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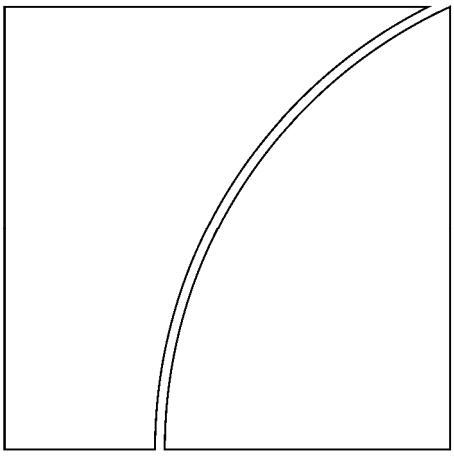

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by Jacob Gyntelberg, Mico Loretan, Tientip Subhanij and Eric Chan

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International portfolio rebalancing and exchange rate fluctuations in Thailand*

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Abstract

We present empirical evidence that the Thai exchange rate is driven in part by international investors' cross-border portfolio rebalancing decisions. Our results are based on two comprehensive, daily-frequency datasets of foreign exchange and equity market capital flows undertaken by nonresident investors in Thailand in 2005 and 2006. We find that net purchases of Thai equities by nonresident investors lead to an appreciation of the Thai baht. In addition, higher returns in the Thai equity market relative to a reference stock market are associated both with net sales of Thai equities by these investors and with a depreciation of the Thai baht. Foreign investors do not appear to hedge the foreign exchange risk related to their equity market positions. Despite this, we find that exchange rate movements were not key drivers of nonresident investors' equity market investment choices in our sample period.

JEL classification: F30, F31.

Keywords: Foreign exchange market, capital flows, Thailand, equity market, nonresident investors, portfolio rebalancing

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1 Introduction

Understanding the role international capital flows play in determining exchange rates has been a long-standing objective of international finance research. The significant growth of international capital flows over the past few decades has created broad-based interest in this topic. Researchers and policy makers are interested in understanding the forces that drive flows in foreign exchange markets and in the relationships between external capital flows and developments in the domestic financial system. These relationships affect the stability of the financial system as well as broader economic developments and conditions. Financial institutions directly engaged in foreign exchange (FX) trading closely monitor their customers' trades, and they develop in-house models of FX returns dynamics based on this partial information about the relationship between flows and returns in the FX market and in domestic capital markets; see, e.g., Gehrig and Menkhoff (2004).

In this paper we examine the influence of equity market related capital flows on the exchange rate for Thailand. We make use of a novel dataset for Thailand, a large and important emerging market economy, which contains two years' worth of comprehensive daily-frequency FX market transactions between licensed FX dealers in Thailand and their nonresident customers. In addition, we also use data on capital flows by nonresident investors in the Thai stock market. The datasets were compiled by the Bank of Thailand (BOT) and the Stock Exchange of Thailand (SET) over the period 2005 to 2006.[1]

We establish four empirical regularities for Thailand regarding the links between capital flows and exchange rate movements. Taken together, our findings suggest that incomplete markets for hedging of foreign exchange risk exist alongside relatively frictionless cross-border equity markets. First, higher returns in the Thai equity market relative to a reference stock market are associated with outflows from Thai equities and a depreciation of the Thai baht. Second, net purchases of Thai equities by nonresident investors lead to an appreciation of the Thai baht. On average, net purchases of Thai equities by nonresident investors of US$ 100 million result in a 0.15 percent appreciation of the baht versus the US dollar. Third, foreign investors do not hedge the foreign exchange risk related to their equity market positions, or can only do so imperfectly.

[1]The data for the Thai stock market have also been used by Chai-Anant and Ho (2008). For a recent study that examines the information content of ultra-high frequency SET data see Pavabutr and Sirodom (2007). Bailey, Mao, and Sirodom (2007) relate investment restrictions in the equity markets of Singapore and Thailand to cross-border information flows. Phongpaichit and Baker (2008) provide a general overview of developments in the capital markets in Thailand since 1997.

As a result, they bear both equity and currency risk when they hold Thai stocks. Finally, in contrast to earlier studies which document the presence of momentum trading generated by FX fluctuations, we show that exchange rate movements were not key drivers of nonresident investors' equity investment transactions in Thailand during our sample period.

