Capital flows, portfolio balance effects, and foreign exchange returns: The case of Thailand*

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Abstract

The influence of investors' portfolio rebalancing decisions for exchange rates is a topic of long-standing interest in international finance. In this paper we propose a novel, market microstructure based theory of the operation of portfolio balance effects, by tying the influence of international capital flows on exchange rates to their revelation of investors' private information about asset returns. Using data for Thailand, we present compelling empirical evidence that portfolio rebalancing flows that are associated with investors' private information have significant effects on the exchange value of the baht. We find that the portion of nonresident investors' FX market order flow in Thailand that is explained by their activity in the Stock Exchange of Thailand has a more pronounced as well as a longer-lasting effect on the baht than other categories of order flow. Our results are based on daily-frequency data covering the 2005 and 2006 calendar years. One novel and so far unused daily-frequency dataset contains all FX market capital flows between banks in Thailand and their nonresident customers. We also use data on daily-frequency returns and and capital flows undertaken by nonresident investors in the stock and bond markets of Thailand.

JEL classification: C32, F31, E58, G14.

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1 Introduction

Understanding the determinants of international capital flows and the role that foreign investors play in international capital markets have been long-standing objectives of the international finance research. The significant growth of international capital flows over the past few decades has resulted in a similar increase in the interest shown in these topics by economic policy makers. Researchers, policy makers, and financial institution directly involved in foreign exchange (FX) trading understand that these capital flows depend on both public information and investors' private information. To the extent that dispersed private information is revealed through capital flows, these flows should affect asset returns systematically. FX dealing banks therefore monitor their own customers' capital flows closely and develop in-house models of FX returns based on their partial information about aggregate capital flows. Economic policy makers are also interested in issues related to the explainability and stability of capital flows in foreign exchange markets and the relationships between external capital flows and developments in the domestic financial system.[1]

Since the mid-1970s, economists have examined the implications of relaxing the assumption—which was embedded in earlier models of FX rate determination—that bonds and other riskless assets denominated in various currencies are perfect substitutes. If exchange rate risk cannot be fully hedged, then bonds denominated in various currencies must differ in at least this aspect of risk. In order to minimize the risk that arises from exchange rate variability, it follows that investors will choose their bond portfolios—as well as, more generally, their portfolios of equities and other financial assets—between domestic-currency and foreign-currency denominated assets in proportions that depend on expected relative rates of return and expected risk premia. If expected rates of return change, then capital flows should occur so as to rebalance investors' international asset holdings. This strand of the FX literature is commonly labeled as the portfolio balance approach.[2]

Portfolio balance models occupy an important place within exchange rate economics literature because they provide plausible scenarios in which international capital flows should help explain exchange rate fluctuations. However, early attempts to detect this implication of the models in actual data were generally unsuccessful. The general lack of empirical evidence in

[1] For a discussion of these issues focused on Thailand see the anthology by Phongpaichit and Baker (2008).

[2] See Kouri (1976), Branson (1977), Frankel (1983), Branson and Henderson (1985), and the survey by Lewis (1995).

favor the portfolio balance hypothesis likely reflected, in part, the fact that many of the early studies relied on low-frequency data. Because capital flows can fluctuate a lot from day to day and are often mean-reverting at high frequencies, the use of lower-frequency data reduces the signal-to-noise in the capital flow series and thus makes it less likely to detect any links between capital flows and exchange rates. In addition, the first generation of empirical portfolio balance models focused mainly on the supply of financial assets and was less concerned with modelling the demand side of asset markets. Since the initial generation of portfolio balance exchange rate models employed asset demand functions that were "postulated" rather than based explicitly on micro foundations, it was also unclear how phenomena such as private information and differences in sophistication across investors might be incorporated or what their effects (if any) on exchange rates could be.[3]

More recently, research has focused on developing models of the demand for international assets that incorporate explicitly the roles of the microstructure of markets and of information held by investors for price formation.[4] The market microstructure literature and the noisy rational expectations literature have established the crucial importance of taking into account carefully both the structure and organization of markets as well as the heterogeneity of information held by investors in order to explain price formation. A fundamental insight from this research is that traded quantities reflect both institutional constraints as well as information heterogeneity. Thus, both aspects need to be modelled in order to understand the price formation process. This literature has established that *order flow*, a concept of net trading volume defined as the difference between the volume of buyer-initiated transactions and the volume of seller-initiated transactions, is a key factor in explaining asset prices. According to this literature, order flow helps to explain asset returns for three reasons: (i) inventory effects, (ii) liquidity effects, and (iii) because it aggregates and conveys private information held by investors that is only later embedded in publicly available information; see Osler (2008).

[3]In addition, these models—as well as the earlier "monetary" models of exchange rate determination—were found to perform poorly out of sample, and their ability to forecast exchange rates was no better than that of the naïve "random walk" model; see Meese and Rogoff (1983). This finding also applies to the vast bulk of models developed since the early 1980s that relate exchange rates to "macro" fundamentals; see, e.g., Cheung et al (2005).

[4]For general introductions to the market microstructure literature, see O'Hara (1995), Madhavan (2000), and Hasbrouck (2006). For applications of market microstructure concepts to FX markets, see the survey by Osler (2008) and the contributions of Lyons (2001), Evans and Lyons (2002), Froot and Ramadorai (2005), Rime et al (2007), and Berger et al (2008).

For applications to stock markets, see the monographs by Harris (2003) and Hasbrouck (2006). For applications to bond markets, see Fleming and Remolona (1999), Brandt and Kavajecz (2004), Green (2004), Chen et al (2007), and Pasquariello and Vega (2007). Among the studies that analyze market microstructure issues across two or more markets are Campbell and Ammer (1993), Chordia et al (2005), Francis et al (2006), Dunne et al (2004), and Cohen and Remolona (2008).

Our paper has two main objectives. First, we test empirically whether twelve hypotheses that have been proposed in the recent market microstructure literature and the new portfolio balance literature can help explain activity in financial markets in Thailand. The hypotheses serve to model the behavior of foreign investors in the financial markets of Thailand, a large and important emerging market economy. Specifically, we investigate how information asymmetries in the onshore FX, stock, and bond markets between domestic and foreign investors, as well as between "sophisticated" and "unsophisticated" investors, affect the trading activity of foreign investors in financial markets in Thailand. Our empirical work makes use of a novel and so far unused daily-frequency dataset for Thailand, which contains two years of daily-frequency FX market capital flows between banks in Thailand and their nonresident customers. In addition, we also use data on capital flows by nonresident investors in the stock and bond markets of Thailand. The new datasets were compiled by the Bank of Thailand (BOT), the Stock Exchange of Thailand (SET) and the Thai Bond Market Association.[5]

We find that net capital flows of nonresident investors are statistically highly significant for explaining returns in the onshore FX market in Thailand as well as in the stock and bond markets in Thailand, and that once the influence of these capital flows is taken into account, macro variables explain only a small part of the variation of FX rates and stock prices in Thailand. We find, as others have done before us for a number of industrial economies, that the dynamics of foreign investors' trading activity in the stock market of Thailand are consistent with the idea that they are less well informed on average than "local" (i.e., Thai) investors and that there is also substantial heterogeneity in the degree of sophistication of foreign investors. Conversely, we find that foreign investors' trading activity in the government bond market of Thailand is not characterized by information asymmetry (relative to local investors) or sophistication heterogeneity, and thus that private information does not appear to play a significant role in foreign investors' net purchases or sales of government bonds. Overall, these findings strongly support one of the central tenets of the market microstructure literature, that order flow helps explain asset returns because it aggregates and conveys private information.

Second, and crucially, we build on these hypotheses to propose and test a new, market microstructure-based theory of the portfolio balance effect. We assert that not all capital flows should have the same effect on the exchange rate; rather, only the portion of capital flows

[5]The data for the Thai stock market have also been used by Chai-Anant and Ho (2008). A recent study that examines the information content of ultra-high frequency SET data is that by Pavabutr and Sirodom (2007).

that is related to and reveals investors' private information about asset returns should influence exchange rates. (A detailed exposition of this proposition is provided in Subsection 2.3 below.) To test this assertion empirically, we formulate two hypotheses—which we label "conjectures" to help distinguish them from the twelve hypotheses considered elsewhere in the paper—about the relationship between FX order flow and FX returns. These conjectures combine our earlier findings, that foreign investors' activity in the SET appears to be linked strongly to private information whereas their activity in the government bond market is not, with our knowledge that foreign investors' activity in the domestic financial markets in Thailand is generally linked tightly to their activity in the FX market, to make the following predictions. The first conjecture is that the portion of foreign investors' two-day spot FX market order flow that is driven by these investors' activity in the stock market in Thailand has a statistically significant and permanent effect on the baht's exchange value, whereas the remaining portion of order flow in the two-day spot segment has at most a transitory effect. The second conjecture postulates that foreign investors' one-day spot FX market order flow that is driven by their activity in the government bond market does *not* affect exchange rates.[6] Our empirical results strongly support both conjectures. For the case of two-day spot FX market segment, we find that the fraction of foreign investors' FX order flow that is associated with their equity market activity has an effect on the baht that is about four times as large as that of all other order flow in this segment. Moreover, we find that the effect of an innovation in the stock market driven two-day spot order flow on the exchange rate is permanent, whereas that of other innovations is not. In addition, we find that the portion of foreign investors' one-day spot order flow that is explained by their bond market transactions has no statistically significant effect on the exchange rate, confirming the second conjecture.

Our study thus makes several novel contributions to the market microstructure literature and to the open economy macro literature. On the market microstructure side, (i) we combine several hypotheses that have been proposed by other researchers to create two novel conjectures, and (ii) we test both the earlier hypotheses and the new conjectures using daily-frequency data that cover a period of nearly two full calendar years and cover comprehensively the purchases and sales by foreign investors of assets in three financial markets of one economy. Compared

[6] As we will report in more detail later in this paper, foreign investors' purchases and sales of shares are generally associated with flows in the two-day settlement segment of the spot FX market, whereas their purchases and sales of government bonds appear to be more closely associated with flows in the one-day settlement segment of the spot FX market.

with other related empirical market microstructure studies, our work is distinguished by the sample's high observation frequency, its relatively long duration, and its inclusion of financial market time series from not just a single market, but from three markets in an economy, and the comprehensive nature of the coverage of (foreign) investors' activity. On the open economy macro side, this work serves to propose and confirm empirically a new theory of the operation of portfolio balance effects on exchange rates: Only the portion of international capital flows that is driven by investors' private information has effects on exchange rates that are both statistically significant and permanent; other capital flows do not have this property.

Moreover, our study is—to the best of our knowledge—the first of its kind that conducts an empirical, market microstructure based analysis of the joint dynamics of returns and foreign investors' activities in the FX, stock and bond markets of a major emerging market economy. As such, our study not only provides new information on aspects of the financial market dynamics in this important economy, but it also helps to highlight commonalities and differences between the market dynamics in Thailand and the market dynamics in more-developed economies, which have so far been the subject of most of the published research in this field.

The remainder of this paper is structured as follows. Section 2 provides a brief review of the relevant recent literature and lists the 12 hypotheses and 2 conjectures we test subsequently in this paper. Section 3 provides an overview of the three financial markets of interest and introduces the datasets used in our study. In Section 4 we examine the empirical evidence for and against each of the hypotheses postulated in Section 2. Section 5 concludes.

