

Shadow FX intervention in Taiwan: Solving a USD 100+ bn enigma

An exploration into the counterparties to life insurers' FX hedges

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Summary

Taiwan is the only major economy which does not publicly release information about its central bank's intervention in FX derivative markets. This paper seeks to provide a simple but tricky to prove solution to this enigma: The Central Bank of the Republic of China is conducting one of the world's largest FX derivative interventions, as of mid-2018 amounting to ~USD 130bn, or 20% of Taiwan's GDP. Structured as FX swaps, conducted with and intermediated by the local banking system, the ultimate counterparty to such transactions is Taiwan's rapidly growing life insurance industry, seeking FX hedges for the vast amounts of household savings it has directed into USD-denominated fixed income markets.

Via its FX swap book, the CBC is taking on FX exposures vastly exceeding that of its reported FX reserves – and in the process curtailing the perennial upward pressure on its currency created by a current account surplus exceeding 10% of GDP for the past decade. The repercussions of the CBC's program are wide-ranging. Its intervention helped create an illusion of a cap on the appreciation of the TWD, which encouraged the dollarization of Taiwanese savings and risk-taking by Taiwanese financial institutions. Further, its provision of FX swaps helped to 'floor' the USD-TWD cross-currency basis, enabling the life insurers' investments abroad. Above all, by keeping a portion of interventions hidden, Taiwan has avoided a necessary discussion about the consequences of its neo-mercantilist trade policies.

The paper consists of six chapters: I. is an introduction laying out why Taiwan's disclosures fall short of international standards. II. digs into Taiwan's cross-border flows and particularly the rise of life insurers. III. is a primer on FX hedging. IV. maps out TWD FX exposures taken via derivatives by private sector actors in & outside Taiwan. V. forms the core contribution and provides a framework able to track unpublished central bank FX interventions. VI. outlines consequences and concludes.

I. INTRODUCTION

FOR the better part of last 20 years, analyzing the ups and downs of FX interventions and the concomitant rise of global FX reserves has been an integral part of understanding FX and sovereign bond markets. Central banks from countries as diverse as Japan, China, Saudi Arabia, Russia, Switzerland, Hong Kong, India and South Korea have each assumed FX exposures north of USD 400bn at the beginning of 2019.

What unites these, and practically every other here unmentioned country, is that the most comprehensive information about their activities in currency markets can be found in a standardized form created by the IMF, the '**Data Template on International Reserves and Foreign Currency Liquidity**' (**IRFCL**). The template was initially developed in 1999 and is a key component of the Special Dissemination Standard (**SDDS**), to which IMF members subscribe in order to "*provide[s] a standard for good practices in the dissemination of economic and financial data*"¹. As of today, 95% of all IMF member countries (including all G20 members), subscribe to the **SDDS** and accept the responsibility to produce an **IRFCL**.

The value of the reserve template lies in the provision of detailed '*Foreign currency resources*' and '*Foreign currency drains*', which includes positions in FX derivative markets, pledging or lending of FX reserves, as well as other contingent exposures – all factors which are not readily revealed by the headline FX reserve series alone. Because of the disclosure of these details, it is usually possible to understand even complicated FX maneuvers conducted by central banks.

Taiwan

SDDS compliance: yes, IRFCL: no

Over 70 of the world's largest countries release an **IRFCL**, with one notable exception: Taiwan. As with any question, there exists an obvious, but ultimately dissatisfying answer: Taiwan is, for historical reasons, not an IMF member and as such has not officially adopted the Special Dissemination Standard.

The website of Taiwan's central bank (the **CBC**) nevertheless prominently features an 'SDDS button' on its main page², highlighting that Taiwan voluntarily "provides

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¹Quoted from the 2013 IRFCL manual, available from the IMF [here](#).

²See its English website [here](#).

most information on the financial and external sectors of the Republic of China" according to IMF established guidelines. Upon another click, it furthermore provides a '*Summary Page on Observance*' of the SDDS³, and assigns itself full compliance in all tested dimensions (coverage, periodicity and timeliness) regarding the foreign sector, which includes the 'international reserves' category.