The remainder of this paper is structured as follows. Section 2 reviews the related literature and lists the testable hypotheses. Section 3 provides an overview of the foreign exchange and equity markets in Thailand and describes the datasets. In Section 4 we examine the empirical evidence for our hypotheses. Section 5 concludes.

2 Related literature and hypotheses

With incomplete markets for hedging of FX risk, assets denominated in various currencies must differ in at least this aspect of risk. Optimizing investors will split their portfolios of stocks, bonds, and other financial assets between domestic-currency and foreign-currency denominated assets in proportions that depend on expected rates of return, risks, and expected risk premia. If expected rates of return or any other component of the portfolio choice problem change, international capital flows should occur as investors rebalance their asset holdings across countries.

The economics literature that formalized this notion is commonly called the portfolio balance approach.[2] Portfolio balance models provide plausible scenarios in which capital flows should help explain both the sign and the magnitude of exchange rate fluctuations. Unfortunately, early attempts to verify empirically this implication of the models were generally unsuccessful; see, e.g., Frankel (1983). The lack of empirical evidence in favor of the portfolio balance hypothesis reflected several factors. First, many of the early studies relied on low-frequency data. Because capital flows can fluctuate considerably from day to day and are somewhat mean-reverting at high frequencies, the use of lower-frequency data—such as monthly or quarterly 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.

Second, early portfolio balance models focused mainly on modeling flows in riskless assets, such as bonds, but not in risky assets such as common stocks.[3] Third, early portfolio balance models analyzed mainly the effects of changes in the *supply* of financial assets, and they were

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

[3]This modeling choice occurred in part because solution methods for general equilibrium models in which asset prices fluctuate unpredictably had not yet been developed.

less concerned with modeling explicitly the demand side of asset markets. Moreover, because the asset demand functions used in the initial phase of the portfolio balance literature were frequently postulated rather than based explicitly on micro foundations, it was unclear how phenomena such as heterogeneity of private information about asset returns might be incorporated into the models.[4]

To address these issues and, in particular, to examine the relationships between exchange rate fluctuations and returns on risky financial assets, researchers have recently succeeded in developing general equilibrium models with multiple assets with uncertain returns. Hau and Rey (2004, 2006) develop such a model and use it to analyze portfolio rebalancing effects on exchange rates. They consider the implications of the empirically relevant observation that the market for hedging of foreign exchange risk is incomplete, whereas cross-border equity markets transactions are relatively frictionless, for the link between portfolio decision by foreign investors and the exchange rate. The model abstracts from private information effects as well as market microstructure issues to develop the consequences of a "pure" portfolio balance story. Using a stylized two-country framework, they analyze the joint equilibrium dynamics of equity returns, exchange rate returns, and investors' portfolio choices. The model of Hau and Rey (2006) also assumes that investors do not fully hedge the actual FX price risk contained in their portfolios. We demonstrate that this assumption is supported by our data for Thailand.[5]

In this paper, we examine the following empirical implications of the stylized framework presented in Hau and Rey (2004, 2006), expressed in terms relevant for nonresident investors in Thailand:

Hypothesis 1 *Net inflows into the Thai stock market by foreign investors should be positively correlated with appreciations of the Thai baht.*

Hypothesis 2 *Higher dollar-denominated SET returns relative to US equity market returns should be associated with net sales of Thai equities by foreign investors.*[6]

[4]In addition, portfolio balance 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—and often worse—than that of the random walk model; see the seminal contribution of Meese and Rogoff (1983) and the follow-on investigation by Cheung, Chinn, and Garcia Pascual (2005).

[5]The model also taken as given that the supply of foreign currency provided by local financial institutions (including the central bank) is less than perfectly elastic. This assumption rules out the case of a fully-pegged exchange rate system, in which the monetary authority intervenes to offset the effects of any capital in- or outflows on the exchange rate and, in the process, makes the supply of foreign currency fully elastic.

[6]This hypothesis was also considered by Brennan and Cao (1997). In their setting, it is obtained as an implication of assumed wealth effects that should influence investors' preferred international portfolio compositions.