2 Literature review and hypotheses

To explain the empirical regularities in FX and stock market order flow data, economists have for over a decade developed models that incorporate detailed assumptions, using "micro" foundations, about the dispersion of private information among investors, and they have derived empirically testable implications of these assumptions while also assuming that economic agents make use of their information in an optimizing or equilibrium framework. In this section we list twelve of these hypotheses, grouping them according to whether their implications are obtained mainly from assumptions about differences in information across investors or from portfolio balance considerations. We formulate the hypotheses in a way that is most readily relevant for financial markets in Thailand. However, they are of course more broadly applicable than just to

the case of Thailand. In the final subsection, we show that these hypotheses may be combined to set forth two novel hypotheses, which we label "conjectures," about important linkages between external capital flows and exchange rate fluctuations.

2.1 Eight hypotheses related to the effects of information heterogeneity

Several recent papers have considered the impact of heterogeneous information—specifically, dispersed information about future macroeconomic fundamentals—for exchange rate determination; see the survey by Osler (2008) and the article by Bacchetta and Wincoop (2006). The implications of these models which are most pertinent for our study are that (i) the exchange rate should be related closely to FX order flow and (ii) observed macroeconomic fundamentals should explain only a small part of high-frequency exchange rate volatility. Thus, if there is heterogeneity in information about future macroeconomic fundamentals for Thailand, the following empirical hypotheses should hold.

Hypothesis 1 *Thai baht returns should be linked closely to FX market order flow.*

Hypothesis 2 *Observed macroeconomic fundamentals should explain only a small fraction of Thai baht volatility.*

For equity markets, building on the work of Admati (1985) on multi-asset noisy rational expectations models and the work of Wang (1993, 1994) on intertemporal asset pricing in the presence of asymmetric information, Brennan and Cao (1997) developed and examined empirically the implications of the information asymmetry assumption for equity prices in an international context. One of their key assumptions is that domestic or "local" stock market investors have more precise information about future returns on equities than foreign investors have. They showed that if at the start of each trading period foreign investors are less well informed about payoffs on equities than local investors are, (i) there will be a home bias in portfolio holdings and (ii) foreign investors' net purchases of local stock will depend positively on lagged returns in the local stock market. The latter behavior has also been dubbed "trend following." They tested these predictions by examining quarterly data on U.S. investors' purchases and sales of equities in 16 emerging markets and 4 industrial markets. They found that U.S. investors' purchases in the local markets were positively associated with both concurrent-quarter and previous-quarter returns on the local market indices and that these findings were stronger for emerging markets

than for markets of industrial economies. They interpreted these results as being consistent with the implications of the information asymmetry assumption.

Dunne et al (2004) developed a model of equity markets in two countries, in which investors have heterogeneous beliefs and in which belief changes are shown to be observable through order flow. In an empirical application using 5 years of intraday data on U.S. and French stock market transactions and the dollar-euro exchange rate, they reported that a substantial fraction of the variation of returns in both equity markets in the FX market is explained by foreign exchange and stock market order flow. Importantly, they found that returns in the two equity markets are explained not only by own-market order flow but also by order flow in the overseas market.

Thus, if there is information heterogeneity between domestic and foreign investors with respect to Thai equity returns, the following three empirical hypotheses should hold.

Hypothesis 3 *Thai equity market returns should be linked closely to foreign investors' equity market order flow.*

Hypothesis 4 (Flow momentum in equities) *Nonresident investors in Thailand change their positions in equities slowly, and their current net equity purchases are accounted for in part by their recent net equity purchases.*

Hypothesis 5 (Return Chasing) *Foreign investors tend to be net buyers of Thai equities when returns in the Thai equity market are positive and net sellers when returns are negative.*

Also for equity markets, Albuquerque et al (2007) note that in addition to cross-country heterogeneity in the investors' information sets, there may well be important within-country heterogeneity in the information sets of investors. They examine two interesting cases. First, whereas the average foreign investor may know less about local equity markets than the average local investor, some foreign investors may be as well informed about local market conditions as the best-informed local investors. Second, knowledgeable (foreign) investors—termed "sophisticated" investors by the authors—not only may have better information than other (foreign) investors about future stock returns but also have a greater ability to locate off-market or private information opportunities. Using monthly data on the stock markets in the non-U.S. G7 economies, they report that the average U.S.-based investor indeed appears to have less information than the average local investor. They also find, however, that any cross-country differences in average investor information sets are much less important than the within-country

differences between sophisticated and unsophisticated investors. In addition to being able to explain two of the well-established empirical regularities mentioned above about U.S. investors' net purchases in foreign stock markets (flow momentum and return chasing), their model also makes a novel prediction about *gross* flows of foreign investors in local equity markets: if there is important heterogeneity in foreign investors' knowledge of local markets and in their sophistication, one should expect to observe a strong positive contemporaneous correlation between foreign investors' gross purchases and gross sales in a local equity market. Albuquerque et al (2007) indeed find that gross purchases and sales of equities by foreign investors tend to be strongly positively correlated in many stock markets. Thus, if there is significant information heterogeneity across foreign investors in Thailand, the following empirical hypothesis should hold.

Hypothesis 6 *There is strong positive contemporaneous correlation between foreign investors' gross buying and selling of Thai equities.*

Conversely, insofar as private information and heterogeneity in foreign investors' sophistication are less relevant for transactions in bond markets than they are in equity markets, we should expect that the contemporaneous correlation of gross buys and gross sells by foreigners in the Thai bond market should be considerably lower than it is in the Thai equity market.

Hypothesis 7 (Absence of flow momentum in bonds) *Nonresident investors' current net bond purchases are not explained significantly by their recent net purchases of bonds.*

Hypothesis 8 *There is little contemporaneous correlation between foreign investors' gross buying and selling of Thai bonds.*

2.2 Four hypotheses related to portfolio rebalancing decisions by foreign investors

In addition to the market microstructure contributions that focus on the effects of information heterogeneity, such as that between local and foreign investors, there are also some recent contributions that focus directly on the portfolio rebalancing decisions in response to changes in returns. For example, Hau and Rey (2004, 2006) use a dynamic equilibrium framework to analyze the joint dynamics of equity returns, equity flows, and exchange rate returns and their implications for portfolio choices of investors. Their key assumption, which is supported by

survey evidence, that international investors hedge only a minor portion of the actual FX risk in their portfolios. In addition, they assume that the supply of foreign currency provided by local financial institutions (incl. the central bank) is less than perfectly elastic.[7]

Under these assumptions, Hau and Rey (2004, 2006) posit that their model has three main empirical implications. They are, (i) exchange rates should be almost as volatile as equity prices, (ii) net equity inflows into the foreign equity market should be positively correlated with an appreciation of the foreign currency, and (iii) higher returns in the foreign equity market (expressed in home-currency terms) relative to returns in the "home" equity market should be associated with a *depreciation* of the foreign currency. This final implication, which arises directly from a portfolio rebalancing argument, contradicts the conventional intuition that strong home equity market returns should be associated with an appreciation of the home currency. The authors tested these implications of their model using daily, monthly, and quarterly stock index and exchange rate data for 17 OECD countries and reported that their hypotheses were supported by the data.

Transposed to the case of financial markets in Thailand, if foreign investors do not hedge their FX exposures fully and if the supply of dollars in the Thai onshore market is not perfectly elastic, the following empirical hypotheses should hold.

Hypothesis 9 *Returns in the Thai FX market are almost as volatile as in the Thai stock market.*

Hypothesis 10 *Net equity inflows into the Thai stock market by foreign investors are positively correlated with appreciations of the Thai baht.*

Hypothesis 11 (Portfolio rebalancing 1) *Higher US-dollar denominated SET returns relative to US equity market returns lead to decreased net purchases of Thai equities by foreign investors.*[8]

Hypothesis 12 (Portfolio rebalancing 2) *Higher US-dollar denominated SET returns relative to US equity market returns are associated with a depreciation of the Thai baht.*

[7] This assumption rules out the case of a fully-pegged exchange rate system, in which the monetary authorities intervene to offset the effects of any capital in- or outflows on the exchange rate and, in the process, make the supply of foreign currency fully elastic.

[8] This hypothesis is also considered by Brennan and Cao (1997) as a consequence of wealth effects that could affect investors' preferred international portfolio composition.

2.3 Two novel conjectures on the relationship between capital flows and exchange rate fluctuations

The preceding hypotheses have been explored in the literature and have generally been found to be consistent with the data. Building on these hypotheses as well as on our knowledge that foreign investors' transactions in the stock and bond markets of Thailand are linked by regulations quite closely to their activity in the FX market, we are able two additional, novel hypotheses on the linkages between FX market order flow and FX returns, i.e., on the properties of the portfolio balance effect.

Portfolio balance effects follow directly from equilibrium theories of portfolio choice, such as the CAPM. Internationally diversified investors hold assets across economies in ways that balance expected returns and ex-ante risks (measured, say, by expected variances and covariances). In response to various shocks, the relative prices of assets (including exchange rates) will adjust, but the full adjustment to a new equilibrium will usually also entail sales of assets in some economies and purchases of assets in other economies and thereby induce international capital flows as investors transfer funds from one economy to another. Market makers in the foreign exchange markets frequently observe not only their customers' FX transactions but also have a reasonably good idea as to why these transactions occur. Of course, not all capital flows will be driven by portfolio readjustments; they could also occur for liquidity reasons (Kyle, 1985). Some transactions that are related to international portfolio rebalancing activity will occur in response to public news, while others will be based on investors' private information. For example, if an FX market maker believes (or knows) that a customer's purchase of baht will be used to acquire shares of a firm listed on the SET, this reveal something not only about the investor's private information about the value of that firm but also about the demand for baht-denominated assets, and the market maker will respond by adjusting upwards her quoted bid and ask rates for the baht, causing an appreciation of the baht. On the other hand, suppose that an FX dealer knows that a customer has sold Thai government bonds and is selling the baht proceeds for dollars to comply with government regulations on permissible bank balances; if the FX dealer has reason to believe that this transaction does not reveal private information about future government bond or asset returns, it will also not induce her to adjust her bid and ask quotes for the baht against the dollar.

We make this proposition operational and empirically testable by focusing on the relationships between foreign investors' aggregate transactions in the FX, stock and government bond markets in Thailand. Starting from the hypotheses (i) that foreign investors' private information revealed through order flow affects returns in the stock market, (ii) that their activity in the government bond market should not be driven noticeably by private information, and (iii) that portfolio rebalancing flows should matter for FX returns only if they reveal private information, we conjecture that any empirical evidence for effects of foreign investors' FX market order flow on FX returns is, in fact, mostly a consequence of those transactions in the Thai financial markets (and the stock market in particular) that are driven importantly by private information. In consequence, the portion of FX order flow that is associated with foreign investors' equity portfolio rebalancing decisions should have a stronger effect on the Thai baht than other types of foreign investors' FX market order flow may have. If this is the case, the following empirical hypothesis or conjecture should hold.

Conjecture 1 *FX order flow driven by foreign investors' Thai equity portfolio rebalancing operations should have a large and permanent impact on the Thai baht.*

Conversely, if foreign investors' information on future returns to government bonds is less heterogeneous and therefore if private information is less of a factor driving their activity in the bond market, a related conjecture may be formulated for the relationship between foreign investors' bond market portfolio rebalancing decisions, induced FX market order flow, and FX returns. In particular, one may speculate that if such portfolio rebalancing decisions generate order flow in the FX market, this type of order flow does not reveal agents' private information but rather reflects liquidity or noise trading and therefore should have, at most, only a small impact on the baht.

Conjecture 2 *FX order flow driven by foreign investors' Thai bond portfolio rebalancing operations has at most a small and transitory impact on the Thai baht.*

3 The markets and the data

3.1 Sample period and definition of nonresident investors

All observations are daily. The data we received run from the beginning of 2005 through early 2008. However, we chose to restrict our sample period to the period from January 2005 until 15

December 2006. On Tuesday, 19 December 2006, the Thai authorities imposed additional and very stringent capital control measures, highlighted by a 30% unremunerated reserve requirement (URR) on nonresident investors' financial holdings apart from stock market holdings. The introduction of these measures caused an abrupt and severe structural break in the behavior of financial markets in Thailand, and for this reason we chose to terminate the sample period on Friday, 15 December 2006.[9] Despite occasional bouts of volatility in returns during the sample period, we did not find evidence of structural breaks during this period.

