments; and short-term off-balance sheet obligations such as letters of credit, and foreign currency derivatives. For most banks, funds sourcing from offshore branches and affiliates will usually also have a short-term exchange rate exposure component.

Since short-term exposures involve relatively certain cash flows, firms can successfully utilize well-designed financial instruments such as forwards, futures, swaps, and options to manage this form of exposure (e.g. Chamberlain et al., 1997; Chow et al., 1997b). In contrast, longer-term exposures are frequently more difficult to assess because these depend on the economic circumstances of bank customers, competitors, and funds suppliers. Because of this greater uncertainty and long-term nature, it is unclear whether readily available financial instruments are useful (e.g., Pringle, 1991; Chow et al., 1997a,b). Furthermore, the complexity and variety of sources of longer-term exposures make it less likely to effectively model these exposures within risk management frameworks. Since longer-term exposures are more difficult to recognize, measure, and hedge, we hypothesize that the long-term exposures are more prevalent than short-term exposures across US banks.

2.3. Economies of scale in exposure management

International banks are, by definition, expected to have currency exposures, in an ex ante sense, which exceed the exposures of domestic banks. However, international banks also typically have organizational structures to identify and manage currency risks, whether these exposures result from direct or indirect sources or are short-term or longer-term in nature. In addition, international banks have a knowledge base of continuing contact with the foreign exchange markets, which is required to hedge currency exposures, and have more opportunities to do so by structuring asset and liability positions. These elements should allow the international banks to gain economies of scale in currency risk management. Studies by Mian (1996), Chow et al. (1997b), and Geczy et al. (1997) suggest that scale economies exist in exposure management. To the extent that international banks are more likely to achieve these economies of scale, we expect that international banks reveal significant exchange rate exposure less frequently than domestic banks.

Following the lines of reasoning discussed above for international banks, large banks are also more likely, in general, to capture economies of scale in currency risk management. Thus, we also expect that large international banks less frequently exhibit significant exchange rate exposure than small international banks and large domestic banks to less frequently exhibit significant exchange rate exposure than small domestic banks.

2.4. Summary of hypotheses

Based on the perspectives of exchange rate exposure presented in this section, we posit the following hypotheses:

2.4.1. Domestic banks compared to international banks

H₀: There is no difference in the frequency of significant exposures between domestic banks and international banks.

H_a: Domestic banks are more frequently exposed than international banks.

2.4.2. Small domestic banks compared to large domestic banks

H₀: For domestic banks, there is no difference in the frequency of significant exposures between small banks and large banks.

H_a: For domestic banks, small banks are more frequently exposed than large banks.

2.4.3. Small international banks compared to large international banks

H₀: For international banks, there is no difference in the frequency of significant exposures between small banks and large banks.

H_a: For international banks, small banks are more frequently exposed than large banks.

2.4.4. Long-term exposures compared to short-term exposures

H₀: There is no difference in the frequency of significant long-term exposures and significant short-term exposures.

H_a: Long-term exposures occur more frequently than short-term exposures.

3. Sample and data

Using Standard and Poor's *Compustat* database, we consider US banks with a minimum of \$1 billion in average total assets and sufficient quarterly cash flow data for inclusion in the sample. The proxy we use for quarterly cash flow is quarterly operating income before adjustment for depreciation and exchange rate gains and losses. We select operating income because of this cash-flow concept's key role in bank management. We recognize that banks may be able to increase operating income by restructuring loans to accommodate borrowers that might otherwise have difficulty in meeting loan terms. Management actions of this type may result in higher reported net income, but may also result in higher income tax expenses for the bank. Moreover, such restructuring decisions are subject to bank examination and supervision guidelines. It is not clear that bank accounting adjustments, on net, result in persistent biases in reported bank operating income.

For purposes of statistical analysis, the banks are required to have at least 30 contiguous quarterly observations over the 1988–1998 examination period. *Compustat* covers 688 banks in their active and research databases, but only 127 of these banks

meet these data requirements for contiguous quarterly observations. Of these 127 banks, we remove duplicates and banks with less than \$1 billion in average total assets, resulting in a sample of 105 US banks.