Hypothesis 3 *Higher dollar-denominated SET returns relative to US equity market returns should be associated with a depreciation of the Thai baht.*

The third hypothesis runs counter to the conventional intuition that strong home equity market returns should, *ceteris paribus*, be associated with an appreciation of the home currency.

3 The markets and the data

In this section, we provide a brief overview of the onshore FX, stock, and government bond markets in Thailand, while focusing mainly on aspects of the markets and the data that are important for the empirical results reported in Section 4. We also note certain regulatory features that induce a relationship between foreign investors' capital market transactions and their FX market transactions that is likely closer in Thailand than in many other economies.

3.1 Sample period and definition of nonresident investors

All observations are daily. The data we received originally ran from the beginning of 2005 through early 2008. After conducting a preliminary analysis, however, we decided not to use data after mid-December 2006, as there was a severe structural break in the data following the imposition of the so-called unremunerated reserve requirement (URR) capital control measures in mid-December 2006. [7] The sample period therefore ranges from the beginning of January 2005 through Friday, 15 December 2006. Despite occasional bouts of volatility in FX and stock market returns during the sample period, we did not find evidence of structural breaks.

Throughout this paper, we focus mainly on the financial market transactions of *nonresident* end-users or investors. Formally, nonresident investors comprise (i) corporations, institutions, funds, financial institutions or juristic persons located outside Thailand; (ii) entities of foreign governments located outside Thailand; (iii) branches and agents of domestic juristic persons located outside Thailand; and (iv) natural persons not of Thai nationalities who do not have alien identity or residence permits. According to information we received from the Bank of

[7] On Tuesday, 19 December 2006, the Thai authorities imposed additional, stringent capital control measures highlighted by a 30% 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 the onshore financial markets in Thailand, and foreign investors' participation in these markets dropped off severely, while their participation in offshore nondeliverable forward markets—for which we do not have data—rose. The controls were lifted in early March 2008, restoring capital market controls in Thailand roughly to their pre-URR status. It remains to be examined whether the effects we found for the pre-URR period also apply in the post-URR period.

Thailand's Data Management Group, financial institutions are the dominant group—with a share well in excess of 90% of total transactions—among the nonresident end-users in Thailand.

Nonresident investors that hold bank balances in Thailand are required to do so by holding so-called nonresident baht accounts (NRBA). During our two-year sample period, balances on NRBAs were restricted not to exceed THB 300 million per nonresident at the end of each day, covering all accounts with all domestic financial institutions in Thailand.[8]

If nonresident investors in Thailand, as a group, wish to build up (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 three ways: (i) by drawing down (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 on allowable balances in NRBAs and because of a general lack of liquidity in the private money markets in Thailand, the most straightforward method by which nonresident investors may acquire (liquidate) the funds involved in the purchase (sale) of baht-denominated shares and bonds is by transacting in the FX market. This institutional feature is one of the keys to our ability to link foreign customers's transactions across FX and stock markets in Thailand and to trace the effects of portfolio balancing decisions in the equity markets on the exchange rate.

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 percent of activity in the onshore FX market before that event, but with the imposition of anti-speculation measures their share declined sharply to only 18 percent of the total in the following year. With the introduction of the URR on 19 December 2006, the share of onshore turnover accounted for by nonresident customers declined further.

3.2 The onshore FX market

The wholesale onshore FX market in Thailand is an over-the-counter market, where trading services are provided by licensed currency dealers, which can be domestic or foreign-owned

[8]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 NRBA regulations for nonresident investors were broadly stable in 2005 and 2006.

banks and brokers. 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). As with most other emerging-market currencies, there is very little trading in baht outside of local business hours.

The onshore FX market in Thailand is closely monitored by the BOT. Onshore commercial banks are required by the BOT 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 BOT 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 BOT. All licensed FX dealers submit detailed daily reports of their FX transactions to the BoT.

In the banks' reports, each transaction record states the counterparty, its type (other dealer, domestic customer, nonresident customer, and BOT), 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.

