ASYMMETRIC INFORMATION AND THE FOREIGN-EXCHANGE SPREADS OF GLOBAL CUSTODY BANKS

Carol Osler
Brandeis International Business School

Tanseli Savaser
Williams College

Thang Nguyen
Brandeis International Business School

Abstract

This paper examines how asymmetric information influences the margins charged by a global custody banks on foreign exchange transactions with customers. For most such trades, the custodian unilaterally sets the price; the client learns that price only after a delay measured in weeks. We hypothesize that custodial margins widen when customers face greater obstacles to identifying their trading costs. We also hypothesize that the custodian sets prices with the intent of protecting the ambiguity surrounding the margins themselves. Our data comprise the complete foreign exchange trading record of a mid-sized custody bank during calendar year 2006. Our regression analysis provides strong support for both hypotheses.

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This paper examines foreign-exchange trading by a global custodial bank. Custody banks serve asset managers by tracking asset values, investing funds as directed, collecting and repatriating income, and settling trades. We examine the determinants of the custody banks' profit margins in currency trades with client funds, focusing primarily on the influence of asymmetric information. We find that margins widen with the difficulty clients face in ascertaining their true transactions costs. We call this the "fog effect," and interpret it as an extension of the market power hypothesis (Angel 1996; Green *et al.* 2007; Osler *et al.* 2008). We also find that the custodian's margins are narrower when other forces tend to widen the client's effective bid-ask spread, such as the involvement of a sub-custodian in the trade. We suggest that this reflects, in part, the bank's desire to avoid extreme prices and thereby maintain ambiguity about its margins.

When carrying out foreign-exchange trades for clients, global custodians effectively serve as market makers. The structure of trading differs widely, however, between custodians and market makers in the dominant OTC market (e.g., Citibank). In the OTC market, customers are active participants in every trade: they contact the banks directly and, after learning the dealers' bid and ask quotes, they decide whether to buy, sell, or pass. By contrast, customers are passive participants in the vast majority of custodian foreign-exchange trades. After an asset manager decides to trade a given foreign asset, it typically instructs its "fund accountant" – the custody-bank employee in charge of administering that fund's assets – to carry out the entire portfolio shift. The custodian immediately accepts responsibility for making the

transaction come about smoothly and efficiently, consistent with its overall goal of relieving the fund of administrative burdens. To arrange the required purchase or sale of foreign currency, the fund accountant sends an instruction to the trading floor. There, a trader purchases or sells the funds in the interbank market for the custodian's own account and then decides – unilaterally – the price at which the bank trades the currency onward with the asset manager. During this process, which can take over a day for certain currencies, the asset manager is not contacted. In fact, after leaving the initial instruction the asset manager typically hears nothing more about the transaction until some days or weeks later when it is listed, along with others, in a summary of recent trading activity. Custody clients know even less about dividend and interest flows: these are typically so small that the funds instruct the custodian to repatriate such flows automatically.

These structural differences in trading practices bring major differences in the execution-cost information available to asset managers. With the negotiated trades of the OTC market, an asset manager immediately knows a trade's date, time, and price, and also knows the bid-ask spread. With standard custodial trades, by contrast, a client knows the date on which it sends the original trade instruction plus whatever it learns from the activity report, which is typically the date of a trade and the price but not the time or the bid-ask spread. Thus, when asset managers trade via custodians they face obstacles to learning information that is crucial for assessing their execution costs – information that the custodians know immediately.

Custody banks thus have a substantial information advantage relative to their clients, though this is an unintended by-product of business relations willingly undertaken for unrelated reasons. Asset managers view themselves as having a comparative advantage in things like

selecting assets, timing markets, and dealing with investors, but not in asset administration. Consequently, they prefer to outsource the administrative functions to custodians, which means that to monitor execution costs they must receive and process transaction information from the custodian. Many funds choose to receive reports quarterly rather than monthly or weekly, which suggests that monitoring costs are perceived to be large, at least relative to the benefits. Whatever the reason, most asset managers take the custodians' margins as fixed costs.

The custody banks' information advantage creates potentially attractive opportunities when they set prices on foreign-exchange trades. The "market power" hypothesis suggests that OTC dealers with an information advantage set wider bid-ask spreads (Angel 1996; Green et al. 2007). The source of this market power is the opacity of OTC markets, where trades between dealers and end users are generally private information. Green et al. find that muni-bond bid-ask spreads on the smallest trades –which typically involve the least sophisticated clients – are over 40 times those on the largest trades. Reasoning similarly, we hypothesize that global custody banks impose wider margins, and thereby wider bid-ask spreads, when customers face greater obstacles to identifying their trading costs. We refer to this as the "fog effect."

Note that the information held asymmetrically differs between the OTC and custody settings. OTC customers face challenges to learning market practices, standard bid-ask spreads, and the current state of the market. Even poorly-informed OTC customers, however, know their trade prices and bid-ask spreads, so they are better informed than custody-bank clients.

The market power of an OTC dealer is sustained because high search costs deter asset managers from investigating the competitiveness of a given quote (Duffie *et al.* (2004)). Here

again, the difficulties faced by customers are more severe in the custodial setting than the OTC setting. An OTC customer can simply call another dealer and compare two sets of bid and ask quotes. A custody client doesn't know the price until later and *never* learns the bid-ask spread. Asset managers can, and often do, choose to call regular dealers instead of their custodian, but then they take on the entire administrative burden of the trade – a burden it was their intent to avoid when they hired the custodian. Another short-run solution is for the manager to contact the custodian's currency traders directly to negotiate prices, but this still requires asset-manager attention to foreign-exchange execution. As a long-run solution an asset manager could shift its assets to a different custody bank. It is difficult for the manager to know, however, whether other custodians actually provide services less expensively, for the same reason it is difficult to know the actual costs of services at the current custodian. In addition, switching custodian banks is an extremely complicated process that takes over a year of concerted staff effort.

Custody clients could possibly infer that a custodian's margin is extreme if their prices are far beyond the day's interbank trading range. Custody banks might therefore avoid extreme pricing in order to protect the ambiguity surrounding margins. If so, custody banks would reduce margins when they send trades through a sub-custodian – which also charges a margin – or when interbank spreads are wide. The ambiguity maintenance hypothesis also implies that custodial margins could be larger for the most volatile currencies.