Regulations governing the onshore FX market in Thailand establish links between FX market and other financial markets for nonresident investors that are probably closer in Thailand than in other economies. We therefore include a review of some of these institutional details in this section along with a description of the data.

Throughout this paper, we will refer frequently to nonresident end-users or investors. Formally, this group comprises (1) corporations, institutions, funds, financial institutions or juristic persons located outside Thailand; (2) Entities of foreign governments located outside Thailand; (3) Branches and agents of domestic juristic persons located outside Thailand; and (4) Natural persons not of Thai nationalities who do not have alien identity or residence permits.

3.2 The onshore FX market in Thailand

The structure of the wholesale onshore FX market in Thailand is similar to that in many other countries. There is no single organized exchange that handles FX transactions; rather, the market is over the counter. Licensed currency dealers, which can be domestic or foreign-owned banks and brokers, provide wholesale FX trading services in Thailand. At the beginning of 2005, there were 39 licensed FX dealers; 21 were domestic financial institutions, and 18 were subsidiaries of foreign financial institutions. After a couple of mergers in late 2005, the number of FX dealers in Thailand was 37 during all of 2006 (20 domestic and 17 foreign). Transactions between FX dealers involving baht as one of currencies are undertaken either directly, i.e., dealer-to-dealer, or indirectly via brokers.[10] The FX dealing institutions in Thailand have a self-regulatory organization called the ACI, an association registered under the Thai Bank

[9] After December 2006, foreign investors' participation in the financial markets in Thailand dropped off severely. The URR and related restrictions were lifted on 2 March 2008; in future work, we intend to examine whether this change caused another structural break and, in particular, if linkages across markets from March 2008 onward resemble those that prevailed prior to mid-December 2006.

[10] Most dealers also have access to the EBS or Reuters platforms in order to execute deals in the major currency pairs such as dollar-euro.

Association, and have established a Code of Conduct and Derivatives Manual as a guideline for operations in the FX market.

All licensed FX dealers must submit detailed reports of their FX transactions on a daily basis to the Bank of Thailand (BoT).[11] In the banks' daily reports, each transaction record states the counterparty, its type (other dealer, domestic customer, nonresident customer, and Bank of Thailand), the volume (in dollar equivalent), the currencies involved (by far the majority of all transactions are in Thai baht vs. U.S. dollars), the applicable exchange rate, and the type of transaction. The five types of transactions are spot (separated further into same-day, "tomorrow" or next-day, and "next" or $T + 2$ transactions), outright forwards ($T \geq 3$, with settlement date), and FX swaps.[12]

Onshore commercial banks are required by the Bank of Thailand to limit their net FX positions in any one currency to no more than 15% of capital (individual currency limit) and to maintain a net overall FX position across all foreign currencies of no more than 20% of capital (aggregate currency limit) at the end of each day. Dealers usually manage to adhere to these limits by conducting transactions in the FX swaps markets. The position limits tend to be particularly important for the branches of foreign banks that operate in Thailand. The Bank of Thailand discourages nondeliverable forward (NDF) trading activity involving Thai baht and has asked onshore financial institutions not to participate in the offshore NDF market, as active participation in the offshore NDF market would mean that an important part of the reporters' FX market activity could not be monitored by the Bank of Thailand. Individual bank reports are aggregated by the BOT.

Of crucial importance to our study is the fact that each transaction is classified as either a "buy" or a "sell." Because all transactions are recorded from the point of view of the reporting bank, a "buy" consists of a *purchase of dollars* (or other foreign currency) by the reporter and hence a *sale of baht* to the counterparty.[13]

[11] The banks submit both "quick" and "clean" reports to the BoT. The banks' "quick" reports, which they must submit to the BoT four times during each business day, comprise only large transactions of at least US$1 million, and they are used mainly for market surveillance purposes. The banks also provide more comprehensive "clean" reports to the BoT with a lag of about 1 week. In this study, we use data from the reporters' "clean" reports.

[12] The dealers' "clean" reports also contain records of FX transactions that do not involve the Thai baht as one of the currencies. For example, reporting banks based in Thailand may execute (and must report) dollar-yen or euro-sterling transactions. We do not include such transactions in our datasets because they do not affect directly the exchange value of the Thai baht.

[13] Unfortunately, the records do not contain information on which counterparty—the reporter or the customer—was the initiator of the transaction. In addition, the transaction records do not contain time-stamp information and frequently are not provided in chronological order, making it impossible to use them to construct intraday

With this information, we constructed daily-frequency *gross* and *net* capital flow series for all 5 types of FX contracts by aggregating across reporters to obtain the gross series and taking the difference between aggregate buys and sells to obtain the net series. This definition of net capital flows does not match perfectly the theoretical definition of order flow, which focuses on which counterparty *initiates* the buy or sell transactions. Based on conversations with FX market participants, however, we believe that "tomorrow" $(T+1)$ and "next" $(T+2)$ spot transactions as well as forward transactions between dealers and their foreign customers are initiated mainly by the customers. Hence, our net capital flow series should match the theoretical concept of order flow very well for these types of transactions. In contrast, FX swaps are initiated by either the reporting banks or end-users, suggesting that in the case of FX swaps our net capital flow measure may not be a good proxy for order flow. In the empirical work reported in Section 4, we indeed find that the FX swap net capital flow series are affected by different factors than the corresponding spot and outright forward series and in regressions that explain baht returns, the coefficient estimates for the FX swap net capital flows are smaller than those for the other FX capital flow variables. Summary statistics for both volume (buy+sell) and order flow (buy−sell) of the five FX series are provided in Table 1.

Distinguishing FX trades by the lengths of their settlement periods and according to whether they are outrights (spot or forward) or swaps (a combination of a spot trade and a reverse-direction forward trade) is important because these contracts serve different purposes and therefore likely depend on different factors. One of the objectives of this study is to determine which FX transactions and flows have the closest (or weakest) links to activity in other onshore financial markets and to the exchange value of the baht. As we show below, the estimated linkages are indeed quite different for the different types of FX contracts.

In addition to aggregating transactions according to whether they are "buys" or "sells" and according to their settlement maturity, they may also be aggregated by the type of the dealer's counterparty—other reporters,[14] nonresident customers, domestic customers, and the Bank of Thailand.[15] Any of the four resulting types of net capital flow series can be either positive or

price or volume series. Hence we are also not able to apply the algorithm of Lee and Ready (1991) to construct order flow measures.

[14]Because for each "buy" transaction of a reporter with another dealer the counterparty reports a "sell" transaction, and vice versa, the aggregate net capital flow between dealers is identically equal to zero on any given day by the conventions used in this study, aside from possible reporting errors. Care was taken to avoid double-counting of transactions between reporters.

[15]Transactions between the Bank of Thailand and FX dealer banks, of course, generally consist of intervention operations. See Bank of Thailand (2004) for an overview of the BoT's goals with respect to the conduct of its FX interventions.

Table 1: Transactions between FX dealers and non-resident customers: Daily volume and order flow

In millions of US dollars.

	Mean	Standard Deviation	Minimum	Maximum
Volume (Buy+Sell)				
4 Jan 2005 – 30 Dec 2005				
Foreign exchange market, overall	780.1	236.2	181.2	1,714.9
Spot, today	34.4	19.8	14.7	299.8
Spot, tomorrow	82.4	62.3	1.3	439.9
Spot, next $(T+2)$	354.1	132.6	23.2	869.1
Forwards	38.1	49.9	0.0	309.0
FX Swaps	271.1	110.7	0.7	686.4
3 Jan 2006 – 15 Dec 2006				
Foreign exchange market, overall	1,155.4	433.5	342.1	4,015.6
Spot, today	45.8	64.3	22.0	980.5
Spot, tomorrow	152.3	101.8	5.4	622.9
Spot, next $(T+2)$	525.4	226.4	70.2	1,634.7
Forwards	47.4	83.9	0.0	744.9
FX Swaps	384.2	179.1	36.2	858.8
Order flow (Buy−Sell)				
Foreign exchange market, overall	−56.2	200.1	−888.6	576.3
Spot, today	18.9	19.3	−8.1	289.2
Spot, tomorrow	20.0	50.9	−193.7	219.6
Spot, next $(T+2)$	24.4	116.7	−486.7	349.6
Forwards	−21.1	48.6	−250.5	114.6
FX Swaps	−98.3	113.3	−483.5	271.8
3 Jan 2006 – 15 Dec 2006				
Foreign exchange market, overall	−78.8	264.6	−1,712.9	671.1
Spot, today	20.4	20.3	−192.3	56.4
Spot, tomorrow	22.9	98.0	−257.8	342.0
Spot, next $(T+2)$	19.6	181.4	−766.2	659.5
Forwards	−17.5	78.6	−591.8	447.6
FX Swaps	−124.3	138.7	−564.5	363.8

Sources: Bank of Thailand, CEIC, authors' calculations

negative on a given day. In our present study, we are limited to using only the transactions between the reporting banks and their nonresident customers. As such, the FX dataset used in this study provides only a partial but, as we shall argue, still very interesting glimpse of the full activity in the onshore FX market in Thailand.

The onshore FX market in Thailand is closely monitored by the Bank of Thailand. The basis for its exchange market controls are the Exchange Control Act (B.E. 2485) and Ministerial Regulation No. 13 (B.E. 2497) issued under the Exchange Control Act. The Bank of Thailand

has been delegated the responsibility of administering the FX market. Appendix 1 provides a brief recapitulation of the major foreign exchange control measures in Thailand over the past decade.

The involvement of nonresident customers in the onshore FX market has evolved significantly in recent years. Nonresident players used to be important participants in the onshore market before restrictions on foreign exchange transactions were imposed in September 2003. Nonresident end-users accounted for almost 50% of activity in the onshore FX market before that crisis, but with the imposition of anti-speculation measures their share declined sharply to only 18% of the total in the following year. With the introduction of the so-called unremunerated reserve requirement (URR) on 19 December 2006, the share of onshore turnover accounted for by nonresident customers declined further, to only about 15% in 2007. According to preliminary reports available at the time of the writing of this paper, the lifting of the URR system on 3 March 2008 has contributed to a moderate recovery in the share of nonresident investors' participation in the onshore market.

Nonresident investors that hold bank balances in Thailand are required to do so by holding so-called nonresident baht accounts (NRBAs).[16] Balances on NRBAs are currently restricted not to exceed THB 300 million per nonresident at the end of each day, covering all accounts open with all domestic financial institutions in Thailand. NRBAs current accounts are used mainly to settle transactions of nonresidents. Foreign currencies converted into baht are normally (though not necessarily) deposited in NRBAs before being invested in equities and bond securities, and correspondingly the proceeds of sales of equities and bonds by nonresidents are frequently deposited first in NRBAs before being converted into foreign currencies.

The market regulations for nonresident investors were broadly stable in 2005 and 2006 until mid-December 2006. The regulations that were in place over the sample period imply that if nonresident investors in Thailand, as a group, wish to build up (or unwind) their positions in long-term baht-denominated financial assets such as bonds or shares, they can do so in the short run only in the following three ways: (i) by drawing down (or building up) their existing baht-denominated bank balances held in NRBAs; (ii) via trading shorter-term fixed-income assets (including money market claims) with domestic market participants, or (iii) by engaging in baht-denominated FX transactions. Because the Thai authorities have placed fairly stringent limits

[16] In April 2008, almost two thirds of total NRBA balances were held in current accounts, 26% in savings accounts, and 8% in time deposit acccounts. Domestic financial institutions are prohibited from paying interest on NRBA accounts except on time deposits with maturities of 6 months or over.

on allowable balances in NRBAs and because of a general lack of liquidity in private money markets in Thailand, the most straightforward method by which nonresident investors may acquire (or liquidate) the funds needed to engage in the purchase (or sale) of baht-denominated shares and bonds is by transacting in the FX market. Because of these constraints, we would expect that activity by foreign investors in the stock and bond markets in Thailand is closely linked to their activity in the onshore FX market in Thailand, and vice versa, on top of any economic reasons for such linkages discussed in Section 2.