We construct daily-frequency *gross* buy and sell capital flow series involving dealers and nonresidents for all 5 types of FX contracts by aggregating the data across reporters, and we take take the difference between aggregate buys and sells to obtain the *net* buy or order flow series. Based on conversations with FX market participants, "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

Table 1: Transactions of nonresident customers, onshore Thai FX market

Daily volume and order flow, in millions of US dollars.

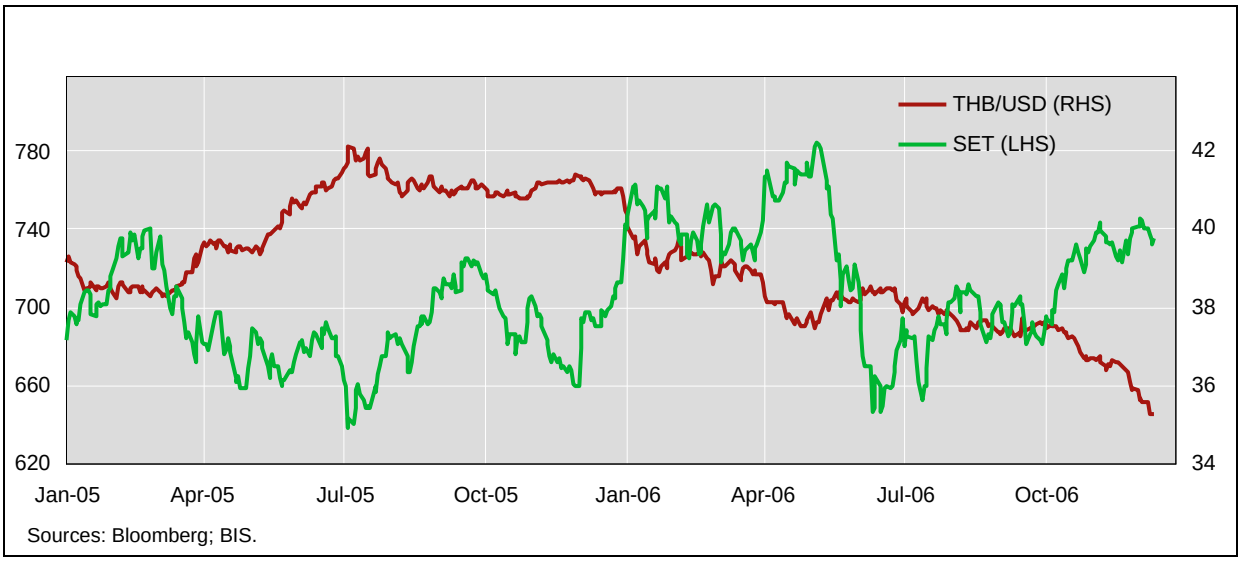
	Mean	Standard Deviation	Minimum	Maximum
Volume (Buy+Sell)				
2005: 4 Jan–30 Dec				
Foreign exchange market, overall	780.1	236.2	181.2	1,714.9
Spot, today	34.4	19.8	14.7	299.8
Spot, tomorrow	82.4	62.3	1.3	439.9
Spot, next $(T+2)$	354.1	132.6	23.2	869.1
Forwards	38.1	49.9	0.0	309.0
FX Swaps	271.1	110.7	0.7	686.4
2006: 3 Jan–15 Dec				
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)				
2005: 4 Jan–30 Dec				
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
2006: 3 Jan–15 Dec				
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

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.[9]

In 2005 and 2006, all three spot FX daily net flow series were positive on average, as nonresident customers were net buyers of baht in both years. Conversely, in 2005 and 2006 nonresident

[9]In addition to transactions between dealer's and non resident customers, there are also transactions between dealers and domestic customers as well as between dealers and the Bank of Thailand. Transactions between the BOT and FX dealer banks generally consist of intervention operations; See Bank of Thailand, Financial Markets Operations Group (2005) for a discussion of the BoT's FX intervention objectives. In our present study, we are limited to using only the transactions between the dealers and their nonresident customers. As such, the FX dataset used in this study provides only a partial but very interesting glimpse of the full activity in the onshore FX market in Thailand.