Asset managers have long suspected that custody banks charge high margins on non-negotiated currency trades. This concern came to public prominence in October of 2009, when two large pension funds sued State Street Bank, one of top three global custodians. According

to the California Public Employees' Retirement System and the California State Teachers' Retirement system: "For years, State Street, led by a group of its internal 'risk traders,' raided the custodial accounts of California's two largest public pension funds, in a total amount exceeding $56 million, by fraudulently pricing foreign currency ("FX") trades State Street executed for the pension funds" (p. 1).

The original court document quotes e-mails among State Street executives that highlight the possibility that custody banks intentionally protect the ambiguity surrounding margins when setting exchange prices:

> When discussing inquiries by the Pension Funds about providing "transparency" in FX execution costs, one Senior Vice President with State Street California commented to other State Street executives that, "[i]f providing execution costs will give [CalPERS] any insight into how much we make off of FX transactions, I will be shocked if [a State Street V.P.] or anyone would agree to reveal the information." Another State Street California executive sought help form State Street executives in formulating a strategy to deflect the Pension Funds' attention away from custody FX "transparency," writing, "[a]ny help you can offer would be appreciated. The FX question is touchy and if we can't provide any further information, we have to somehow get [CalPERS] comfortable with that since our RFP response indicated we could provide execution cost transparency" (page 3, paragraph 4).

To examine the possibility that custody banks set margins with some awareness of their information advantage, we analyze the complete foreign exchange trading record of a mid-sized global custody bank during calendar year 2006. We focus on the custody bank's margins, defined as the gap between the price the banks charge their customers and the price at which they cover the trade by trading with other banks.

Our main results are based on a regression analysis, but simple averages tell the story. Our custody bank's average margin on all trades against the US dollar was 20.8 basis points. This far exceeds the 3.4 basis-point average margins on the small subset of trades in which

funds called their custody-bank traders directly and negotiated the price. This suggests the custodian charges a high margin when the client funds are least informed about true transactions costs, as implied by the fog effect. Simple averages also tell a story consistent with the ambiguity maintenance hypothesis. The average margin on emerging-market currencies that involve sub-custodians, 15.6 basis points, is less than half the 35.6 basis-point average margin associated with other emerging market currencies. The ambiguity maintenance hypothesis is also aptly illustrated by the case of Hong Kong. Because the Hong Kong dollar is tightly fixed to the US dollar, asset managers can easily infer their transaction costs and thus custody dealers have no information advantage. Consistent with this, the 0.5 basis-point average custody margin on Hong-Kong dollar trades was less than 2 percent of the average across all currencies.

Our regression-based analysis of the determinants of custody FX margins controls for other factors potentially relevant to bid-ask spreads, such as a fund's trading volume and a currency's market liquidity. It is important to note, however, that the custodial situation differs so dramatically from the OTC currency market that some familiar hypotheses do not apply. For example, the literature suggests that volatility should raise transaction costs because it heightens dealer inventory risk (Ho and Stoll 1978). However, custody-banks bear no inventory risk on non-negotiated trades. Likewise, the literature finds that volatility should raise transaction costs when it reflects the arrival of fundamental information and associated adverse-selection risk (Foucaults 1999). However, traders at small and mid-sized custody banks – who are more like currency salespeople than interbank traders – generally do not take speculative positions and are therefore not exposed to adverse-selection risk.

Our regression analysis provides strong support for the idea that custody banks are aware of their information advantage when setting customer prices. Consistent with the fog effect, the regressions indicate that margins widen by 19 basis points when a dealer receives trade instructions from a fund accountant rather than negotiating the price directly with the fund manager. Consistent with the ambiguity maintenance hypothesis, the regressions indicate that margins are positively related to volatility, negatively related to interbank spreads, and narrow by over 10 basis points when sub-custodians are involved.

To test the robustness of our results we run a censored regression using a sample that excludes the small minority of trades with negative spreads. We also re-run the regressions including individual fund dummies, which allows for differences in underlying custodial agreements across asset managers. Additionally, we constrain the sample to include only funds that actually call directly; we include only the six most liquid currencies; we include only the 16 emerging market currencies. Our main conclusions are unaffected by these modifications.

In short, our analysis shows that custody-bank dealers fulfill their primary professional responsibility, which is to make money for their employers – and, thus, for their shareholders – by trading judiciously with clients. When they carefully assess whether a given customer is willing to pay a wider margin, the dealers we study act like dealers in any market, whether it be the OTC currency market, the municipal bond market, or the market for used cars.

The rest of this paper has four sections. Section I, which follows, discusses our data and characterizes average custody-bank margins. Section II presents our methodology. Section III presents our results. Section IV concludes.

I. DATA

Custodian banks worldwide administer assets worth about $100 trillion (Institutional Investor Magazine (2007)). The business has expanded rapidly in recent decades, propelled by growth in the asset management industry and by a 1974 U.S. law requiring that pension funds separate investment management and custody management services. Global custody banks, which administer internationally-owned assets, handle roughly one third of the industry's total assets (Institutional Investor Magazine (2007)). Despite its immense size, the custody business has rarely been examined by academicians and never by researchers in microstructure.

After a massive consolidation the industry is now dominated by a few large banks: the top fifteen custodian banks manage over eighty percent of the total (Institutional Investor Magazine (2007)). This presumably reflects, at least in part, the industry's intense computational requirements and consequent economies of scale. As shown in Schmeidel et al. (2006), doubling the assets under management of a mid-sized European custody bank would increase its total costs by only 70 percent. Cullinan et al. (2005) reach a similar conclusion.

We analyze the complete record of foreign-exchange transactions between asset managers and a mid-sized global custody bank during calendar year 2006. For each transaction these data include: (i) the two currencies, (ii) the amount traded in both currencies, (iii) the transaction price, (iv) the time the trade was requested and the time the trade was carried out, (v) a trade type variable indicating whether the trade was for a special purpose such as income repatriation or corporate action (meaning, for example, the exercise of warrants or participation in a tender offer), (vi) a code distinguishing each specific fund, (vii) an indicator of

whether the fund was indexed or actively managed, (viii) the fund's assets under management on December 31, 2006, and (vi) the custody bank's income from the transaction in US dollars.