The daily overall transaction volume between dealers and nonresident end-users averaged US$ 780 million in 2005 and US$ 1,155 million in 2006.[17] As shown in Table 1, in both 2005 and 2006 spot-next transactions (which settle on a $T + 2$ basis) made up roughly 45 percent of the nonresident end-user total, FX swaps accounted for an additional 33 to 35 percent, spot-tomorrow ($T + 1$) transactions contributed 11 to 13 percent to the total, and spot-today (same day settlement) and outright forwards each accounted for less than 5 percent of the total nonresident customer transaction volume.

Average daily volume in 2006 was higher than in 2005 in part because of two periods of market turmoil, the first occurring in May and June 2006 in response to global equity market volatility, the second in September 2006 during a period of heightened political uncertainty.[18] In both 2005 and 2006, all three spot FX daily net capital flow series were positive on average, as nonresident customers were net buyers of baht in both years. Conversely, in both 2005 and 2006 nonresident customers were net sellers of baht through outright forwards and through FX swap contracts.

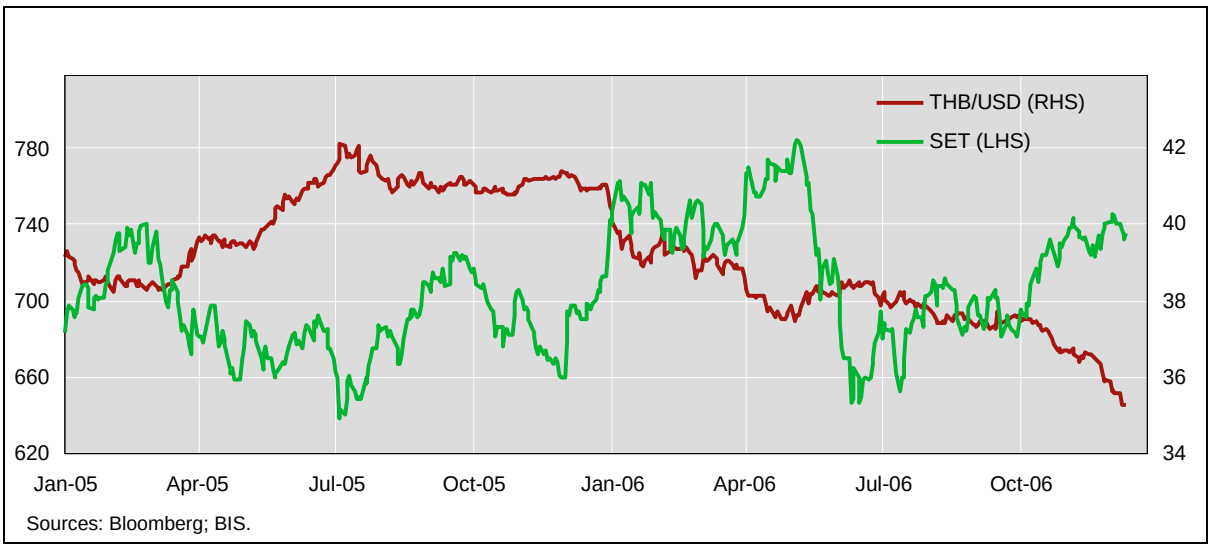
The bilateral THB/USD spot exchange rate used in this study is collected by the BIS as of 7:15 pm Bangkok time (corresponding to 2:15 pm CET). This choice of collection time—shortly after equity, bond and onshore FX trading has ended in Bangkok—should allow the daily FX returns to reflect all relevant intraday information without being affected by global market developments that occur after the close of business in the onshore markets.

As shown in Figure 1, the baht depreciated on net against the dollar in the first half of 2005, reaching a low of about 42 THB/USD in July 2005. Over the subsequent six quarters, however,

[17] Total daily turnover between dealers and nonresident customers dropped to US$ 638 million in 2007. The precipitous decline of volume from 2006 to 2007 is attributable mainly to the measures that went into effect on 19 December 2006.

[18] The single most active day in our sample, in terms of overall nonresident customer transaction volume, occurred on 21 Sept. 2006, after then-Prime Minister Thaksin was unseated in a coup. Gross and net capital flows were both exceptionally large that day. Nonresident customers were net sellers of baht of US$1.713 billion. Nonresident customers' net capital flows in spot, forward, and FX swaps contracts were all negative that day.

Figure 1: Stock Exchange of Thailand index and Thai baht/US dollar exchange rate



the baht appreciated sharply on balance against the dollar, reaching the 35 THB/USD mark by mid-December 2006. Over the sample period as a whole, the mean daily return on THB/USD was very close to zero, and the standard deviation of daily returns was 0.33%. The minimum and maximum values of daily returns in the sample were −1.54% and +1.26%, respectively. The dollar's major currencies index, which measures its trade-weighted exchange value against some of the major foreign currencies, is calculated daily by Federal Reserve Board staff and was obtained from the Board's website.[19]

3.3 The equity market in Thailand

The Stock Exchange of Thailand (SET) was established initially under the Securities Exchange of Thailand Act, BE 2517 (1974), also known as the SET Act, that was enacted on 20 May 1974. The exchange's first trading day was 30 April 1975. On 1 January 1991, the Securities Exchange of Thailand officially changed its name to the Stock Exchange of Thailand (SET). In 1992, the replacement of the original SET Act by the Securities and Exchange Act, BE 2535(1992), or SEA, marked the beginning of modern Thai capital market development. The 1992 Act created a new legal framework and improved securities business regulations. As defined in the SEA (1992), the SET's primary roles are to serve as a center for the trading of listed securities, to provide the essential systems needed to facilitate securities trading, to undertake any business

[19]The Federal Reserve's major currencies index measures the dollar's exchange value, listed by descending magnitude of the weights, against the euro, the Canadian dollar, the yen, pound sterling, the Swiss franc, the Australian dollar, and the Swedish krona. The combined weight of the euro and the Canadian dollar in this index has fluctuated between 60% and 70% in recent years.

Table 2: Transactions of nonresident customers in the equity and bond markets: Daily volume and order flow

In millions of US dollars.

	Mean	Standard Deviation	Minimum	Maximum
Volume (Buy+Sell)				
4 Jan 2005 – 30 Dec 2005				
Stock Market	228.7	82.8	36.5	588.8
Bond Market	55.5	50.8	0.0	276.6
3 Jan 2006 – 15 Dec 2006				
Stock Market	285.5	140.3	87.7	1,121.6
Bond Market	88.0	68.1	1.1	388.8
Order flow (Buy−Sell)				
4 Jan 2005 – 30 Dec 2005				
Stock Market	12.1	39.4	−109.9	169.1
Bond Market	6.4	47.4	−162.4	182.5
3 Jan 2006 – 15 Dec 2006				
Stock Market	12.7	60.1	−147.5	388.8
Bond Market	7.4	68.0	−225.6	235.0

Sources: Bank of Thailand, CEIC, authors' calculations

relating to the Securities Exchange (such as clearinghouse, securities depository center, securities registrar, or similar activities), and to undertake any other business approved by the SEC of Thailand.

The main share price indicator of the SET is the SET index, which is a composite index calculated based on stock prices of companies listed on the main board of the SET. It is a market capitalization-weighted price index which compares the current market value of all listed common stock against the base date value.

Since 1991 the SET has operated a fully computerised trading system, the "Automated System for the Stock Exchange of Thailand" (ASSET). In this trading system, two principal methods of trading are available: Automatic Order Matching (AOM) and Put-Through (PT). Trading hours are grouped into two sessions: 10 am to 12:30 pm and 2:30 pm to 4:30 pm. The Thailand Securities Depository Co. Ltd. (TSD), a SET subsidiary, operates the settlement and clearing processes for all listed securities. Settlement for equities is performed on a $T+3$ basis. Investors can trade securities on the SET through any of 39 brokerage houses, many of which are foreign-owned.

Table 3: Selected statistics, Stock Exchange of Thailand

	2004	2005	2006	2007	2008[a]
SET Index	668.1	713.73	679.84	858.1	678.20
Number of listed companies	440	486	476	475	479
Average daily turnover value (in THB million)	20,508	16,454	16,281	17,097	17,891
Average transaction deals (number of deals)	129,400	113,968	117,340	112,952	126,789
Market P/E ratio	9.40	9.40	8.1	12.63	11.01

Source: Stock Exchange of Thailand

[a]As of 25 August

Our stock market dataset also contains the daily closing values of the SET index and the daily gross buy and sell transaction volumes by nonresident investors.[20] As with the FX datasets, we terminate the sample on Friday, 15 December 2006, because the government's URR measures were announced and went into effect the following week. Summary statistics for nonresident investors' transaction volumes and net capital flows on the SET are provided in Table 2, and additional selected statistics about the Stock Exchange of Thailand are provided in Table 3. Average daily gross transaction volume (buys+sells) on the SET by nonresident investors in 2005 and 2006 was the equivalent of US$ 229 million and US$ 286 million, respectively, or less than a third of average daily gross capital flows between FX dealers and nonresident customers. The mean daily return of the SET was 0.01% in 2005 and 0.07% in 2006. The standard deviation of daily returns was about 0.65% in both 2005 and 2006. The single largest negative and positive daily moves during the sample period were -1.9% and $+2.1\%$, respectively. As Figure 1 demonstrates, the stock market experienced bouts of elevated volatility in 2006 during the same two periods as the onshore FX market did.

3.4 The bond market in Thailand

Debt financing in Thailand has become more diversified in recent years. Even as bank loans have grown steadily since 2001, the bond market has grown even more rapidly. In June 2008, the outstanding amount of bonds was almost as large as the aggregate amount of bank loans. At end-2007, almost two thirds of outstanding securities in the bond markets were comprised of government bonds (ca. 36%) and state agency bonds (ca. 29%); Bank of Thailand paper is

[20]The counterparties to the SET's nonresident customers' transactions are, by construction, domestic investors, which can be either retail investors or institutional investors.

included in the state agency bonds category. Corporate bonds made up roughly 22% of the outstanding total at the end of 2007.

The Thai Bond Market Association acts as a bond pricing agency and also sets market conventions and standards. It was granted the status of a securities-business related association and a self-regulated organization in September 2005. In 2005, 2007, and 2007, trading volume in the bond markets was overwhelmingly (about 98%) concentrated in Bank of Thailand bonds, government bonds, and treasury bills. In 2007, about 61% of total trading volume was between dealers and their customers, and the remaining 39% were between dealers.

Our bond market dataset consists of daily-frequency buy and sell transaction totals by nonresident investors in the secondary market. Nonresident investors' participation in the Thai bond market in 2005 and 2006 was quite limited. Total daily transaction volumes by nonresident investors averaged only US$55 million and US$88 million in these two years, amounting to roughly 15% and 19% of all bond market trades, respectively. Bond market transactions are also classified according to whether they are "outright" (or ordinary) or "other" transactions. The most common settlement lags for outright transactions, which make up about 70% of all transactions in our sample, are $T+2$ and $T+3$. Bond trades classified as "other," which appear to be used mainly in financing transactions, settle mostly on a same-day or $T+1$ basis and contribute about 30% to the total volume. As we demonstrate in Section 4, these two types of bond market transactions differ not only in the length of their average settlement period, but also respond differently to market developments and their impact on stock and FX returns are also not the same.