Five bilateral rates against the US dollar, namely the British pound, Canadian dollar, German mark, Japanese yen, and Mexican peso, represent the exchange rate factors.² Using bilateral rates may facilitate the detection of exposures. According to Bartov and Bodnar (1994), it may be more difficult to detect exposure to an exchange rate index if firms have different relative linkages than those reflected in the index. The five currencies chosen represent the major trading partners of the US and are likely to be the currencies of broadest concern to US banks. Canada, Germany, Japan, Mexico, and the UK historically have been the top US trading partners as measured by gross trading volume, although China has recently joined the top five trading partners in place of the UK (US Census Bureau). In all cases, the exchange rate is measured as the percent change in the average quarterly value of the dollar, calculated using the average of the daily figures provided by the Board of Governors of the Federal Reserve System. We gather the other macroeconomic data from *International Financial Statistics*.

4. Methodology to identify currency exposures

We estimate exchange rate exposure for each bank as the correlation between operating income generated by the bank and contemporaneous and lagged exchange rates. In a subsequent stage of the study, we analyze and interpret the exposure results to derive implications for international and domestic banks as detailed by our hypotheses.

A distributed lag model captures the relationships between unanticipated operating income and short-term and long-term exchange rate changes. We generate the data for the unanticipated component using a seasonal random walk framework, following Bowen et al. (1987), Brown (1993), and Walsh (1994). More specifically, we estimate a time series of unanticipated quarterly operating income for each bank as the residual from regressing the previous four-quarter lagged values of operating income on the current values as

$$I_{it} = a_i + b_i I_{i(t-4)} + v_{it} \quad (1)$$

where I_{it} is operating income before adjustment for depreciation for bank i at time t ; ³ v_{it} is residual or unanticipated operating income for bank i at time t ; a_i , b_i are regression coefficients for bank i at time t .

² We also examine whether the Asian currency crisis has influenced the Japanese yen exposure results. When we truncate the examination period after the second quarter of 1997, our main conclusions remain the same.

³ We test whether the operating income measure in Eq. (1) is stationary using the augmented Dickey–Fuller technique for each bank model (see Dickey and Fuller, 1979). The tests reveal that 45 out of the 105 cases cannot reject the presence of a unit root. Thus, we assess the robustness of our results by analyzing subsets of banks with and without unit roots in the data and find our main conclusions are the same.

The residuals divided by their standard deviation form UI_{it} , the standardized unanticipated operating income variable (e.g., Walsh, 1994), which we subsequently use in Eq. (2).

This approach for developing the unanticipated operating income variable removes the effects of trend-dominated influences on bank activities and macroeconomic factors that may confound the exchange rate-cash flow linkage. By using unanticipated operating income, we should identify robust relationships since this approach places a heavier burden on hypothesis testing than when working with operating income in “level” form. Also contributing to this objective is the use of a sample period that spans several business fluctuations.

The general formulation used to estimate exposure to exchange rate risk for the each bank is

$$UI_{it} = c_i + \sum_{q=0}^{L_i} w_i(q)X_{t-q} + u_{it} \quad (2)$$

where UI_{it} is standardized unanticipated operating income before adjustment for depreciation (a proxy for cash flows) for bank i in time period t ; X_{t-q} is percentage change in the exchange rate factor in time period $t - q$; c_i is intercept for bank i ; $w_i(q)$ are weights or response coefficients, which represent the sensitivity of cash flows to short-term and long-term exchange rate changes, for bank i and quarters 0 through L . The $w_i(q)$ follow the Almon technique (1965), as described below; L_i is lag length, up to 12 quarters, determined by the Akaike (1973) criterion for bank i ; u_{it} is stochastic error term.