We exclude all transactions that do not involve the US dollar (e.g., transactions between yen and euros), trust-fund transactions, currencies that account for less than one percent of all transactions, and corporate-action transactions (which likewise account for only 1 percent of transactions). The final sample includes between 75,000 and 100,000 transactions in 27 currencies, worth in aggregate between $50 and $100 billion.[1] About 80 percent are asset-allocation trades and the rest are income-repatriation trades. A small minority of transactions – 3 percent – were negotiated directly with the dealers.

Our sample of client funds includes on the order of 1,000 individual asset managers with mean assets under management of about $1 billion. Of these, roughly two-thirds had net asset value below $100 million, one-fifth had net asset value between $100 and $600 million, and ten percent had net asset value in excess of $600 million. Since custodians primarily serve "real money" funds – such as mutual funds and pension funds – it is not surprising that our sample includes only a handful of hedge funds.

The definition of a "trade" relevant to our analysis differs from the individual transactions originally recorded by the custody bank. Individual transactions in a given currency are often aggregated into a single sum before trading, a process that often involves netting. For example, if a fund were purchasing new Polish shares worth 1,100 zloties and liquidating dividend income worth 100 zloties, the amounts would be offset and the trader would be requested by the fund accountant to purchase 1,000 Polish zloties.

[1] We leave some figures ambiguous to protect the anonymity of the custody bank.

Since our interest is in the proportionate margin *as perceived by the trader*, we work with the original trade quantities perceived by the traders. To reconstruct these quantities, we identify clusters of transactions that share a currency and an exact price and that occur within five minutes of each other. For each cluster, the trade amount is the net of the component amounts; dollar income is the sum of income from each individual transaction; the margin is that income divided by the trade amount. The fund associated with a trade is identified as the one that made the largest single component transaction.

After clustering there are roughly 25,000 trades with average trade size of about $1.7 million. This is comparable to standard trade sizes in the electronic foreign-exchange interbank market (EBS and Reuters Matching) but it is large relative to average equity trades. Jones and Lipson (2003), for example, report a mean trade size of $39,000 for their NYSE sample. The custody-bank's income-repatriation trades tend to be small, averaging only around $600,000 each. Negotiated trades, by contrast, tend to be large, averaging $2,800,000 each, though not all large trades are negotiated.[2] Defining a "large" trade to be worth $5 million or more we find that only 13.5 percent of large trades are negotiated. The data provide some support for the notion that the most market-savvy asset managers – who presumably work for relatively large funds – rely most heavily on negotiated trades. While the average fund size overall is roughly $1.6 billion, the average fund size for large negotiated trades is around $13.2 billion while the average fund size for large non-negotiated trades is only around $4.5 billion.

Roughly 20 percent of trades were in euro-dollar; dollar-yen and sterling-dollar each accounted for a further 10 to 12 percent of trades; the Hong Kong dollar and Korean won each

[2] To be complete, the last category of trades -- non-negotiated asset-allocation trades -- average $1.8 million.

accounted for between seven and eight percent of trades; the currencies of Australia, Canada, and Switzerland each accounted for 4 to 5 percent of trades; the currencies of Brazil, India, Indonesia, Malaysia, Mexico, Singapore, South Africa, Sweden, Taiwan, and Thailand each accounted for 2 to 3 percent of trades; and the remainder of the sample involved the currencies of Chile, Denmark, Hungary, Israel, New Zealand, Norway, the Philippines, Poland, and Turkey. As shown in Figure 1A, trades tend to be largest for the major currencies.

This paper focuses on the custody bank's margin, meaning the proportionate gap between the price it charges the customer (P_c) and the price at which it covers the trade. For 16 of currencies in our sample the trade is covered in the interbank market, so the margin is $|(P_c - P_I)/P_C|$.[3] For the remaining 11 currencies, the trade involved a sub-custodian with a branch in the currency's sponsoring country. Sub-custodians are involved whenever a country imposes exchange controls and also in a few other emerging markets. The sub-custodian purchases the currency in the local interbank market and charges the main custodian a marked-up price, P_{sc}, in which case the main custodian's margin in is $|(P_c - P_{SC})/P_C|$.

Margins on non-negotiated trades should never be negative because dealers can cover their positions before setting prices for the client. By contrast, the recorded spreads on non-negotiated transactions can be negative when a transaction in one direction is netted into a trade in the other direction. While 8.4 percent of the original transactions have negative margins, after applying our clustering algorithm we found, reassuringly, that only 0.2 percent of trades have negative margins. Of the remaining negative-margins trades, almost all correspond to negotiated trades. The 1.8 percent share of such trades with negative margins seems

[3] The decision to use the customer price as the scale factor was the custodian's.

plausible, since negotiated trades are subject to inventory risk. For comparison, Green et al. (2007) find an overall 1.4 percent loss frequency for municipal bond trades.

This custody bank's margins vary widely across currencies, as shown in Figure 1B. Average margins range from a minimum of 0.5 basis points for trades in Hong Kong dollars to 51 basis points for trades in (New) Turkish Lira. More important for our purposes is variation in margins across trade types. The average margin overall is 20.8 basis points. As predicted by the fog effect, margins on non-negotiated trades are largest, averaging 22.4 basis points, while margins on the relatively transparent negotiated trades average only 3.4 basis points. As predicted by the ambiguity maintenance hypothesis, the average margin on emerging-market currencies that involve sub-custodians, 15.6 basis points, is less than half the 35.6 basis-point average margin associated with other emerging market currencies.

II. METHODOLOGY

To examine more closely how asymmetric information influences custody-bank margins we use regression analysis. We regress the margin for each trade t, $Margin_t$, on variables that capture potential manifestations of the information asymmetry between the custodian and its client funds, X_t, plus other relevant factors suggested in the literature, Z_t:

$$Margin_t = \alpha + \beta X_t + \gamma Z_t + \eta_t \qquad (1)$$

Descriptive statistics for all variables are provided in Table 1.

A. Fog and Ambiguity Maintenance Effects

The asymmetric information variables, X_t, include dummies to distinguish trades with differing levels of information advantage, taking as the baseline the negotiated trades. One dummy is unity for non-negotiated asset-allocation trades; a second dummy is unity for

income-repatriation trades. The distinction between asset-allocation and income trades will only matter if the obstacles to recovering execution costs can actually be overcome on asset-allocation trades. If not, one more obstacle to inferring execution costs – the fact that asset managers may not even know when income flows arrive – should make no difference.