Given these assurances, it is all the more striking that Taiwan does not follow IRFCL disclosure standards for its FX reserves. The CBC clearly has the technical capacity to compile the necessary information, as it is a straightforward process based on information covered by any central banks' internal accounting systems. Market participants are broadly aware of the absence of the data covered by the reserve template in Taiwan, as are foreign policy makers – including the U.S. Treasury Department which, in its biannual FX reports to Congress⁴ regularly bemoans the lack of insight Taiwan provides.

This paper will attempt to answer whether Taiwan simply does not consider the release of an IRFCL as particularly informative or if there are deeper reasons it has so far objected to releasing a reserve template. The road to an answer will be bumpy and will require, among other things, a deep dive into Taiwan's life insurance industry and its cross-border transactions, a detailed look at the demand and supply in TWD FX derivative markets as well as non-standard CBC FX operations. This resulting body of work will ultimately lay out evidence that suggests one of the largest FX derivative interventions any central bank globally has so far undertaken.

II. PERENNIAL TRADE SURPLUSES, DEBT OUTFLOWS & THE RISE OF THE LIFE INSURERS

THIS chapter seeks to provide the clearest possible understanding of financial flows between Taiwan and the rest of the world. It will commence by examining Taiwan's enduring Current Account surpluses, their reflection as debt outflows in the Financial Account, as well as the key role of the life insurance industry, acting as the primary mediator for Taiwan's savings.

A. Perennial Trade Surpluses

With the progression of globalization during the past 30 years, Taiwan first carved out and then cemented its place as the backbone of the Information and Communication Technology

³The English version is available [here](#).

⁴Treasury's latest FX report is available [here](#). The request for Taiwan to release more granular FX intervention data is in footnote 20 on page 41. Earlier versions, for instance the [Spring 2017](#) report, contain more explicit requests. Especially pertinent are the sections starting on page 19 – in fact, this introduction is based on Treasury's assessment set forth there.

(ICT) value chain in Northeast Asia. It is home to numerous giants in electronic and semiconductor-related industries, has the highest share globally of ICT value-added as a share of total GDP (15% vs. a global average of 1.4%)⁵ and delivers chips and other hardware to practically all nations assembling these components into final products.

Taiwan's strength in the ICT trade is clearly visible in its trade accounts, with a trade surplus in this category easily averaging north of 10% of GDP for the past 20 years.

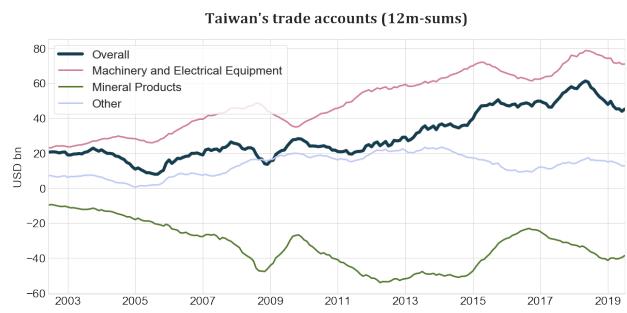


Fig. 1. Overall trade surplus and net amounts by category, all depicted as 12 month rolling sums. Source: Ministry of Finance, Taiwan

Due to a lack of domestic natural resources, Taiwan is dependent on foreign oil, gas and other minerals, a fact also clearly visible in its trade statistics and the prime detractor of the large ICT-related surplus. All other product categories exhibit low relative volatility (compared to the two aforementioned ones) and, when all combined, result in a small but steady trade surplus in the 'other' category.

The quarterly released Balance of Payments (**BoP**) statistics (upper panel, Fig. 2) conform to the dynamics shown by the monthly trade figures, highlighting Current Account surpluses on the order of ~USD 70bn, or well over 10% of Taiwan's GDP, during the past four years.