4 Empirical findings

Appendix 2 lists the acronyms, descriptions, and units of measurement of all variables used in the regression models. The regression models and tables constructed to test the hypotheses are reported in Appendix 3. All regression equations were estimated by OLS unless indicated otherwise. Standard tests for misspecification of the regression relationships were performed for all models and were not statistically significant. Most regression equations include the first lagged value of each regressor to allow for non-synchronous dynamics.[21]

[21] In initial work, which is not reported separately, we tested whether additional lags of the regressors should be included. The corresponding F-statistics did not indicate the presence of higher-term lagged relationships between the regressors and the dependent variable, and hence in most cases only regressions with 1 lag for each regressor are shown.

4.1 Influence of information heterogeneity

In this subsection we report tests the hypotheses related to the heterogeneity of information held by investors and its relationship to order flow and returns in the various financial markets in Thailand. **Hypothesis 1** sets forth the idea that in the onshore FX market in Thailand returns should be explained significantly by own-market order flow. To test this hypothesis we estimated a linear regression of daily baht returns on the 5 types of order flow between reporters and their foreign customers. By construction, positive values of order flow represent net purchases of baht by foreign customers, and an appreciation of the baht against the dollar implies a negative value for the THB value. The coefficients on the current values of all 5 order flow variables are negative, as expected; the coefficient estimates for the spot-tomorrow, spot-next ($T + 2$) and outright forward ($T \geq 3$) variables are strongly significant. The regression F-statistic is also highly significant, indicating that the regression model as a whole explains the returns on the THB/USD, and the R^2 statistic shows that about 41% of the total variation of the dependent variable is explained by the regression equation.[22] In sum, the own-market order flow variables are statistically very significant in explaining returns in the FX market.

Interestingly, the FX swap flow variable does not have a significant same-day effect on baht returns. We interpret this finding as being consistent with our earlier observation that this regressor may not be a good proxy for true order flow in this segment of the FX market; to the extent that order flow is mis-measured, we would expect a downward bias (i.e., toward zero) in the point estimate of this regressor's influence.

The coefficients on the contemporaneous two-day spot and outright forward order flow regressors are close to -0.000013 and -0.000018, respectively. This implies that the marginal impact of a US$ 100 million increase in order flow in one of these variables is an appreciation of the baht against the US dollar of roughly 0.13% or 0.18%, respectively. For comparison, Evans and Lyons (2002) estimated for the mark/dollar market that $100 million in order flow moved that exchange rate by 0.05%, and Lyons (1995) estimated that $100 million would generate a 0.1% change in the mark/dollar exchange rate. We interpret the larger values of the coefficient estimates in our regression as being consistent with the hypothesis that the mark/dollar market

[22] The lagged values of the dependent variables and the regressors are (with one exception) all statistically insignificant, indicating that most of the exchange rate adjustment in reaction to order flow happens within a business day. Standard diagnostic tests did not indicate meaningful model misspecification.

is deeper and more liquid than the baht FX market and therefore that the dollar/mark rate's contemporaneous response to order flow is smaller than that of the baht/dollar rate.

Hypothesis 2 states that observable macroeconomic variables should have only a small influence, compared with that of the order flow variables, on baht returns. We tested this hypothesis by augmenting the first regression model with 5 macro variables (as well as three order flow series from the equity and bond markets, as is explained below when we examine the evidence for Hypothesis 12). We find that an overnight appreciation of the US dollar against the major foreign currencies leads to a depreciation of the baht, as does a relative outperformance on the previous day of the SET index relative to the S&P500 index. Changes in global equity market volatility, proxied by the VIX, previous-day fluctuations in domestic interest rates implied by baht 1-year interest rate swaps, and previous-day fluctuations in baht-dollar interest rate differentials also do not have a statistically significant influence.[23] Importantly, adding these eight regressors (and their lags) raises the fraction of the dependent variable's variance that is explained by the regression only moderately, from 41% to 53%, and the point estimates of the coefficients of the FX order flow variables are very close to those in the simpler regression.[24] We infer that the macro variables indeed do not provide much additional information useful for explaining the variation of daily baht returns.

According to **Hypothesis 3**, equity market returns in Thailand should be explained significantly by order flow of foreign investors. We indeed find that on days when foreign investors increase their net holdings of Thai equities by US$ 100 million equivalent, ceteris paribus the SET index rises 1 percent. The point estimate on the coefficient of the foreign investors' net purchase variable is not only positive, it is also statistically strongly significant and larger in absolute value than the coefficients of any of the FX market order flow series. Increases in foreign customers' purchases of baht via two-day spot and outright forward contracts also predict gains in the stock market index, suggesting that at least a part of foreign investors' order flow in the FX market is driven by their portfolio rebalancing decisions in the stock market.[25] An outperformance by 1% of the SET index relative to the S&P500 index on the previous day

[23] The coefficients on a few of the two-day lagged macro variables were, however, statistically significant.

[24] In a separate regression, we tested whether the increase in the R^2 statistic from 0.41 to 0.53 was caused mostly by the inclusion of the equity and bond order flow regressors or by the inclusion of the five "macro" regressors. We found that the increase was due almost entirely to the inclusion of the stock and bond market order flow series.

[25] In future work we hope to disaggregate the buy and sell totals for outright forwards into those with $T+3$ settlement and those with $T>3$ settlement, to allow us to examine further the nature of the finding that returns in the stock market, where transactions settle on a $T+3$ basis, are explained by order flow in the forward segment of the FX market.

predicts a decline in the SET of 0.16%, while an appreciation of the baht vs. the dollar of 1% on the preceding business day predicts a 0.41% decline in the SET. In contrast, none of the foreign investors' net capital flow series in the bond market, whether in the form of "outright" or "other" purchases and sales, helps explain stock market returns, and the influence of fluctuations in global equity market volatility, the exchange value of the dollar versus the major foreign currencies, and fluctuations in one-day lagged interest rates is similarly subdued.

According to **Hypothesis 4**, if private information significantly drives equity market order flow and if foreign investors' information lags systematically behind that of domestic investors, there should be flow momentum, or positive serial correlation across several working days, in the net purchases of shares by foreign investors in Thailand. Conversely, according to **Hypothesis 7**, if private information plays only a minor role in bond markets, there should be little or no serial correlation in foreign investors' net purchases of bonds. Both of these hypotheses are borne out by the data: The first-order serial correlation of foreign investors' net equity purchases is 0.50, and the autocorrelation function declines only slowly out to the 5th lag. In contrast, any serial correlation in their net purchases of bonds is very minor, the estimated serial correlation coefficients are all very small, and they fluctuate about zero.

As in other equity markets around the world, and also in accordance with simple stories of information heterogeneity, we find strong evidence for Thailand of return chasing in the patterns of foreign investors' net purchases of equities (**Hypothesis 5**): When SET returns have been positive in recent days, foreign investors tend to be net buyers of equities. According to **Hypothesis 6**, if there is a substantial degree of heterogeneity in the sophistication of foreign investors, their daily gross buys and sells of equities in Thailand should be strongly correlated. The data confirm this hypothesis as well. The correlation of their contemporaneous daily gross buys and gross sells is 0.74; this compares with a correlation of 0.61 of the daily gross buys and gross sells by domestic retail investors in Thailand, a group which is also likely to be characterized by differing degrees of sophistication of its members. The reverse relationship is expressed in **Hypothesis 8**: If the degree of sophistication of those foreign investors that participate in the bond market in Thailand is fairly homogeneous, the correlations of their daily gross buys and gross sells should be low. We find that the data support this hypothesis as well, as the correlations coefficients among both the outright and "other" types of gross buys and sells is 0.11 or less over the sample period.

4.2 Influence of portfolio rebalancing decisions

We now turn to examining the empirical evidence for the set of six hypotheses that are based on the ideas that portfolio rebalancing by foreign investors has quantitatively important effects on order flow and returns and that foreign investors' portfolio rebalancing activity in the stock market may be an important factor driving their transactions in the foreign exchange market. Roughly in accordance with **Hypothesis 9** on the relative volatilities of foreign exchange and equity market returns, we find that the ratio of volatility in daily Thai baht and daily SET returns was roughly 0.3 during both years of the sample period. This ratio of the relative volatilities is at the lower end of the range of ratios reported by Hau and Rey (2006) for industrial economies. This result likely reflects the fact that the price elasticity of foreign exchange supply is higher in Thailand than in most industrial economies, because the Bank of Thailand's foreign exchange intervention activity has as one of its objectives limiting volatility in the foreign exchange market (see Bank of Thailand, 2004). It may also indicate a higher level of foreign investors' risk aversion in the baht FX market than in industrial-country currency markets (see Hau and Rey, 2006, p. 295). Nevertheless, we conclude that the data support this hypothesis.

Hypothesis 10 states that net inflows into the Thai stock market by foreign investors should be positively correlated with appreciations of the baht. Regression analysis shows, however, that this hypothesis is not supported in our sample period as none of the four lagged baht variables are statistically significant. The same regression equation shows that there is strong support for **Hypothesis 11**, according to which a lagged outperformance of the SET index relative to the S&P500 index predicts a decrease in foreigners' net purchases of Thai equities: The coefficient of the first lag of the regressor that captures relative SET/S&P500 returns is negative and statistically significant. Thus, what drives foreign investors' net flows in the Thai equity market is not only "simple" return chasing (Hypothesis 5) but also a wealth effect that drives them to rebalance their domestic and foreign portfolios in reaction to lagged relative returns across equity markets.

Hypothesis 12 concerns a different implication of the portfolio balance hypothesis: If the SET outperforms other stock markets (proxied by the S&P500), foreign investors should sell baht and hence the baht should depreciate. Regression analysis shows that this relationship is indeed statistically significant in our sample. The effect is, however, not large: a 1% higher

return of the SET relative to the S&P500 is, on average, associated with a subsequent 0.03% depreciation of the baht.

4.3 Empirical evidence for Conjectures 1 and 2

The final two hypotheses or conjectures considered in this paper, which combine several of the effects predicted by the preceding hypotheses, serve to test some of the implications of our new, market microstructure-based theory of the operation of the portfolio balance effect. We reported above that own-market order flows in the equity market and in foreign exchange market have significant effects on returns in their respective markets; moreover, these effects are also permanent in the sense that the coefficients of the lagged regressors do not fully offset the impact of the contemporaneous regression variables. In addition, we found that foreign exchange order flow affects stock market returns and that stock market order flow affects foreign exchange returns. Information heterogeneity was found to affect foreign investors' stock market activity, but did not appear to affect their activity in the bond markets in Thailand. Because a substantial fraction of foreign exchange market activity conducted by nonresident investors is induced by these agents' stock market activities, our first novel hypothesis (Conjecture 1) is that the portion of foreign exchange order flow that is driven by equity market activity should a more pronounced effect on the exchange value of the baht. Our second novel hypothesis (Conjecture 2) is that FX order flow that is driven by bond market activity in Thailand should only have a small, or even insignificant, effect on the baht.

Our foreign exchange market dataset does not contain direct information as to the purpose of the transactions and, in particular, does not indicate which transactions of foreign investors' are related to their decisions to acquire or sell equities or bonds. We therefore estimated the portion of order flow that can be attributed to stock and market activity statistically, by regressing each of the five FX order flow series separately on stock and bond market variables. We found that foreign customers' two-day-settlement spot market transactions are explained statistically by stock market variables but not by bond market variables. In contrast, spot-tomorrow FX transactions are explained mostly by bond market variables and not by stock market variables.[26]

[26]The R^2 statistics show that 19% and 12%, respectively, of the total variation in the 2-day spot and 1-day spot series is explained by these first-stage regressions. In addition, we found that FX swap order flow is linked statistically to bond market order flow as well. However, because the *overall* influence of this regressor on baht returns was found earlier to be insignificant, and because the portions of net FX swap flows explained by bond market activity do not affect FX returns significantly, we do not report here the results of split FX swap order flow.