Custodial banks might attempt to maintain uncertainty about its margin by ensuring that the price charged to the client, P_C, is not viewed as unreasonable. To illustrate, suppose asset managers know that an *x*-percent margin is extreme. If the price on a trade in, say, euros falls outside the day's reported interbank price range by *x* percent or more, the clients would have strong reason to suspect that the margin is unreasonable. To be safe from suspicion, therefore, custody-bank dealers may be careful to quote prices on day *d* within that range:[4]

$$MaxCustodyPriceRange_d = ln[P^H_d(1+x)/P^L_d(1-x)] \approx ln(P^H_d/P^L_d) + 2x/100\ , \qquad (2)$$

where P^H_d (P^L_d) is the day's high (low) interbank price.

As discussed in Section I, the custodian's margin is determined not only by P_C but also by the price at which it covers the trade, P_C or P_{SC}. For currency *c*, the main custodian's maximum sustainable margin consistent with maintaining ambiguity is thus:

$$MaxMargin_c \approx Mean[ln(P^H_d/P^L_d)]/2 + x/100 - AvgSubCustMargin_c - AvgInterBkSprd_c/2. \quad (3)$$

This expression highlights three factors of potential relevance for custodial margins: a currency's volatility, the margins imposed by sub-custodians, and interbank spreads. Realized margins will be sensitive to these factors when banks are constrained by the price range of Equation (2); whether they are ever so constrained is an empirical question.

[4] Foreign-exchange traders at regular dealing banks as well as custody banks have mentioned, anecdotally, that they are discouraged from spreading prices beyond the day's range plus/minus three percent.

We calculate a currency's daily realized volatility using five lags of squared daily returns (data from Global Insight); its annual realized volatility is the sum of squared daily returns over the calendar year. Annual realized volatility for all 27 currencies is shown in Figure 2A. The regressions capture cross-sectional variation in volatility, $CSVol_C$, by the currency's annual volatility divided by the (unweighted) average of annual volatility over the 27 currencies. The regression captures the each currency's volatility history, $TSVol_C$, as its daily realized volatility divided by its annual volatility.

We include a dummy variable that distinguishes the currencies for which sub-custodians are typically involved (1 = sub-custodian involvement). We also include currency-specific measures of average interbank half-spreads. In the absence of any other consistent information on spreads across all these markets, we calculate half-spreads as the (log) difference between exchange rates in Global Insight – which are the average of intraday interbank mid-quotes – and exchange rates in www.Oanda.com – which are the average of intraday interbank ask quotes (all exchange-rate data cover 2006). Since these are quite noisy we include only the sample average for each currency. As shown in Figure 2B, these average half-spreads are a few basis points for the most liquid currencies and are generally below one-half percent. For future reference, we note that interbank spreads for the Chilean peso and the Korean won appear to be outliers, an inference supported by apparent distortions in the underlying Oanda data.

B. Traditional Influences on Bid-Ask Spreads

The literature identifies at least three additional influences on bid-ask spreads that we include in Z_t: fund size, market liquidity, and trade size.

A market maker's most active customers, who generate the most trading profits, can generally expect a volume discount (Bernhardt et al. (2005)). Thus Z_t includes each fund's trading volume in USD millions. As an alternative measure of fund clout we include (log) fund net asset value, also in USD millions, as of December 31, 2006.

Though bid-ask spreads are sometimes used as a measure of liquidity, a precise definition of liquidity continues to elude the profession and it is still possible that spreads can be influenced by liquidity. In the model of Roşu (2009), for example, where traders are sensitive to execution delays, spreads narrow in markets with high activity and low execution delays – which would typically be considered markets with high liquidity. Though data on daily trading activity are unavailable for currencies, we capture cross-sectional variation in trading activity by including a currency's overall trading volume in April, 2007 as a percent of global trading volume (BIS Triennial Survey (2007)). In addition, it is common knowledge in the foreign-exchange market that liquidity tends to be low on Fridays, especially late in the day.[5] We therefore include day-of-the-week dummies, with Monday as the baseline day.

We include (log) trade size because microstructure theory suggests many reasons why trade size itself could influence spreads. However, none of the microstructure arguments appear applicable in the context of custodial trades. Bid-ask spreads could rise with trade size because such trades bring higher inventory risk (Ho and Stoll 1981) and higher adverse-selection risk (Glosten 1989, Easley and O'Hara 1987). But inventory risk should be unimportant for custody-bank traders. As discussed in Section II, the dealers can cover any non-negotiated trade amount before setting the client's price. Dealers at small and mid-sized custodians, like

[5] Regular dealers report that anyone trading late on Fridays should expect to pay wider spreads.

this one, also do not contend with adverse-selection risk, because taking speculative positions is not one of their responsibilities; indeed, some global custodians have prohibited speculative foreign-exchange trading. The literature also suggests that bid-ask spreads could *decline* with trade size in liquid two-tier markets, where dealers have a strategic incentive to attract large trades for their information value (Naik et al. (1997); Osler et al. (2007)). However, information has little value to traders that do not speculate.

Finally, we note that the literature on bid-ask spreads suggests two reasons why volatility might be important. These reasons are unlikely to apply in the custodial context, however, because they rely on inventory risk (Ho and Stoll 1981) and adverse selection (Foucault 1999). Therefore we consider any influence of volatility to be related to the custody-bank's information advantage, as described above.

III. RESULTS

This section first presents the results of running OLS regressions of Equation (1) on our full sample of 27 currencies. It then examines whether the results are robust to modifications in the regression methodology or in the sample.

A. Baseline Regression, Full Sample

The results of running equation (1) on the full sample, presented in Table 2, column 1, provide substantial support for the fog effect. The coefficients on trade-type dummies indicate that margins on non-negotiated trades are 20 basis points wider than margins on negotiated trades, other things equal. This figure, which is quite close to the 17 basis-point difference in average margins reported earlier, is economically substantial. By comparison, interbank half-spreads average just eight basis points (trading-volume-weighted). There is no statistical

difference between margins on income-repatriation and asset-allocation trades, suggesting that ascertaining true execution costs is sufficiently challenging for clients that the additional ambiguity associated with the timing of income trades makes little difference.