Figure 1: Thai baht/U.S. dollar exchange rate and SET index in 2005 and 2006



customers were net sellers of baht through outright forwards and through FX swap contracts. The daily overall transaction volume between dealers and nonresident end-users averaged US$ 780 million in 2005 and US$ 1,155 million in 2006. Table 1 provides additional summary statistics on volume and order flow in the onshore FX market. 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. 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, during a period of heightened global equity market volatility, the second in September 2006, during a brief period of political turmoil in Thailand.[10]

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 Central European Time). 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.

[10]The single most active day in our sample, in terms of overall nonresident customer FX market 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.

Table 2: Transactions by nonresident customers, Stock Exchange of Thailand

Daily volume and order flow, in millions of US dollars.

	Mean	Standard Deviation	Minimum	Maximum
Volume (Buy+Sell)				
2005: 4 Jan–30 Dec	228.7	82.8	36.5	588.8
2006: 3 Jan–15 Dec	285.5	140.3	87.7	1,121.6
Order flow (Buy−Sell)				
2005: 4 Jan–30 Dec	12.1	39.4	−109.9	169.1
2006: 3 Jan–15 Dec	12.7	60.1	−147.5	388.8

Sources: Bank of Thailand, CEIC, authors' calculations.

The baht depreciated against the dollar in the first half of 2005, reaching a low of about 42 THB/USD in July 2005 (see Figure 1). Over the subsequent six quarters the baht appreciated sharply against the dollar, reaching the 35 THB/USD mark by mid-December 2006. Over the sample period as a whole, the average 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.

3.3 The equity market

Our stock market dataset contains the daily closing values of the Stock Exchange of Thailand (SET) index and the daily gross buy and sell transaction volumes, as well as the net buy volumes, by nonresident investors. As with the FX dataset, we terminate the sample on Friday, 15 December 2006, because the government's unremunerated reserve requirement (URR) measures were announced and went into effect the following week. 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.[11]

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.

Summary statistics for nonresident investors' transaction volumes and net capital flows on the SET are provided in Table 2. Average daily gross transaction volume (buys+sells) on the

[11] 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.

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 shows, stock prices in Thailand experienced bouts of elevated volatility in 2006 during the same two periods as the onshore FX market did.

4 Empirical findings

We now turn to examining the empirical evidence for the hypotheses. All variables used in the regression models are listed in Table 3. All regression equations were estimated by OLS. Standard tests for misspecification of the regression relationships were performed for all models and were not statistically significant. We also 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.

Table 3: List of variables used in the regression models

Variable	Description	Units
THB	THB/USD spot exchange rate	Log first diff.
SET	SET index, expressed in US dollars	Log first diff.
SPX	S&P 500 index	Log first diff.
SET_SPX	Excess return of SET index, expressed in US dollars, over 1-day-lagged S&P 500 index	Log first diff.
OF_SET	Net purchases of shares on SET by nonresidents (NRs), i.e., gross share purchases − gross share sales by NRs	USD million
OF_SPOT_TD	Net baht purchases by NRs via FX spot-today	USD million
OF_SPOT_TM	Net baht purchases by NRs via FX spot-tomorrow	USD million
OF_SPOT_NXT	Net baht purchases by NRs via FX spot-next (T+2)	USD million
OF_FWD	Net baht purchases by NRs via FX outright forwards	USD million
OF_SWAP	Net baht purchases by NRs via FX swaps	USD million
USD_MCI	Major currencies index of US dollar	Log first diff.
VIX	VIX index	First diff.
THB_IRS_1Y	1-year Thai baht interest rate swap rate	First diff., pct. points
D_IRS_1Y	Differential between 1-year Thai baht and 1-year US dollar interest rate swaps	First diff., pct. points

4.1 Imperfect hedging

One of the key assumptions of the Hau and Rey (2006) framework is that foreign exchange risk is not perfectly hedged. For Thailand, we find that this assumption is highly plausible when it comes to foreign investors' equity market positions. Table 4 reports the results of a regression of nonresident investors' FX swap transactions—which would be a natural instrument for hedging FX price risk—on current and lagged values of stock market flows and returns. The regression clearly indicates that FX swap market activity is not driven by either equity market order flows or equity market returns: None of the individual slope coefficients in this regression are statistically significant, and the adjusted R^2 of the regression is 0.05. This is consistent with imperfect or perhaps even no hedging of foreign exchange risk embedded in equity market positions.[12]