We analyze the possibility that competitive effects between banks may cause bank earnings to be related, thus necessitating a system approach. The pairwise correlations for the 105 banks in the sample indicate that 16.7%, 17.0%, 16.7%, 16.3%, and 17.7% of the correlations are significant at the 5% level for the Canadian dollar, British pound, German mark, Japanese yen, and Mexican peso, respectively. These relatively low proportions of significant correlations do not indicate that a system approach is necessary.

We construct the exchange rate factor in Eq. (2) to be orthogonal to the interest rate differential and relative economic activity levels by using the residual, x_{jt} , defined in Eq. (3) below. Essentially, x_{jt} captures the exchange rate variation not explained by the variation in interest rates or economic activity.

$$XRT_{jt} = a_j + b_jINT_{jt} + c_jGDP_{jt} + x_{jt} \quad (3)$$

where XRT_{jt} is country j currency/US dollar exchange rate at time t ; INT_{jt} is difference in long-term interest rates between country j and the US at time t ; GDP_{jt} is ratio of the real economic activity level in country j to the US at time t ; x_{jt} is residual or unexplained exchange rate component for country j at time t ; a_j , b_j , c_j are regression coefficients for country j .

We assess whether the three variables in Eq. (3) for each of the five countries are non-stationary using the augmented Dickey–Fuller test (see Dickey and Fuller, 1979). The tests indicate that the data are not stationary; unit roots cannot be

rejected for 14 out of the 15 variables. The only variable that rejects the presence of a unit root is the GDP ratio for Canada. Since we use the first differences in the residuals from Eq. (3) as the independent variables in Eq. (2), the possibility that we may be overdifferencing in the event of cointegrated variables is investigated using the method of Engle and Granger (1987). We do not find strong evidence of cointegrated variables; unit roots in the residuals cannot be rejected for all five country models. Thus, using the first difference of the residuals in Eq. (2) should be valid. Unit root tests on these first differences show they are stationary.

Using a purged exchange rate factor is not uncommon in exchange rate exposure studies that use the market-based methodology (e.g., Choi et al., 1992; Choi and Prasad, 1995; Martin et al., 1999). In essence, exchange rate exposure is estimated as the sensitivity of operating income (or stock returns) to the portion of exchange rate movements not otherwise reflected in the macroeconomic variables.

We use the long-term government bond rates published by *International Financial Statistics* to develop the interest rate factor. This proxy is consistent with studies that suggest bank earnings are more sensitive to long-term rates than short-term rates (e.g., Kane and Unal, 1988; Madura and Zarruk, 1995). In the case of Mexico, we substitute short-term money market rates from *International Financial Statistics* for reasons of data availability.

We use the inflation-adjusted GDP or GNP, depending on availability in *International Financial Statistics*, to represent the level of real economic activity. In the case of Mexico, we substitute industrial production, again because of data availability.

The model expressed in Eq. (2) allows a lagged relationship between exchange rate movements and operating income of up to twelve quarters; thus, q may take on the values of 0 to 12. With a zero lag, the exchange rate is contemporaneous in the sense that it represents the movement in the exchange rate over the same period the bank generates the operating income. Walsh (1994) provides some evidence that exchange rate changes affect operating income with a lag. Bartov and Bodnar (1994) and Chow et al. (1997b) also provide evidence of a lagged relationship between exchange rate changes and firm value. The lag structures across banks in the sample are likely to vary as bank managers address different market niches, different deposit bases, and face different competitive environments. We use the maximum likelihood criterion developed by Akaike (1973) to identify the optimal lag period for each bank.

We estimate Eq. (2) using the polynomial distributed lag technique developed by Almon (1965). This approach imposes the assumption that the pattern of the weights occurs in the form of a polynomial structure. A third degree polynomial is sufficiently flexible to allow for typical lag patterns. Weights, $w(q)$, may take on positive or negative values, depending on the nature of the exchange rate exposure.