The results also support the ambiguity-maintenance hypothesis. Volatility has a positive and highly significant effect in both the cross-section and the time-series. Cross-sectional volatility, alone, appears to account for much of the cross-sectional variation in margins. To illustrate, consider the currencies for which trading does not involve a sub-custodian, one of which is Singapore. Volatility averages 9.6 percent for the group as a whole but only 4.2 percent for the Singapore dollar (SGD is subject to a managed float). The average margin on non-sub-custodial currencies is 30 basis points while margins on Singapore-dollar trades average only 9.8 basis points, a difference of 19.8 basis points. Our estimates suggest that the volatility gap accounts for 15.1 basis points – or 76 percent – of that margin gap.

The coefficients indicate that the involvement of a sub-custodian reduces the main custodian's margins by 11.0 basis points, other things equal, as predicted by the ambiguity-maintenance hypothesis. The ambiguity-maintenance hypothesis does not predict, however, the positive coefficient on the interbank half-spread. As discussed below, this surprising result disappears when we exclude Chile and South Korea, the two emerging markets with apparent errors in interbank price data.

The remaining coefficients have signs consistent with standard theory. The negative and significant coefficient on fund trading volume suggests that a very-active fund trading $10 billion over the year would be charged margins roughly four basis points lower than a fund trading only $100 million over the year (roughly a four standard-deviation difference). The

coefficient on our other measure of fund size, NAV (also a four standard-deviation difference), is also negative and significant, though less important economically since it suggests that the difference in margins between a very large fund ($100 billion NAV) and a fairly small one ($100 million NAV) would only be about 1 basis point. The relative importance of these two variables seems sensible, since dealers are aware of a fund's trading activity but generally do not know a fund's NAV.

As predicted by existing theory, custody-bank margins are narrower for more liquid currencies, but the coefficient implies that margins between the least and most liquid currencies only differ by one basis point, other things equal. Likewise, margins appear to be about 1.7 basis points wider on Fridays, the days with exceptionally low liquidity, than other days. Finally, the results indicate that margins are unrelated to trade size, which is unsurprising since the traditional theories do not seem relevant to the custody-bank context.

B. Robustness

The baseline regression, when estimated on the full sample, produced one result inconsistent with our initial hypotheses: the positive coefficient on the interbank half-spread. This could reflect mis-measurement of the interbank half-spreads for Chile and South Korea (Figure 2B). A review of the underlying data suggests that the Oanda prices, in particular, are often distorted for these two currencies. When we re-run the baseline regression excluding these two currencies, the coefficient on the interbank half-spread becomes negative as expected while the coefficients on most variables are essentially unchanged (Table 2, column 2). Even so, interbank half-spreads appear to have only a modest impact on custody-bank margins. A rise in the interbank half-spread from the level of the euro (2.4 basis points) to the

level of the Turkish Lire (42.3 basis points), a difference of roughly four standard deviations, would reduce the custody-bank margin by only four basis points.

We next test the robustness of our results by experimenting with different estimation approaches. We begin by running a censored regression on all trades with positive margins, to verify that that the small minority of trades with negative margins do not distort our results, while continuing to rely on the sample with only 25 currencies. The marginal effects, reported in Table 3, column 1, are almost identical to the coefficients from the previous regression.

As a second methodological modification, we add individual fund dummies, once again using the 25-currency sample. This could help capture fund-specific variation in margins associated with the pre-specified fee arrangements negotiated between the custodian and each client fund. Some funds prefer to compensate their custodian by paying high up-front fees and low execution costs while others prefer the reverse, and these arrangements can also vary in other ways. As shown in Table 3, column 2, the inclusion of hundreds of fund dummy variables leaves unchanged our conclusions about the influence of custodial banks' information advantage. As found previously, margins on non-negotiated trades are about 20 basis points higher than those on negotiated trades; cross-sectional volatility accounts for a large share of the cross-sectional variation in margins; and the presence of a sub-custodian reduces margins by about 10 basis points. The coefficient on fund trading volume becomes insignificant, which suggests – logically enough – that the most active funds tend to choose compensation packages with smaller margins and higher fees.

We next examine the implications of constraining the sample in various ways. We first examine whether funds that call traders directly to negotiate trades are treated differently

from other funds, since such calls reveal relatively strong concern about execution costs. We continue to exclude trades in the Chilean peso and South Korea won and we run the regression both with and without fund dummies. As shown in Table 3, columns 1 and 2, the results are almost identical to the results obtained with the full sample of firms. We infer that the fog effect and the ambiguity-maintenance hypothesis apply equally to funds of varying sophistication and concern about execution quality.

Since our cross-sectional market liquidity variable might fail to capture important differences among currencies, we run separate regressions for the most liquid currencies and for the emerging-market currencies. The currencies of the six countries in the most-liquid group – Australia, Canada, Europe, Japan, Switzerland, and the U.K. – account for about half of the trades in our sample and a bit more than 60 percent of trade value. The currencies of the 13 countries in the emerging-market group – Brazil, Hungary, India, Indonesia, Israel, Malaysia, Mexico, the Philippines, Poland, South Africa, Taiwan, Thailand, and South Africa – account for 22 percent of trades and 18 percent of trade value.

Once again we run the regressions both with and without fund dummies. The estimated coefficients, shown in Table 3, columns 3 through 6, continue to support our main qualitative conclusions for both groups: margins are substantially higher on non-negotiated trades than negotiated trades, volatility is important the cross-section and over time, and the presence of a sub-custodian dramatically reduces margins at the main custody bank.

Beyond this commonality, the new results are distinct in a few interesting ways. We note first that the coefficient on interbank spreads is insignificant for the liquid currencies but large and significant for emerging-market currencies. This suggests that custody-bank dealers

find themselves constrained by maximum price ranges more frequently for emerging market currencies than developed-country currencies. This seems plausible, given the emerging-market currencies' high volatility, large average interbank spreads, and frequent involvement of sub-custodians. A higher frequency of constrained pricing for emerging-market currencies could also explain why the coefficients on the trade-type dummies are noticeably higher for the most liquid currencies.

The day-of-the-week dummies bring to light another important difference between these two groups of currencies. The Friday dummies are significant for the most liquid currencies and insignificant for the emerging market currencies. In the literature, the potential relevance of liquidity is demonstrated using models that (implicitly) assume liquid markets with no barriers to trading. But nine of our 16 emerging-market currencies were subject to official exchange controls and trades in one more involved a sub-custodian. For such currencies, liquidity would be determined by the market's institutional structure as much as by trading activity, so the estimated connection between trading activity and spreads could be attenuated.