Table 4: Dependence of FX swap order flow on stock market returns and order flow

Dependent variable: `OF_SWAP`

Variable	Coefficient	Std. error	t-stat.	Prob.
C	−119.846	6.556	−18.281	0.000
`SET(-1)`	87.471	715.459	0.122	0.903
`SET(-2)`	477.911	740.034	0.646	0.519
`SET(-3)`	393.414	747.530	0.526	0.599
`OF_SET`	0.279	0.227	1.226	0.221
`OF_SET(-1)`	0.279	0.256	0.912	0.362
`OF_SET(-2)`	0.233	0.249	0.391	0.696
`OF_SET(-3)`	0.136	0.206	0.661	0.209
	R^2	0.075	F-stat	3.668
	Adj. R^2	0.054	Prob.(F-stat)	0.000

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

4.2 Portfolio rebalancing and exchange rate returns

Hypothesis 1 states that net inflows into the stock market by foreign investors should be positively correlated with appreciations of the baht. In our regressions *appreciation* of the baht requires a *negative* sign for the coefficient(s). Table 5 shows that daily-frequency baht returns do indeed depend significantly and with the "correct," i.e., negative, sign on same-day and one-day-lagged net purchases of shares by nonresident investors, `OF_SET` and `OF_SET(-1)`.

[12]The major currencies index of US dollar is calculated daily by the Federal Reserve. It measures the dollar's trade-weighted exchange value against 7 major currencies. Listed in descending order of their weights in the index, these currencies are the euro, the Canadian dollar, the yen, pound sterling, the Swiss franc, the Australian dollar, and the Swedish krona.

Table 5: Dependence of FX returns on own-market order flow, stock market order flow, and proxies for macroeconomic conditions

Dependent variable: THB

Variable	Coefficient	Std. error	t-stat.	Prob.
C	0.0002	0.0003	0.5494	0.583
THB(-1)	−0.0608	0.0673	−0.9037	0.367
THB(-2)	−0.0566	0.0571	−0.9924	0.322
OF_SPOT_TD	-3.11×10^{-6}	9.91×10^{-6}	−0.3138	0.754
OF_SPOT_TD(-1)	2.11×10^{-6}	6.62×10^{-6}	0.3194	0.750
OF_SPOT_TM	-8.38×10^{-6}	2.45×10^{-6}	−3.4161	0.001
OF_SPOT_TM(-1)	1.59×10^{-6}	2.29×10^{-6}	0.6926	0.489
OF_SPOT_NXT	-12.70×10^{-6}	1.08×10^{-6}	−11.7950	0.000
OF_SPOT_NXT(-1)	3.14×10^{-6}	1.36×10^{-6}	2.3190	0.021
OF_FWD	-18.61×10^{-6}	2.27×10^{-6}	−8.1948	0.000
OF_FWD(-1)	-0.40×10^{-6}	2.46×10^{-6}	−0.1630	0.871
OF_SWAP	-0.24×10^{-6}	1.28×10^{-6}	−0.1900	0.849
OF_SWAP(-1)	3.60×10^{-6}	1.31×10^{-6}	2.7494	0.006
OF_SET	-10.72×10^{-6}	4.21×10^{-6}	−2.5449	0.011
OF_SET(-1)	-4.72×10^{-6}	4.47×10^{-6}	−1.0576	0.291
VIX(-1)	0.0003	0.0002	1.1674	0.244
VIX(-2)	66.3×10^{-6}	0.0002	0.3144	0.753
USD_MCI(-1)	0.0832	0.0363	2.2906	0.023
USD_MCI(-2)	−0.0064	0.0374	−0.1710	0.864
SET_SPX(-1)	0.0344	0.0162	2.1235	0.035
SET_SPX(-2)	0.0162	0.0158	1.0259	0.306
THB_IRS_1Y(-1)	0.0075	0.0053	1.4274	0.155
THB_IRS_1Y(-2)	0.0137	0.0053	2.5972	0.010
D_IRS_1Y(-1)	−0.0073	0.0046	−1.5733	0.117
D_IRS_1Y(-2)	−0.0146	0.0049	−2.9792	0.003
	R^2	0.520	F-stat	13.562
	Adj. R^2	0.481	Prob.(F-stat)	0.000

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

The total average effect of this variable on baht/dollar returns is computed as the sum of the two coefficients; US$ 100 million net purchases of Thai equities result in a 0.15 percent appreciation of the baht versus the US dollar. Table 5 also shows that baht returns depend significantly—and with a negative sign—on nonresident investors' net purchases of baht via spot-tomorrow, spot-next, and outright forward FX contracts.