For these two order flow series we retrieved the explained or fitted values and the residuals, and we used these four new variables (and their first lags) as regressors, augmenting the regression equation that was discussed above when we examined the evidence for Hypothesis 1.

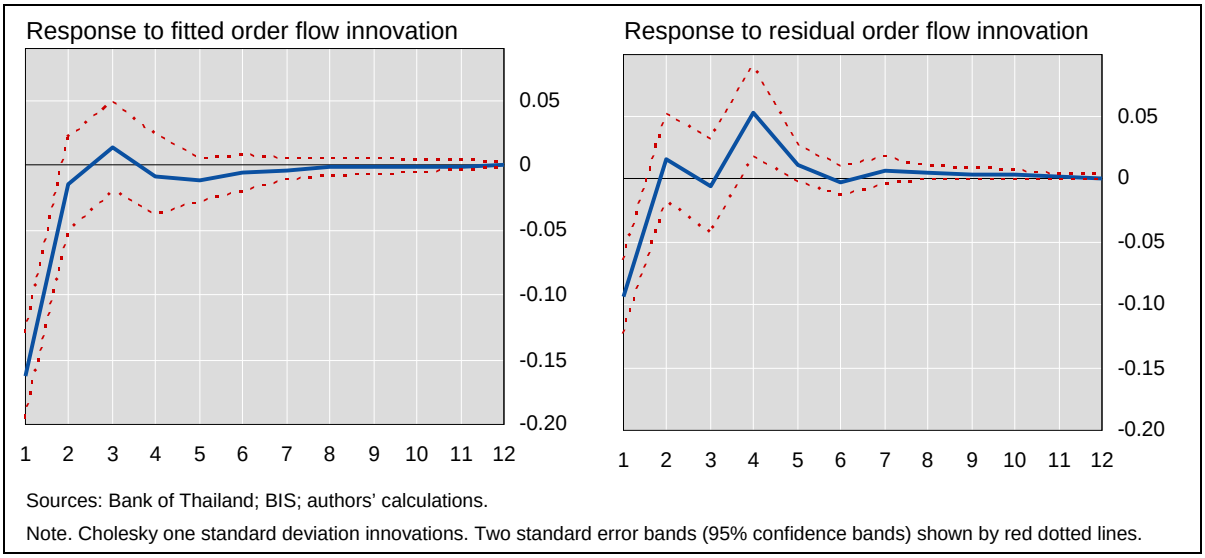
Because the fitted values and residual values of the spot-tomorrow and spot-next series are not observed directly but are generated from first-stage regressions, it is known that the resulting dependence between the generated regressors and the regression's error term renders analysis based on OLS standard errors invalid (Pagan, 1984; Wooldridge, 2002). Specifically, Pagan (1984) showed that whereas the OLS-based point estimates and the OLS-based standard errors on the residual regressors are actually consistent, OLS-based standard errors on the fitted regressors are inconsistent. We used a two-stage least squares procedure in which we used instruments for the fitted regressors to adjust for this issue and to obtain consistent estimates for the standard errors on the fitted regressors.

Our main findings concerning **Conjecture 1** are as follows. Both the fitted and the residual regressors for two-day spot order flow derived from the first-stage regressions are statistically significant, and the coefficients have the correct signs. However, the coefficient on the fitted regressor is more than three times (in absolute value) as large as that the coefficient on the residual regressor. The difference between the two point estimates is statistically different from zero. The coefficient of the fitted spot-next regressor is also much larger than the coefficients the spot-tomorrow and outright-forward regressors. In addition, the R^2 statistic is now 0.49, versus 0.41 for the regression without a split of the order flow (Hypothesis 1), indicating that this split has succeeded in raising the information content of the order flow variables substantially. We interpret these results as clear evidence in favor of Conjecture 1. This implies that heterogeneous information drives equity market activity and returns, and thus indirectly drives FX market activity and returns as well.

Additional evidence in favor of Conjecture 1 comes from studying whether the fitted and residual components of the 2-day spot series differ not only in their initial impact on baht returns but also in the time series profiles of their effects. In particular, we ask if one regressor has a permanent effect on the level of the baht whereas the other does not. To address this issue, we estimated a three-variable vector autoregressive model that included the fitted portion of spot-next order flow, the residual portion of spot-next order flow, and baht-dollar returns; three lags of the variables were included in the VAR. As lagged baht returns do not tend to drive spot-next order flow, we orthogonalized the impulse response function to let innovations in the

Figure 2: Impulse response functions of THB to spot-next order flow innovations

Percent change in exchange rate across days



Sources: Bank of Thailand; BIS; authors' calculations.

Note. Cholesky one standard deviation innovations. Two standard error bands (95% confidence bands) shown by red dotted lines.

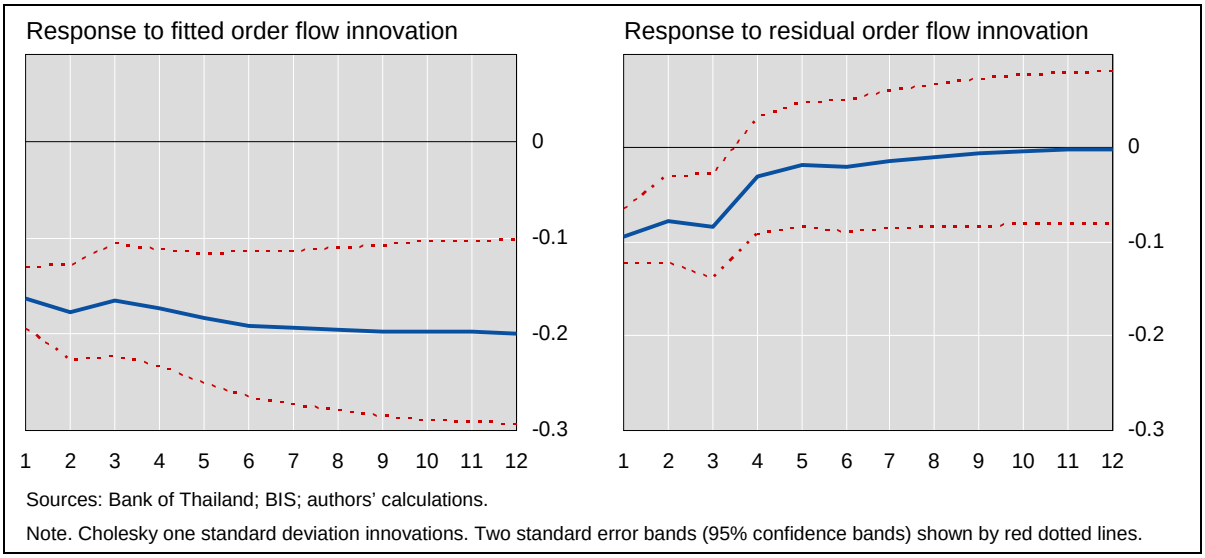
order flow series drive FX returns but not vice versa. We then calculated two impulse response functions to trace the effects of innovations in the fitted and residual components of spot-next order flow on baht returns.

The impulse response functions shown in Figure 2 show that a 1 standard deviation innovation in the portion of 2-day spot order flow that can be attributed to equity market variables has an initial impact on baht returns that is almost twice as large (0.16% vs. 0.09%) as that of a 1 standard deviation innovation in residual spot-next order flow. Taking into account that the standard deviations of the fitted and residual portions of 2-day spot order flow were US$ 58.6 million and US$ 126.6 million, respectively, in the sample period, it follows that, dollar for dollar, innovations to the fitted portion of FX order flow have an initial impact on the baht that is roughly four times as large as shocks to the residual portion.

The long-term effects of these innovations on the level of the Thai baht's exchange value are shown by the cumulative response functions (CRFs) in Figure 3. The CRF in the left-hand panel demonstrates that the initial impact of an innovation in spot-next FX order flow driven by equity market activity is not reversed subsequently, i.e., that the initial impulse has a permanent effect on the level of the exchange rate. In conclusion, the VAR analysis confirms that equity market driven FX order flow has both a large and a permanent effect on the exchange rate. In striking contrast, the right-hand panel of Figure 3 shows that initial impact of an innovation in the residual portion of spot-next FX order flow on the level of the baht is quickly undone over the next few days and thus that the cumulative impact of such an innovation on the level of the

Figure 3: Cumulative response functions of THB to spot-next order flow innovations

Percent change in exchange rate across days



Sources: Bank of Thailand; BIS; authors' calculations.

Note. Cholesky one standard deviation innovations. Two standard error bands (95% confidence bands) shown by red dotted lines.

baht is therefore zero. Hence, even though the point estimate of the contemporaneous effect of residual two-day spot order flow is statistically significant, an innovation in this variable has no lasting influence on the level of the baht.

Conjecture 2 is also supported by the data. We reported earlier, in Subsection 4.1, that the overall spot-tomorrow net capital flow variable has a statistically significant impact on baht returns, and also that foreign investors' activity in the government bond market in Thailand did not appear to be driven by private information. Here, we find that the portion of spot-tomorrow order flow that is related to foreign investors' transactions in the government bond market—obtained as the fitted value from the first-stage regression of spot-tomorrow FX order flow on bond market activity—does *not* have a statistically significant impact on returns. Instead, *all* of the explanatory power of the overall spot-tomorrow order flow variable is found to derive from the residual component. This strongly indicates that because heterogeneous information does not appear to drive investors' bond market activity and returns, it also does not drive FX market activity or returns. Put differently, because this portion of FX market activity does not convey investors' private information, it does not affect prices and returns in the FX market.[27]

[27]Since September 2003, nonresident investors that bought bonds issued by domestic financial institutions in Thailand have been required to hold these bonds for at least 3 months. Although the size of nonresident investors' holdings of such bonds is not large, this constraint may also be contributing to the result reported here.

5 Concluding remarks

In this paper, we have formulated a novel, market microstructure based theory of the operation of the portfolio balance effect, and we have presented compelling empirical evidence that FX flows in Thailand that are associated with equity market transactions of foreign investors have a statistically significant and permanent influence on the Thai baht's exchange value. We also found that FX flows associated with government bond market transactions of foreign investors have no significant (short- or long-term) influence on the exchange rate. These findings support our conjectures that investors' portfolio rebalancing decisions that are driven by private information should not only affect returns in those markets but exchange rate returns as well, whereas portfolio rebalancing flows that originate from markets in which investors' private information plays little or no role should have at most a limited impact on the exchange rate.

It is worth emphasizing that our present study applies to Thailand, a major emerging market economy. It remains to be studied if similar results regarding the validity our two main conjectures hold for more-developed market economies or for other emerging market economies. It will also be interesting to examine whether FX order flow induced by foreign investors' activity in an economy with a well-developed corporate bond market—for which private information should be roughly as important as for stock markets—has effects on that economy's currency that are comparable to those associated with FX flows that are induced by stock market transactions.

Furthermore, our empirical work provides useful information for the case of Thailand on the statistical significance and the numerical magnitude of the effects postulated by several hypotheses set forth in the recent market microstructure literature and the new portfolio balance literature. We found solid support for the 8 hypotheses related to the consequences of information heterogeneity and for 3 of the 4 hypotheses related to portfolio rebalancing. The only hypothesis that was not supported by the data concerns the link between foreign investors' net purchases of equities in Thailand and a preceding appreciation of the baht; we found that the point estimates of the regressors for baht appreciation were not significantly different from zero. Over our sample period, exchange rate appreciation did not (on average) drive foreign equity investment into Thailand and likewise that equity market sell-offs by foreigners were not (on average) driven by exchange rate depreciation. In addition, we found that even though the effect predicted by Hypothesis 12—that a relative outperformance of Thai equities leads to a

depreciation of the baht—was statistically significant, the numerical magnitude of this effect was very small and hence may not be of much consequence in practice.