IV. CONCLUSIONS

This paper examines the margins charged by a global custody bank on its foreign-exchange trades with client funds. Most funds take the cost of acquiring or disposing of foreign exchange as a fixed cost of doing business overseas and simply assign the custodian to take care of it. As a result, the clients are not involved in negotiating prices and, in fact, they only learn the prices belatedly in periodic activity reports.

This arrangement, entered into willingly by both parties, gives the custodian's currency dealers a considerable information advantage relative to the clients. While the custody-bank

dealer immediately knows the prices it charges and the effective bid-ask spread, the clients only learn the price, never the bid-ask spread, and they learn the price with a lag. We suggest that custodians set wider margins when the uncertainty or "fog" surrounding their prices is highest. We also suggest that custodians avoid setting extreme prices so as to maintain the ambiguity surrounding their margins.

Our data comprise the complete foreign-exchange trading record of a mid-sized global custody bank for calendar year 2006. Our regression analysis of the determinants of custodial margins suggests that, consistent with the fog effect, margins on standard custodial trades are about 20 basis points higher than when the dealer actually negotiates a price with the customer. Consistent with the ambiguity maintenance hypothesis, we find that margins widen substantially with currency volatility, that they tend to vary inversely with interbank bid-ask spreads, and that they are reduced by about 10 basis points when a sub-custodian is involved. These conclusions are sustained over numerous robustness tests.

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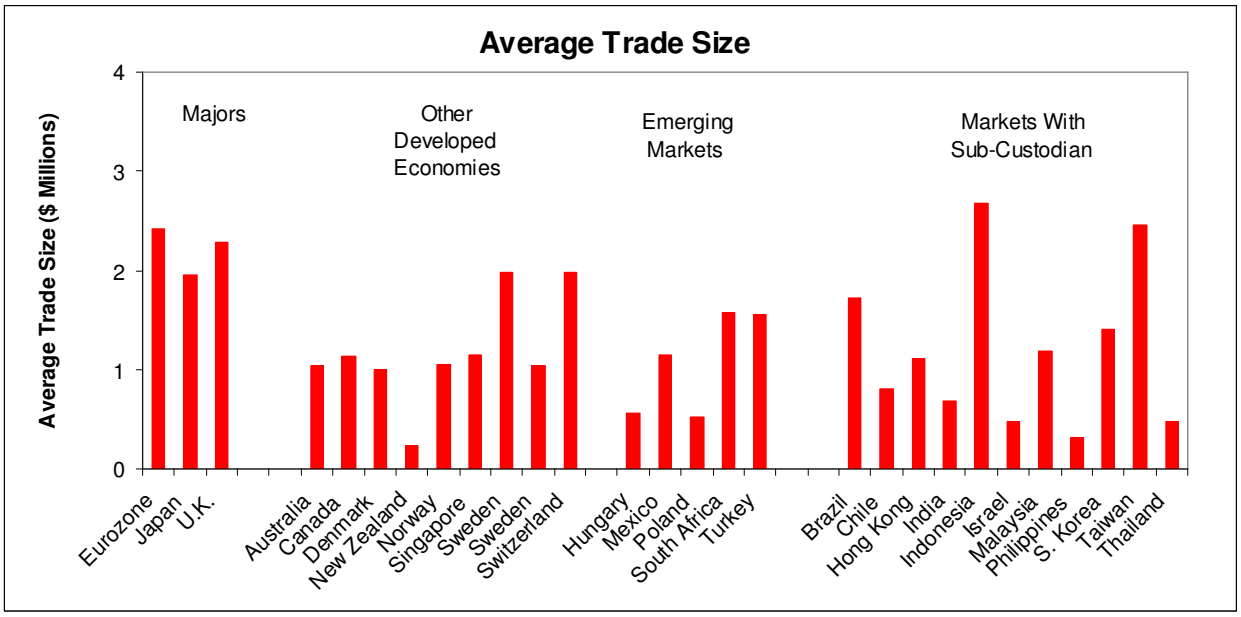
Figure 1: Average Trade Sizes

Sample includes the complete trade record for a mid-sized custody bank during calendar year 2006.