5. Results

Table 1 reports the frequency of detecting significant exchange rate exposures using the Almon distributed lag technique to estimate Eq. (2). The number of banks that exhibit significant exchange rate exposures is reported (percentage in

Table 1
Frequency of significant exchange rate exposures of 105 US banks and subsets

Currency	All banks (N = 105)	Domestic (N = 41)	International (N = 64)	$Z_{\text{Dom-Int}^1}$
<i>Panel A: Domestically oriented compared to internationally oriented banks</i>				
GBP	39 (37%)	20 (49%)	19 (30%)	1.97**
CAD	33 (31%)	10 (24%)	23 (34%)	-1.28
DEM	20 (19%)	13 (32%)	7 (11%)	2.52***
JPY	38 (36%)	21 (51%)	17 (27%)	2.58***
MXP	28 (27%)	14 (34%)	14 (22%)	1.36
At least one	82 (78%)	36 (88%)	46 (72%)	2.10**
	All domestic (N = 41)	Small (N = 16)	Large (N = 9)	$Z_{\text{Small-large}}$
<i>Panel B: Small domestically oriented compared to large domestically oriented banks</i>				
GBP	20 (49%)	7 (44%)	6 (67%)	-1.14
CAD	10 (24%)	3 (19%)	2 (22%)	-0.20
DEM	13 (32%)	4 (25%)	5 (56%)	-1.54
JPY	21 (51%)	8 (50%)	5 (56%)	-0.27
MXP	14 (34%)	8 (50%)	4 (44%)	0.27
At least one	36 (88%)	14 (88%)	8 (89%)	-0.10
	All international (N = 64)	Small (N = 19)	Large (N = 26)	$Z_{\text{Small-large}}$
<i>Panel C: Small internationally oriented compared to large internationally oriented banks</i>				
GBP	19 (30%)	8 (42%)	6 (23%)	1.36
CAD	23 (34%)	7 (37%)	9 (35%)	0.15
DEM	7 (11%)	4 (21%)	3 (12%)	0.85
JPY	17 (27%)	6 (32%)	5 (19%)	0.94
MXP	14 (22%)	8 (42%)	3 (12%)	2.36**
At least one	46 (72%)	17 (89%)	15 (58%)	2.65***

We report the number of banks that exhibit significant exchange rate exposures with the associated percentage in parentheses. Significant bank exposure is defined at the 10% level or less and detected by applying the Almon (1965) distributed lag technique to

$$UI_{it} = c_i + \sum_{q=0}^{L_i} w_i(q)X_{t-q} + u_{it}$$

where UI_{it} is standardized unanticipated operating income before adjustment for depreciation and exchange rate gains and losses bank i at time t , X_{t-q} is the percentage change in the exchange rate factor at time $t - q$, c_i is intercept for bank i , $w_i(q)$ are exposure coefficients for bank i for quarters 0 through L , L_i is lag length, up to 12 quarters, determined by the Akaike (1973) criterion for bank i , and u_{it} is stochastic error term. The Z values indicate whether (i) domestic banks have exposure more frequently than international banks, (ii) small domestic banks more frequently have exposure than large domestic banks, and (iii) small international banks more frequently have exposure than large international banks. *, **, and *** indicate the level of significance as 10%, 5%, and 1%, respectively.

parentheses), for each of the five currencies separately and then for the category of “at least one” of these five currencies, with statistical significance at the 10% level or lower. Panel A indicates the frequency of significant exposures for the 105 US banks

in the sample and also for subsets constructed according to the extent of international activities. We classify banks as internationally oriented if they are included in *The Bankers' Almanac* (1999), and domestically oriented otherwise. Panel B (panel C) reports the frequency of exposures specifically for the subset of 41 domestically oriented (64 internationally oriented) banks and for the 16 small domestically oriented (19 small internationally oriented) and nine large domestically oriented (26 large internationally oriented) banks.

As reported in panel A of Table 1, of the 105 banks in the sample, 39 (37%) are exposed to the British pound (GBP), 33 (31%) are exposed to the Canadian dollar (CAD), 20 (19%) are exposed to the German mark (DEM), 38 (36%) are exposed to the Japanese yen (JPY), and 28 (27%) are exposed to the Mexican peso (MXP). These proportions are similar in magnitude to the studies of Chamberlain et al. (1997) and Choi et al. (1992), which estimate exposures as the sensitivity of returns to changes in a trade-weighted exchange rate index.