When considering the robustness and generality of our results, one should keep in mind three data-related limitations that were imposed on our work. First, our FX market order flow dataset currently consists of the aggregate transactions between nonresident end-users and FX dealers. As such, it covers only a part of the overall onshore Thai baht market. Going forward, it may become possible to extend our analysis to transactions between domestic end-users and FX dealers as well as to transactions between dealers. At present, however, these data are not available. Second, the sample covers a period of only two years; because we found clear evidence of a severe structural break following the imposition of the URR capital control measures in mid-December 2006, we decided not to include the data after the URR measures went into effect. In early March 2008 these controls were lifted, restoring capital market controls in Thailand roughly to their pre-URR status. An interesting question for policy makers and other market observers alike is whether the portfolio rebalancing effects we uncovered for the pre-URR period also apply in the post-URR period. We hope to address this question as soon as the post-URR period can be deemed to be sufficiently long. Finally, we note that the split between the portion of FX order flow that is driven by stock and bond market activity and the remainder was performed statistically. As such, the resulting variables are proxies for the true quantities, and it remains to be seen whether better proxies can be constructed.

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Appendix 1 — Capital flow control measures in Thailand since 1998

Date	Measures
29 January 1998	Nonresidents (NRs) who do not have any underlying trade or investment activities in Thailand are allowed to obtain Thai credit facilities from their onshore counterparties up to a combined outstanding of 50 million baht per entity
11 September 2003	The amount of Thai baht that onshore financial institutions can borrow short-term from nonresidents without underlying trade or investment is limited to no more than 50 million baht per entity. However, transactions that have underlying trade or investment are allowed without restrictions.
14 October 2004	Onshore financial institutions are requested to limit the outstanding balance of Nonresident baht account (NRBA) at the close of business day to no more than 300 million baht for each nonresident, unless exempted by the Bank of Thailand on a case-by-case basis. Money parked in current and saving NRBAs is not allowed to receive any interest rates.
18 December 2006	The Unremunerated Reserve Requirement (URR) is imposed. The URR requires resident financial institutions to withhold 30% of foreign currencies exchanged against Thai baht, except those related to trades in goods and services, or repatriation of investments abroad by residents. Rule was updated on 19 December to exclude stock market transactions.
3 March 2008	- The BOT lifts the remaining capital controls (URR). - Revision of rules for onshore counterparties in providing Thai baht liquidity to nonresident without underlying to not exceeding 300 million baht per group of NRs (from 50 million per group of NR). - Revision of rules for the amount of Thai baht that onshore financial institutions can borrow from NRs without underlying trade or investment to not exceed 10 million baht per group of NRs (from 50 million baht in case of short-term borrowing per group of NRs).

Appendix 2 — List of variables used in the regression models

Variable Name	**Description**	**Units**
THB	THB/USD spot exchange rate	Log first difference
SET_USD	SET index, expressed in US dollars	Log first difference
USD_MCI	US dollar index, trade-weighted	Log first difference
SPX	S&P500 index	Log first difference
SET_USD_SPX	Excess return of SET index over S&P500 index	Log first difference
VIX1	VIX index	First difference
THB_IRS_1Y	1-year Thai baht interest rate swap	First difference, percentage points
D_IRS_1Y	Difference between the rate of 1-year Thai baht interest rate swap and the rate of 1-year US dollar interest rate swap	First difference, percentage points
FOREIGN_N_SET_USD	Net trading in shares by foreigners (purchases – sales)	USD million equivalent
OUTRIGHT_N_BOND_USD	Net outright trading in bonds by foreigners (purchases – sales)	USD million equivalent
OTHER_N_BOND_USD	Net trading in bonds by foreigners for other purposes (purchases – sales)	USD million equivalent
W_SPOT_TD_N	FX, spot, today, net (buy-sell)	USD million
W_SPOT_TM_N	FX, spot, tomorrow, net (buy-sell)	USD million
W_SPOT_N_N	FX, spot, next (T+2), net (buy-sell)	USD million
W_FWD_N	FX, outright forwards, net (buy-sell)	USD million
W_SWAP_N	FX swaps, net (buy/sell–sell/buy)	USD million
FITTEDBOND_SPOT_TM	FX, spot, tomorrow, net (buy-sell), fitted values from first-stage regression on bond variables	USD million
RESIDBOND_SPOT_TM	FX, spot, tomorrow, net (buy-sell), residuals from first-stage regression on bond variables	USD million
FITTEDSET_SPOT_N	FX, spot, next (T+2), net (buy-sell), fitted values from first-stage regression on equity variables	USD million
RESIDSET_SPOT_N	FX, spot, next (T+2), net (buy-sell), residuals from first-stage regression on equity variables	USD million

Sources: Bank of Thailand; Bloomberg; CEIC; Federal Reserve; BIS.

Appendix 3 — Regression results

Hypothesis 1

Dependent Variable: THB
Method: Least Squares
Sample (adjusted): 1/07/2005 12/15/2006
Included observations: 448 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	7.73E-05	0.000250	0.309741	0.7569
THB(-1)	-0.062799	0.045559	-1.378421	0.1688
THB(-2)	-0.072011	0.040411	-1.781989	0.0754
W_SPOT_TD_N	-3.46E-06	6.45E-06	-0.536807	0.5917
W_SPOT_TD_N(-1)	4.13E-06	5.97E-06	0.691374	0.4897
W_SPOT_TM_N	-1.08E-05	2.10E-06	-5.130015	0.0000
W_SPOT_TM_N(-1)	1.63E-06	1.93E-06	0.847823	0.3970
W_SPOT_N_N	-1.33E-05	8.94E-07	-14.92286	0.0000
W_SPOT_N_N(-1)	2.96E-06	1.06E-06	2.795933	0.0054
W_FWD_N	-1.75E-05	1.98E-06	-8.813487	0.0000
W_FWD_N(-1)	1.57E-06	1.99E-06	0.787328	0.4315
W_SWAP_N	-1.21E-06	1.10E-06	-1.101428	0.2713
W_SWAP_N(-1)	2.77E-06	1.10E-06	2.512842	0.0123

R-squared	0.410139	Mean dependent var	-0.000212
Adjusted R-squared	0.393867	S.D. dependent var	0.003206
S.E. of regression	0.002496	Akaike info criterion	-9.119544
Sum squared resid	0.002710	Schwarz criterion	-9.000431
Log likelihood	2055.778	Hannan-Quinn criter.	-9.072588
F-statistic	25.20515	Durbin-Watson stat	1.892803
Prob(F-statistic)	0.000000		

Hypotheses 2 and 12 (Portfolio rebalancing 2)

Dependent Variable: THB
Method: Least Squares
Sample (adjusted): 1/11/2005 12/15/2006
Included observations: 319 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000204	0.000314	0.649494	0.5165
THB(-1)	-0.077703	0.067917	-1.144088	0.2535
THB(-2)	-0.081280	0.058546	-1.388306	0.1661
W_SPOT_TD_N	-2.70E-06	9.93E-06	-0.271477	0.7862
W_SPOT_TD_N(-1)	-2.53E-07	6.71E-06	-0.037694	0.9700
W_SPOT_TM_N	-9.34E-06	2.48E-06	-3.761106	0.0002
W_SPOT_TM_N(-1)	2.02E-06	2.32E-06	0.870430	0.3848
W_SPOT_N_N	-1.30E-05	1.12E-06	-11.53652	0.0000
W_SPOT_N_N(-1)	3.74E-06	1.39E-06	2.680973	0.0078
W_FWD_N	-1.93E-05	2.31E-06	-8.335030	0.0000
W_FWD_N(-1)	4.74E-07	2.54E-06	0.186443	0.8522
W_SWAP_N	-4.78E-07	1.30E-06	-0.367869	0.7132
W_SWAP_N(-1)	3.13E-06	1.35E-06	2.319637	0.0211
FOREIGN_N_SET_USD	-1.02E-05	4.27E-06	-2.398685	0.0171
FOREIGN_N_SET_USD(-1)	-5.23E-06	4.58E-06	-1.140983	0.2548
OUTRIGHT_N_BOND_USD	-6.45E-06	3.39E-06	-1.903037	0.0580
OUTRIGHT_N_BOND_USD(-1)	-4.34E-06	3.28E-06	-1.325157	0.1862
OTHER_N_BOND_USD	-2.54E-06	4.88E-06	-0.519605	0.6037
OTHER_N_BOND_USD(-1)	6.07E-06	4.70E-06	1.290590	0.1979
VIX1(-1)	0.000190	0.000254	0.748812	0.4546
VIX1(-2)	8.79E-06	0.000212	0.041371	0.9670
USD_MCI(-1)	0.090673	0.036918	2.456042	0.0146
USD_MCI(-2)	-0.015729	0.037949	-0.414478	0.6788
SET_USD_SPX(-1)	0.033463	0.016741	1.998879	0.0466
SET_USD_SPX(-2)	0.018188	0.016042	1.133774	0.2578
THB_IRS_1Y(-1)	0.005475	0.005442	1.006069	0.3152
THB_IRS_1Y(-2)	0.017117	0.005455	3.138004	0.0019
D_IRS_1Y(-1)	-0.005539	0.004822	-1.148684	0.2516
D_IRS_1Y(-2)	-0.017945	0.005075	-3.535793	0.0005

R-squared	0.533812	Mean dependent var	-0.000311
Adjusted R-squared	0.488801	S.D. dependent var	0.003307
S.E. of regression	0.002365	Akaike info criterion	-9.169927
Sum squared resid	0.001621	Schwarz criterion	-8.827637
Log likelihood	1491.603	Hannan-Quinn criter.	-9.033229
F-statistic	11.85954	Durbin-Watson stat	1.883381
Prob(F-statistic)	0.000000		

Hypothesis 3

Dependent Variable: SET_USD
Method: Least Squares
Sample (adjusted): 1/11/2005 12/15/2006
Included observations: 319 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000210	0.001050	-0.200295	0.8414
W_SPOT_TD_N	-6.51E-05	3.32E-05	-1.961203	0.0508
W_SPOT_TD_N(-1)	3.53E-05	2.24E-05	1.571627	0.1171
W_SPOT_TM_N	7.99E-06	8.31E-06	0.961855	0.3369
W_SPOT_TM_N(-1)	-2.05E-06	7.77E-06	-0.264202	0.7918
W_SPOT_N_N	2.26E-05	3.76E-06	6.009419	0.0000
W_SPOT_N_N(-1)	-1.25E-05	4.66E-06	-2.690422	0.0076
W_FWD_N	1.92E-05	7.73E-06	2.480313	0.0137
W_FWD_N(-1)	-1.19E-06	8.51E-06	-0.139442	0.8892
W_SWAP_N	-3.23E-06	4.35E-06	-0.742266	0.4585
W_SWAP_N(-1)	-4.44E-08	4.51E-06	-0.009853	0.9921
FOREIGN_N_SET_USD	0.000102	1.43E-05	7.145836	0.0000
FOREIGN_N_SET_USD(-1)	-1.92E-05	1.53E-05	-1.254281	0.2107
OUTRIGHT_N_BOND_USD	1.59E-05	1.13E-05	1.406139	0.1608
OUTRIGHT_N_BOND_USD(-1)	-1.14E-06	1.10E-05	-0.104100	0.9172
OTHER_N_BOND_USD	1.25E-05	1.63E-05	0.768442	0.4428
OTHER_N_BOND_USD(-1)	-1.16E-05	1.57E-05	-0.735085	0.4629
VIX1(-1)	-0.001377	0.000848	-1.623558	0.1056
VIX1(-2)	-0.001610	0.000711	-2.265063	0.0242
USD_MCI(-1)	-0.189992	0.123476	-1.538691	0.1250
USD_MCI(-2)	0.164496	0.126925	1.296006	0.1960
SET_USD_SPX(-1)	-0.157713	0.055991	-2.816732	0.0052
SET_USD_SPX(-2)	-0.087286	0.053653	-1.626857	0.1049
THB(-1)	-0.408533	0.227154	-1.798483	0.0731
THB(-2)	-0.041297	0.195812	-0.210902	0.8331
THB_IRS_1Y(-1)	-0.012635	0.018201	-0.694207	0.4881
THB_IRS_1Y(-2)	-0.061433	0.018244	-3.367301	0.0009
D_IRS_1Y(-1)	0.025079	0.016129	1.554903	0.1211
D_IRS_1Y(-2)	0.041668	0.016975	2.454682	0.0147