1B: Mean Custody-Bank Margins by Currency

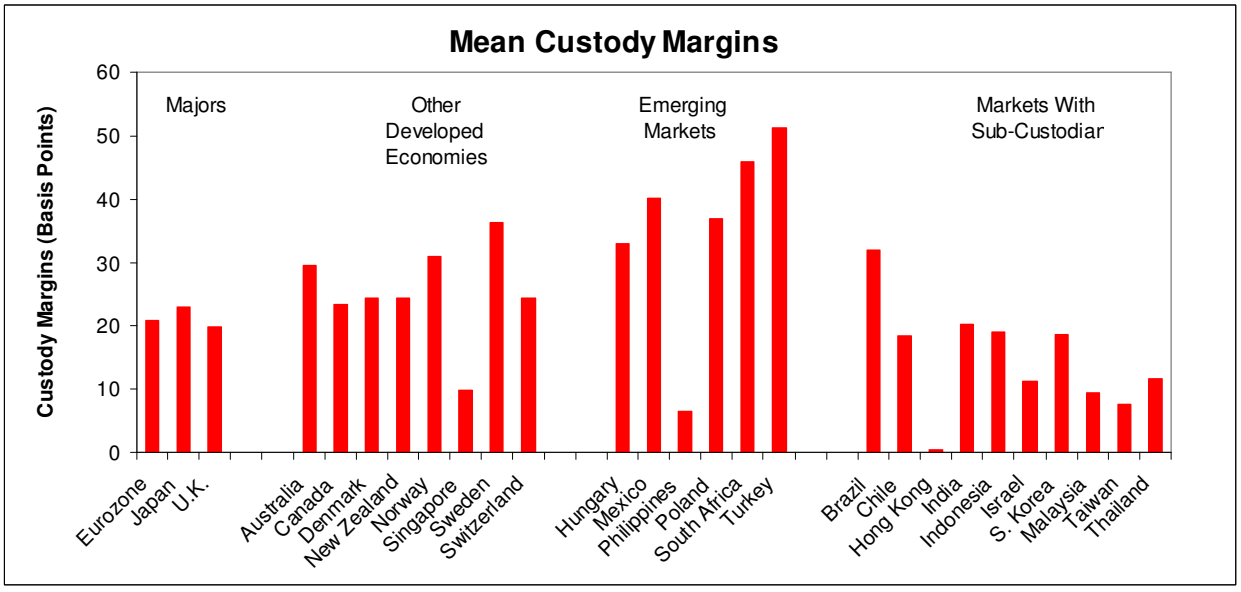
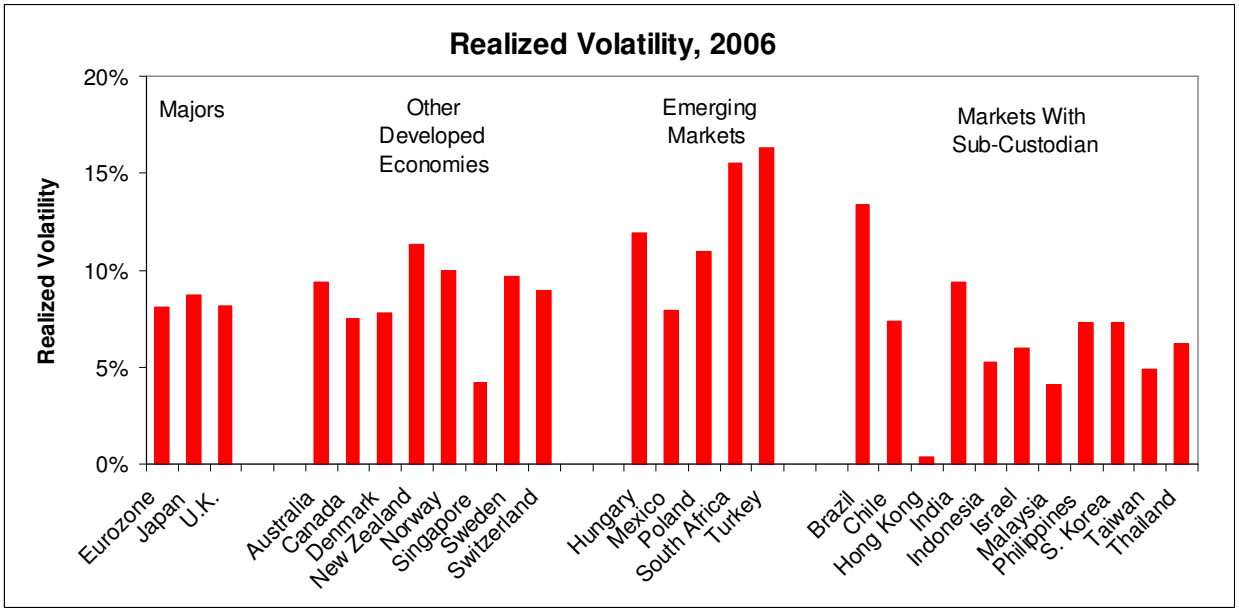


Figure 2: Currency Volatility

Standard deviation of exchange-rate levels during calendar year 2006, relative to average exchange-rate level. Returns based on daily interbank mid-quotes from Global Insight.



2B: Mean Interbank Bid-Ask Spreads, 2006.

Figure shows the mean (log) difference between interbank ask prices provided by www.Oanda.com and interbank mid-quotes provided by Global Insight. Daily data cover calendar year 2006. Units are basis points.

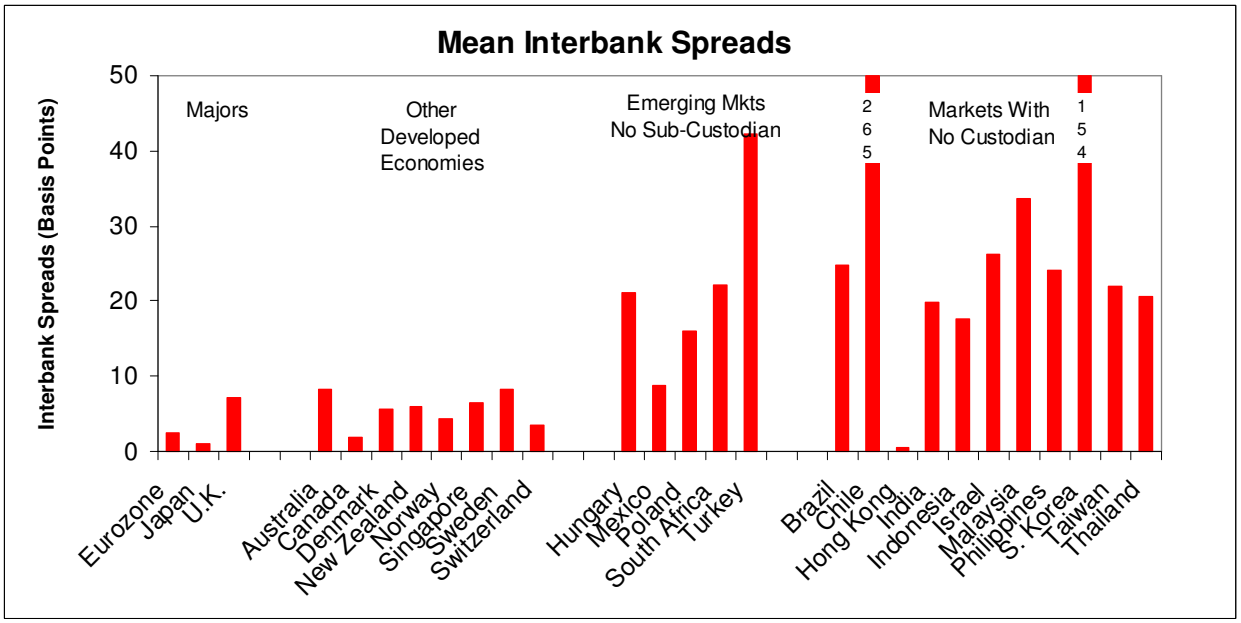


Table 1: Descriptive Statistics

Sample comprises custody-bank margins taken from the complete transaction record for a mid-sized custody bank during 2006. Interbank half-spreads are calculated as the mean (log) difference between average intraday interbank ask prices provided by www.Oanda.com and average intraday interbank mid-quotes provided by Global Insight using weekday data for 2006.