Arguably more important than the proportion of banks with exposure to each of the individual currencies is the assessment of the frequency of exposure to “at least one” of the five currencies. Our sample reveals that 78% of all the banks, 88% of domestically oriented banks, and 72% of internationally oriented banks have exposure to at least one of the currencies. These rather high proportions are similar to the findings reported by Choi and Elyasiani (1997). Clearly, these high proportions of banks with significant exposures are not a result of chance.

Focusing on the sub-sample of 41 domestically oriented banks in panel A of Table 1, the banks demonstrate a relatively high frequency of exposure across all currencies. The frequency of significant exposures ranges from 24% for the Canadian dollar to 51% for the Japanese yen. Moreover, with 88% of the domestic sub-sample shown to have exposure to at least one of the five currencies, there is strong support for the long-held belief that domestic firms have exposure to exchange rate risk (e.g., Wentz, 1979; Hodder, 1982; Jorion, 1990).

We find the proportion of domestically oriented banks in the sample with significant exposures to exceed that proportion for internationally oriented banks, except in the case of the Canadian dollar. And the proportion of domestically oriented banks which show exposure to “at least one” currency is also higher than that for the international banks (88% versus 72%). The *Z* values indicate that internationally oriented banks have significant exposure less frequently than domestically oriented banks with respect to the British pound, German mark, and Japanese yen, and “at least one” of the five currencies.⁴ These results support the argument that economies of scale in exposure management may exist (Mian, 1996; Chow et al., 1997b; and Geczy et al., 1997) and may be attainable for those institutions with the greatest extent of international operations.

Panels B and C of Table 1 help examine the belief that economies of scale may be attainable by the largest banks. We rank the full sample of 105 banks according to total assets, and then separate the banks into three size-based groups of 35. Panel

⁴ The *Z* values reported in this study assume independent samples.

B (panel C) reports the frequency of exposure for the 16 domestically oriented (19 internationally oriented) banks within the group of small banks and nine domestically oriented (26 internationally oriented) banks within the group of large banks. The comparisons of proportions show a significantly greater proportion of the smaller internationally oriented banks are exposed to the Mexican peso and to “at least one” of the five currencies. Thus, panel C of Table 1 provides some evidence that asset size contributes to achieving economies of scale for internationally oriented banks.

The results show that the extent of international operations rather than asset size is indicative of the willingness and ability of banks to hedge their exposures. International banks are more likely to have the skills, resources, and organizational systems available to achieve economies of scale in the management of exchange rate exposures. Domestic banks are less likely to justify the skills, resources, and organizational systems to implement exchange rate risk management programs due to their relatively low volume of direct involvement in international business. These results also suggest that indirect exposures play a major role in contributing to the exposures of domestic banks. Thus, domestic banks may find further justification for implementing exchange rate risk management systems and programs by accounting for the impact of their indirect exposures on operating income.

Table 2 summarizes the distribution of the optimal lags identified using the Akaike (1973) criterion. The first column displays the number of banks in the sample with significant exposures to indicate the frequency of exposure regardless of the optimal lag structures identified. The next seven columns summarize the distribution of optimal lags. For example, of the 49 banks found to have an optimal lag structure of 0 or 1 quarter, 7 (14%) are statistically significantly exposed to the GBP, 2 (5%) to the CAD, 1 (2%) to the DEM, 3 (6%) to the JPY, and 1 (2%) to the MXP. Casually inspecting the data, we observe shorter optimal lags occur most frequently for all the currencies, yet we can notice that the significant exposures are most frequently associated with the longer optimal lags for all the currencies.