Table 6: Dependence of investors' flows in the stock market on FX returns, SET returns, and relative performance of the SET index versus the S&P500 index

Dependent variable: OF_SET

Variable	Coefficient	Std. error	t-stat.	Prob.
C	7.16	2.07	3.453	0.001
THB(-1)	367.28	871.21	0.421	0.674
THB(-2)	535.90	845.97	0.633	0.527
THB(-3)	302.80	847.25	0.357	0.721
THB(-4)	−79.55	823.88	−0.097	0.923
SET(-1)	3408.58	424.37	8.032	0.000
SET(-2)	1343.18	419.29	3.203	0.002
SET(-3)	245.84	422.75	0.582	0.561
SET(-4)	877.06	405.89	2.161	0.032
SET_SPX(-1)	−1574.13	363.24	−4.334	0.000
SET_SPX(-2)	−245.80	360.73	−0.681	0.496
SET_SPX(-3)	295.21	364.72	0.809	0.419
SET_SPX(-4)	−251.59	352.25	−0.714	0.476
	R^2	0.359	F-stat	13.083
	Adj. R^2	0.332	Prob.(F-stat)	0.000

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

Another implication of the portfolio balance hypothesis, stated here as **Hypothesis 2**, is that when SET index returns exceed (lagged) S&P500 index returns, nonresident investors should be net *sellers* of Thai equities. The regression results we report in Table 6 are consistent with this prediction: the coefficient of the first lag of SET_SPX, the variable that captures relative SET/S&P500 returns, is both negative and statistically significant. Thus, foreign investors' net purchases of Thai equities are explained by more than just return chasing. The results in Table 6 also show that nonresident investors' net share purchases depend positively on lagged stock returns, a pattern sometimes termed "return chasing."

A final implication of portfolio rebalancing, stated as **Hypothesis 3**, is that if the SET outperforms other stock markets the baht should depreciate, and vice versa. This follows because when nonresident investors in Thailand are net sellers of shares on the SET, they are generally also net sellers of baht in the FX market in order to comply with regulations on permissible balances held in NRBA bank accounts. Our regression analysis shows that this relationship holds. In Table 5, the coefficient of the first lag of SET_SPX, the variable that measures the outperformance of the SET index relative to the S&P500 index, is positive, i.e., implies a depreciation of the baht, as well as statistically significant. However, this portfolio balance effect, while statistically

significant, is not large numerically: 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.

Finally, we also find that exchange rate fluctuations did not drive foreign investors' equity investment flows in Thailand in our sample period. This can be seen from the uniformly insignificant coefficients on the lagged values of the variable `THB` in Table 6. This finding may reflect the fact that during 2005 and 2006 exchange rate volatility was at multi-year lows. If this conjecture is correct, this empirical result may not carry over to other, more volatile time periods.

5 Concluding remarks

In this paper we have provided, for the case of Thailand, empirical evidence on the statistical significance and the numerical magnitude of several key effects postulated in the portfolio rebalancing literature. We have found support for all three hypotheses related to linkages between investors' portfolio rebalancing decisions and exchange rate fluctuations. However, even though we find that a relative outperformance of Thai equities is associated with a depreciation of the baht (Hypothesis 3), the numerical magnitude of this effect is quite small.

In terms of policy implications, our overall finding that portfolio rebalancing by nonresidents are important for the exchange rate implies that a deeper exploration of the drivers of these investors' decisions would be useful to central banks seeking to manage exchange rate volatility. This applies particularly in the current post financial crisis environment, in which global financial capital flows may remain volatile. Finally, our empirical study is based on data from Thailand, a major emerging market economy. It will be interesting to see if similar results also hold for other emerging market economies.

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