	Mean	Std. Dev.	Min	Max	Skew	Kurtosis
Independent Variable						
Margins in basis points	20.8	49.3	-129.9	6,637.1	86.4	10,984
Asymmetric Information						
Cross-Sec Volatility	0.8	0.6	0.002	3.220	2.0	8
Time-Series Volatility	1.0	1.0	0.001	28.4	5.7	80
Interbank Half-Spread	28.7	55.5	0.5	265.4	3.7	14
27 Currencies	14.2	11.2	0.5	42.3	0.7	-0.1
25 Currencies						
Traditional						
Fund Trading Volume	$1.0 bn	$2.6 bn	$0.0 bn	$16.4 bn	3.9	20
Fund NAV	$1.6 bn	$3.4 bn	$0.0	$2.5 bn	4.3	27
(Log) Fund NAV	4.8	3.9	-18.1	10.1	-3.2	14.9
Market Liquidity	11.4%	13.3%	0.1%	37.0%	1.1	3
(Log) Market Liquidity	-3.6	1.8	-6.9	-1.0	-0.5	2
Trade Value	$1.7 mn	6.8	$1.0	$479 mn	26.8	1,332
(Log) Trade Value	12.3	2.4	0	20.0	-0.7	4

Table 2. Baseline Regressions: Determinants of Custody-Bank Margins

Table shows the results from running the following regression:

$$Margin_t = \alpha + \beta X_t + \gamma Z_t + \eta_t ,$$

where X_t comprises variables relevant to the information asymmetry between custodians and their client funds and Z_t comprises the control variables. OLS with robust standard errors. Sample comprises custody-bank margins taken from the complete transaction record for a mid-sized custody bank during 2006.

Independent Variable: Margin	Baseline	25 Currencies
Fog		
Reg. Asset-Allocation (+)	19.6***	20.0***
Income Repatriation (+)	20.0***	20.6***
Ambiguity Maintenance		
Cross-Sec Volatility (+)	11.7***	12.4***
Time-SeriesVolatility (+)	2.7***	2.5***
Subcustodian (-)	-11.0***	-11.2***
Interbank Half-Spread (-)	0.03***	-0.1*
Traditional		
Fund Trading Volume (-)	-0.5***	-0.5***
Fund NAV (-)	-0.1***	-0.1*
Market Liquidity (-)	-0.7**	-1.3**
Tuesday	0.9	0.8
Wednesday	0.8	0.9
Thursday	0.6	0.8
Friday (-)	1.7***	2.0***
Trade Value	0.1	0.2
Constant	-10.0***	-12.4***
Adjusted R^2	0.051	0.052

Table 3: Methodological modifications

Table shows the results from running the following regression:

$$Margin_t = \alpha + \beta X_t + \gamma Z_t + \eta_t ,$$

where X_t comprises variables relevant to the information asymmetry between custodians and their client funds and Z_t comprises the control variables. Column 1 reports marginal effects from a censored regression on trades with positive margins. Column 2 reports coefficients from OLS estimation with robust standard errors when individual fund dummies are included in Z_t. Sample comprises custody-bank margins taken from the complete transaction record for a mid-sized custody bank during 2006.

Indep Variable: Profits/$	Baseline Censored	With Fund Dummies
Fog		
Reg. Asset-Allocation (+)	20.4***	19.4***
Income Repatriation (+)	21.0***	21.2***
Ambiguity		
Cross-Sec Volatility (+)	12.4***	12.0***
Time-SeriesVolatility (+)	2.5***	2.5***
Subcustodian (-)	-11.1***	-10.4***
Interbank Half-Spread (-)	-0.1	-0.1
Traditional		
Fund Trading Volume (-)	-0.5***	-0.0
Fund NAV (-)	-0.1	-4.4***
Market Liquidity (-)	-1.3***	-0.7**
Tuesday	0.8	0.9 **
Wednesday	0.9	1.1***
Thursday	0.9	1.1**
Friday (-)	2.1**	2.1***
Trade Value	0.2	-0.2
Constant	NA	18.1***
Adjusted R^2	0.051	0.052

Table 4: Regressions with Constrained Samples

Table shows the results from running the following regression:

$$Margin_t = \alpha + \beta X_t + \gamma Z_t + \eta_t ,$$

where X_t comprises variables relevant to the information asymmetry between custodians and their client funds and Z_t comprises the control variables. OLS with robust standard errors. Sample comprises custody-bank margins taken from the complete transaction record for a mid-sized custody bank during 2006.

Indep Variable: Profits/$	Funds That Call Directly		Most Liquid Currencies		Emerging-Market Currencies	
Individual Fund Dummies?	No	Yes	No	Yes	No	Yes
Fog						
Reg. Asset-Allocation (+)	19.6***	19.7***	22.3***	23.7***	18.4***	15.8***
Income Repatriation (+)	18.0***	20.7***	24.7***	27.2***	11.5***	10.3***
Ambiguity						
Cross-Sec Volatility (+)	12.3***	11.9***	17.1***	14.6***	11.0***	10.7***
Time-SeriesVolatility (+)	2.9***	2.9***	1.1***	1.0***	4.0***	4.0***
Subcustodian (-)	-10.1***	-9.8***	NA	NA	-11.3***	-11.6***
Interbank Half-Spread (-)	-0.2***	-0.2**	-0.1	-0.1	-0.6***	-0.4***
Traditional						
Fund Trading Volume (-)	-0.3***	-0.8***	-0.7***	-0.9***	0.7**	-0.7
Fund NAV (-)	-0.0	0.4	-0.2***	0.2	-0.0	1.0**
Market Liquidity (-)	-2.0***	-1.4***	-0.7**	-0.2	-1.8	-0.4**
Tuesday	1.2**	1.4**	0.6	0.6	0.5	0.3
Wednesday	1.8***	1.3***	-0.9	-0.9	5.5	6.4
Thursday	0.9***	1.9***	0.2	0.2	1.9	2.6
Friday (-)	1.7**	1.9**	2.9***	2.9***	-0.3	0.5
Trade Value	-0.1	-0.3	0.2**	-0.3*	-0.5	-0.6**
Constant	-11.5***	-11.0***	-16.5***	-16.5***	5.7	15.3
Adjusted R^2	0.041	0.028	0.095	0.028	0.028	0.028