Table 2
Distribution of optimal lag length for 105 US banks

Currency	All banks	Optimal quarterly lags						
		0–1	2–3	4–5	6–7	8–9	10–11	12
GBP	39 of 105 (37%)	7 of 49 (14%)	1 of 3 (33%)	4 of 9 (44%)	6 of 8 (75%)	4 of 6 (67%)	8 of 15 (53%)	9 of 15 (60%)
CAD	33 of 105 (31%)	2 of 44 (5%)	2 of 6 (33%)	2 of 4 (50%)	8 of 11 (73%)	0 of 5 (0%)	7 of 11 (64%)	12 of 24 (52%)
DEM	20 of 105 (19%)	1 of 66 (2%)	0 of 5 (0%)	1 of 4 (25%)	4 of 6 (67%)	1 of 3 (33%)	3 of 5 (60%)	10 of 16 (63%)
JPY	38 of 105 (36%)	3 of 49 (6%)	3 of 7 (43%)	6 of 7 (86%)	4 of 6 (67%)	8 of 9 (89%)	7 of 9 (78%)	7 of 18 (39%)
MXP	28 of 105 (27%)	1 of 53 (2%)	0 of 0 (–)	2 of 8 (25%)	3 of 5 (60%)	3 of 5 (60%)	6 of 13 (46%)	13 of 21 (62%)

We report the number of US banks (percentage in parentheses) with significant exchange rate exposures across the optimal lag periods established by the Akaike (1973) criterion. Significant bank exchange rate exposure is defined at the 10% level or less.

Table 3

Frequency of significant short-term and long-term exchange rate exposures of 105 US banks and subsets

Currency	All banks			Domestically oriented			Internationally oriented		
	Short term	Long term	Z_{ST-LT}	Short term	Long term	Z_{ST-LT}	Short term	Long term	Z_{ST-LT}
GBP	8 of 52 (15%)	21 of 36 (58%)	-4.46***	1 of 10 (10%)	14 of 21 (67%)	-4.05***	7 of 42 (17%)	7 of 15 (47%)	-2.13**
CAD	4 of 50 (8%)	19 of 40 (48%)	-4.50***	1 of 18 (6%)	7 of 20 (35%)	-2.46***	3 of 32 (9%)	12 of 20 (60%)	-4.18***
DEM	1 of 71 (1%)	14 of 24 (58%)	-5.60***	0 of 20 (0%)	11 of 17 (65%)	-5.58***	1 of 51 (2%)	3 of 7 (43%)	-2.17**
JPY	6 of 56 (11%)	22 of 36 (61%)	-5.53***	3 of 15 (20%)	14 of 22 (64%)	-3.00***	3 of 41 (7%)	8 of 14 (57%)	-3.60***
MXP	1 of 53 (2%)	22 of 39 (56%)	-6.68***	1 of 19 (6%)	11 of 20 (55%)	-4.06***	0 of 34 (0%)	11 of 19 (58%)	-5.11***

We report the proportion of significant exposures relative to the number of banks identified to have optimal lags in each category with the associated percentage in parentheses. The short-term column summarizes the proportions of significant exposures for banks with optimal lags of one year or less (i.e. lags of 0 through 3). The long-term column summarizes the proportions of significant exposures for banks with optimal lags of greater than two years (i.e. lags of 8 through 12). The Z values indicate whether long-term exposures occur more frequently than short-term exposures (i) across the sample of US banks, (ii) for the subset of domestically oriented banks, and (iii) for the subset of internationally oriented banks. **, and *** indicate the level of significance as 10%, 5%, and 1%, respectively.

Table 3 explores whether statistically significant long-term exposures are more prevalent than short-term exposures across the entire sample and across the domestically oriented and internationally oriented subsets. We classify the exposures as short term when the optimal lags are one year or less and long term when the optimal lags are greater than two years. We omit from the analyses those banks with optimal lag structures between the short-term and long-term classifications since it is not clear whether these exposures are distinctly short term or long term.⁵

In this table, we compare the frequency of significant short-term exposures to the frequency of significant long-term exposures across the entire sample by currency. Of the 52 banks with short-term optimal lags, 8 (15%) have statistically significant exposure to the GBP. In contrast, of the 36 banks with long-term optimal lags, 21 (58%) have statistically significant exposure to the GBP. The difference in these two proportions is statistically significant at the 1% level, with a Z value of -3.45 . Across all five currencies, we show the frequency of long-term exposures to be significantly greater than the frequency of short-term exposures. This result is consistent with our hypothesis that long-term exposures are more prevalent across US banks since such exposures are more difficult to identify, measure, and hedge.