R-squared	0.467332	Mean dependent var	0.000669
Adjusted R-squared	0.415902	S.D. dependent var	0.010348
S.E. of regression	0.007909	Akaike info criterion	-6.755238
Sum squared resid	0.018138	Schwarz criterion	-6.412948
Log likelihood	1106.460	Hannan-Quinn criter.	-6.618540
F-statistic	9.086760	Durbin-Watson stat	2.001185
Prob(F-statistic)	0.000000		

Hypotheses 4 (Flow momentum for equities) and 7 (No flow momentum for bonds)

Autocorrelation in foreign investors' equity, bond, and foreign exchange market order flow					
	Lag 1	Lag 2	Lag 3	Lag 4	Lag 5
Equities	0.55	0.42	0.34	0.23	0.17
Bonds					
Outright	-0.06	0.01	0.02	-0.03	0.02
Other	-0.06	-0.01	-0.05	-0.07	0.06
Foreign exchange					
Spot, today	0.11	-0.03	0.01	0.07	0.10
Spot, tomorrow	0.50	0.34	0.25	0.20	0.19
Spot, next (T+2)	0.29	0.23	0.14	0.14	0.12
Outright forwards	0.07	0.00	0.08	0.08	0.00
FX swaps	0.34	0.28	0.26	0.28	0.26

Sources: Bank of Thailand; CEIC; BIS; authors calculations Table number

Hypotheses 5 (Return chasing in equities), 10, and 11 (Portfolio rebalancing 1)

Dependent Variable: FOREIGN_N_SET_USD
Method: Least Squares
Sample (adjusted): 1/11/2005 12/04/2006
Included observations: 293 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	7.161321	2.073745	3.453328	0.0006
THB(-1)	367.2805	871.2079	0.421576	0.6737
THB(-2)	535.8982	845.9649	0.633476	0.5269
THB(-3)	302.7972	847.2489	0.357389	0.7211
THB(-4)	-79.55409	823.8842	-0.096560	0.9231
SET_USD(-1)	3408.581	424.3658	8.032175	0.0000
SET_USD(-2)	1343.184	419.2886	3.203482	0.0015
SET_USD(-3)	245.8405	422.7490	0.581528	0.5614
SET_USD(-4)	877.0603	405.8687	2.160946	0.0315
SET_USD_SPX(-1)	-1574.131	363.2416	-4.333563	0.0000
SET_USD_SPX(-2)	-245.7985	360.7257	-0.681400	0.4962
SET_USD_SPX(-3)	295.2129	364.7201	0.809423	0.4190
SET_USD_SPX(-4)	-251.5925	352.2483	-0.714248	0.4757

R-squared	0.359269	Mean dependent var	9.249867
Adjusted R-squared	0.331809	S.D. dependent var	42.72296
S.E. of regression	34.92300	Akaike info criterion	9.987523
Sum squared resid	341492.5	Schwarz criterion	10.15081
Log likelihood	-1450.172	Hannan-Quinn criter.	10.05292
F-statistic	13.08341	Durbin-Watson stat	1.083884
Prob(F-statistic)	0.000000		

Hypotheses 6 and 8 (Contemporaneous correlations among buy and sell volumes)

Correlations between gross purchases and sales by nonresident investors	
Equities	
Foreign investors	0.74
Memo item: Domestic retail investors	*0.61*
Bonds	
Outright	0.11
Other	0.06
Foreign exchange	
Spot, today	0.71
Spot, tomorrow	0.16
Spot, next (T+2)	0.29
Forwards	0.07
Swaps	0.24
Sources: Bank of Thailand; CEIC; BIS; authors calculations	Table number

Hypothesis 9 (Relative volatility of returns)

Summary statistics of daily returns in the Thai foreign exchange and stock markets

US dollar-equivalent return, per cent

	Mean	Standard deviation	Minimum	Maximum
4 Jan 2005 – 30 Dec 2005				
Thai baht / US dollar	0.02	0.30	-1.54	1.08
Stock Exchange of Thailand Index	-0.01	0.94	-3.50	2.41
Relative volatility[1]		0.32		
3 Jan 2006 – 15 Dec 2006				
Thai baht / US dollar	-0.06	0.35	-1.10	1.26
Stock Exchange of Thailand Index	0.09	1.14	-3.51	3.94
Relative volatility[1]		0.31		
4 Jan 2005 – 15 Dec 2006				
Thai baht / US dollar	-0.02	0.33	-1.54	1.26
Stock Exchange of Thailand Index	0.04	1.04	-3.51	3.94
Relative volatility[1]		0.32		

[1] Relative volatility is defined as the standard deviation of the daily return on the Thai baht / US dollar divided by the standard deviation of the daily return on the Stock Exchange of Thailand Index.

Sources: Bank of Thailand; BIS; CEIC; authors' calculations. Table number

Conjectures 1 and 2

Dependent Variable: THB
Method: Two-Stage Least Squares
Sample (adjusted): 1/14/2005 12/04/2006
Included observations: 332 after adjustments
Instrument list: C THB(-1) THB(-2) W_SPOT_TD_N W_SPOT_TD_N(-1) RESIDBOND_SPOT_TM RESIDBOND_SPOT_TM(-1) RESIDSET_SPOT_N RESIDSET_SPOT_N(-1) W_FWD_N W_FWD_N(-1) W_SWAP_N W_SWAP_N(-1) SET_USD SET_USD(-1) SET_USD(-2) SET_USD(-3) SET_USD(-4) FOREIGN_N_SET_USD FOREIGN_N_SET_USD(-1) FOREIGN_N_SET_USD(-2) FOREIGN_N_SET_USD(-3) FOREIGN_N_SET_USD(-4) OUTRIGHT_N_BOND_USD OUTRIGHT_N_BOND_USD(-1) OUTRIGHT_N_BOND_USD(-2) OUTRIGHT_N_BOND_USD(-3) OUTRIGHT_N_BOND_USD(-4) OTHER_N_BOND_USD OTHER_N_BOND_USD(-1) OTHER_N_BOND_USD(-2) OTHER_N_BOND_USD(-3) OTHER_N_BOND_USD(-4)

	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000165	0.000303	0.542534	0.5878
THB(-1)	-0.060948	0.056382	-1.080994	0.2805
THB(-2)	-0.187112	0.047064	-3.975694	0.0001
W_SPOT_TD_N	2.63E-07	6.43E-06	0.040823	0.9675
W_SPOT_TD_N(-1)	5.73E-06	6.34E-06	0.903281	0.3671
FITTEDBOND_SPOT_TM	7.47E-07	8.98E-06	0.083200	0.9337
FITTEDBOND_SPOT_TM(-1)	-2.20E-06	8.83E-06	-0.248793	0.8037
RESIDBOND_SPOT_TM	-7.76E-06	2.36E-06	-3.286219	0.0011
RESIDBOND_SPOT_TM(-1)	2.15E-06	2.33E-06	0.923128	0.3566
FITTEDSET_SPOT	-3.06E-05	2.54E-06	-12.08423	0.0000
FITTEDSET_SPOT(-1)	1.03E-05	3.02E-06	3.405858	0.0007
RESIDSET_SPOT	-9.91E-06	1.14E-06	-8.668116	0.0000
RESIDSET_SPOT(-1)	4.04E-06	1.25E-06	3.233847	0.0014
W_FWD_N	-1.52E-05	2.23E-06	-6.803423	0.0000
W_FWD_N(-1)	3.47E-06	2.36E-06	1.471653	0.1421
W_SWAP_N	-7.15E-08	1.23E-06	-0.058291	0.9536
W_SWAP_N(-1)	2.58E-06	1.27E-06	2.032665	0.0429

R-squared	0.487347	Mean dependent var	-0.000283
Adjusted R-squared	0.461307	S.D. dependent var	0.003210
S.E. of regression	0.002356	Sum squared resid	0.001748
F-statistic	18.71564	Durbin-Watson stat	2.000250
Prob(F-statistic)	0.000000	Second-Stage SSR	0.001748

First Stage Regression for Conjecture 1

Dependent Variable: W_SPOT_N_N
Included observations: 372 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	14.33492	7.169963	1.999302	0.0463
SET_USD	3727.768	782.4695	4.764106	0.0000
SET_USD(-1)	1326.659	809.3462	1.639174	0.1020
SET_USD(-2)	1723.586	817.5442	2.108248	0.0357
SET_USD(-3)	1073.561	750.6940	1.430091	0.1536
FOREIGN_N_SET_USD	0.418551	0.248410	1.684920	0.0929
FOREIGN_N_SET_USD(-1)	-0.426405	0.279993	-1.522914	0.1287
FOREIGN_N_SET_USD(-2)	0.350783	0.267800	1.309869	0.1911
FOREIGN_N_SET_USD(-3)	0.150443	0.225237	0.667934	0.5046

R-squared	0.189922	Mean dependent var	23.08909
Adjusted R-squared	0.172069	S.D. dependent var	143.2000
S.E. of regression	130.2987	Akaike info criterion	12.60143
Sum squared resid	6162926.	Schwarz criterion	12.69624
Log likelihood	-2334.866	Hannan-Quinn criter.	12.63908
F-statistic	10.63813	Durbin-Watson stat	1.453170
Prob(F-statistic)	0.000000		

First Stage Regression for Conjecture 2

Dependent Variable: W_SPOT_TM_N
Included observations: 376 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.
C	25.29639	3.681145	6.871882	0.0000
OUTRIGHT_N_BOND_USD	-0.183425	0.080093	-2.290145	0.0226
OUTRIGHT_N_BOND_USD(-1)	-0.293096	0.083176	-3.523799	0.0005
OUTRIGHT_N_BOND_USD(-2)	-0.280712	0.083804	-3.349639	0.0009
OUTRIGHT_N_BOND_USD(-3)	-0.269559	0.082731	-3.258258	0.0012
OTHER_N_BOND_USD	-0.108273	0.120725	-0.896858	0.3704
OTHER_N_BOND_USD(-1)	-0.108545	0.120759	-0.898860	0.3693
OTHER_N_BOND_USD(-2)	-0.165395	0.124532	-1.328126	0.1850
OTHER_N_BOND_USD(-3)	-0.101060	0.119933	-0.842638	0.4000

R-squared	0.120371	Mean dependent var	19.27691
Adjusted R-squared	0.101197	S.D. dependent var	72.55469
S.E. of regression	68.78565	Akaike info criterion	11.32351
Sum squared resid	1736448.	Schwarz criterion	11.41757
Log likelihood	-2119.820	Hannan-Quinn criter.	11.36085
F-statistic	6.277673	Durbin-Watson stat	0.974766
Prob(F-statistic)	0.000000		