⁵ The results reported in Table 3 are unchanged if we classify banks with optimal lags of four or five as short term and banks with optimal lags of six or seven as long term.

Next, we investigate the prevalence of longer-term exposures for the domestically oriented banks. The subset of domestically oriented banks with short-term optimal lags, reveals 10%, 6%, 0%, 20%, and 6% have significant exposure to the GBP, CAD, DEM, JPY, and MXP, respectively. In comparison, 67%, 35%, 65%, 64%, and 55% of those banks identified to have longer term optimal lags have significant exposure to the GBP, CAD, DEM, JPY, and MXP, respectively. The *Z* values comparing these proportions confirm that longer term significant exposures are more prevalent. These results help to substantiate that, although domestic banks do not have direct exposures, they are likely indirectly exposed to exchange rate risk that is longer term in nature.

Lastly, we examine the subset of internationally oriented banks. Of the internationally oriented banks identified to have short term optimal lags, 17%, 9%, 2%, 7%, and 0% have significant exposure to the GBP, CAD, DEM, JPY, and MXP, respectively. In comparison, 47%, 60%, 43%, 57%, and 58% of those banks identified to have longer term optimal lags have significant exposure to the GBP, CAD, DEM, JPY, and MXP, respectively. Again, the *Z* values show that the longer term significant exposures are more prevalent across all the currencies. It is likely that international banks are better able to hedge their short-term exposures due to the relative ease of identifying and measuring these exposures, as well as the availability of well-designed financial instruments. These results may indicate that the risk management systems in place in many of these banks are less effective at identifying and measuring the longer term sources of exposure or that these banks are willing to remain unhedged against these exposures.

6. Summary

Risk management continues to receive substantial attention by bankers, regulators, policy makers, and academics. This study focuses on the exchange rate risk dimension for 105 US banks over the 1988–1998 period. We discuss the potential direct and indirect effects of exchange rate risk on cash flows of banks, along with the potential short-term and long-term effects on cash flows.

There is strong evidence that exchange rate risk affects the operating income of the domestically oriented banks in the sample. More specifically, 88% of the domestically oriented banks have significant exposure to either the British pound, Canadian dollar, German mark, Japanese yen, or Mexican peso. This empirical finding supports the hypotheses that domestic firms have exposure to exchange rate risk.

Additionally, for the sample of banks used in this study, domestically oriented banks more frequently exhibit significant exposure than the internationally oriented banks, with respect to the British pound, German mark, Japanese yen, and “at least one” of the five currencies. This finding is consistent with the belief that economies of scale are attainable for those institutions with the greatest extent of international activities. Domestic banks may be less likely to justify the skill, resources, and organizational support systems to implement exchange rate risk management programs due to their relatively low volume of direct international business. However, the

findings in this paper suggest that many domestic banks should strengthen their exchange rate risk management efforts because of the indirect impact of exchange rate risk on cash flows.

As hypothesized, we find that longer-term exposures are more prevalent than short-term exposures across the sample of US banks, sub-sample of domestically oriented banks, and sub-sample of internationally oriented banks. This finding helps confirm the pervasiveness and importance of longer-term exposures that are more difficult to identify, measure, and hedge. By definition, domestic banks mainly have indirect exposure to the longer-term impacts of exchange rate risk. Combined with the lack of exchange rate exposure management programs, the finding of longer-term exposures is not surprising. The prevalence of longer-term exposures within the group of internationally oriented banks, however, is indicative of a focus on hedging short-term exposures that are easier to identify, measure, and hedge.

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