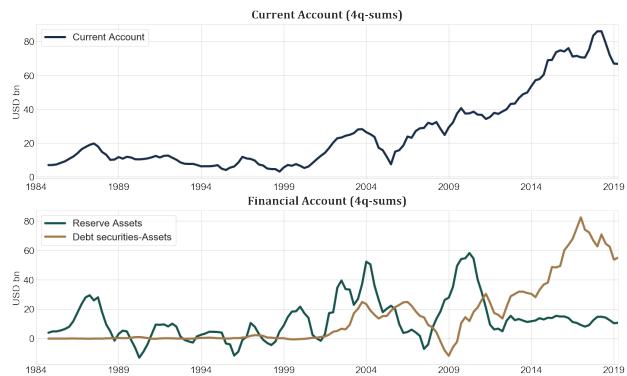


Fig. 2. Balance of Payments statistics for Taiwan. Source: CBC

B. Slowing FX Reserve Accumulation & Private Debt Outflows

Surpluses on the Current Account have to axiomatically be accompanied by an increase in net claims on the Rest of the

⁵Based on 2014 World Input Output tables available [here](#).

World. This manifests itself as Financial Account outflows in Balance of Payments accounts.

As with the trade statistics before, the Financial Account consists of dozens of line items, yet the key drivers can be summarized by two series alone: the accumulation of FX reserves by the CBC and the purchases of overseas debt by the private sector, both shown in the lower panel of Fig. 2. FX reserve accumulation was the predominant mechanism for recycling Taiwan's Current Account surplus until 2003 and was briefly resurrected in the immediate aftermath of the financial crisis in 2008. But formal reserve accumulation has since settled down to a much lower and less volatile level of around USD 10bn per annum.

Private acquisitions of foreign debt grew in the mid-2000s, but these flows partly reversed during the global financial crisis. They subsequently picked up notably, replacing FX reserve accumulation as the main Current Account recycling mechanism and virtually matched the increase in the Current Account surplus after 2014.

Fig. 3 shows the same information, this time as cumulative sums starting in 1984. Especially in recent years, the explanatory power of the two discussed categories is very high, almost exactly matching cumulative Current Account surpluses of USD 900bn. This cumulative sum is roughly equally split between FX reserves on the CBC's balance sheet and holdings of foreign debt by Taiwan's private sector.

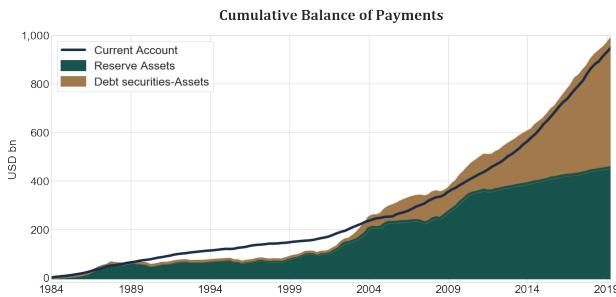


Fig. 3. Cumulative Balance of Payments, Source: CBC

Digging deeper into the BoP statistics (Fig. 4) shows that while Depository Institutions (i.e. banks) do contribute to purchases of foreign bonds, the overwhelming share is purchased by the 'Other Sector' category, which typically houses a country's insurance sector, mutual funds & other financial institutions aside from banks. As evidenced in Fig. 5, in Taiwan's case, the life insurance sector is the key purchaser of foreign fixed income assets⁶ and thus also the linchpin of the Current Account recycling mechanism.

⁶The slight difference in the two time series is largely due to a) FX accounting effects, as the life series is based on current FX rates, whereas the cumulative flow numbers are accounted for at exchange rates present in each quarter; b) accounting differences regarding the issuance of Formosa bonds.

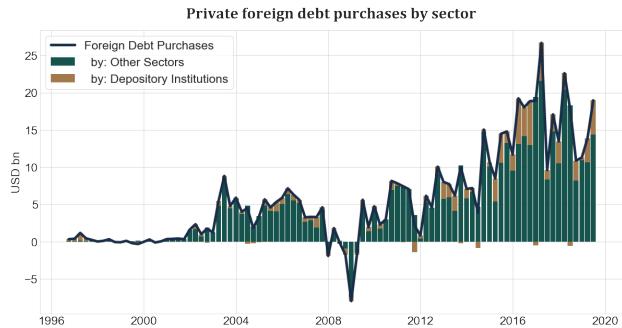


Fig. 4. Foreign debt purchases by sector, Source: CBC

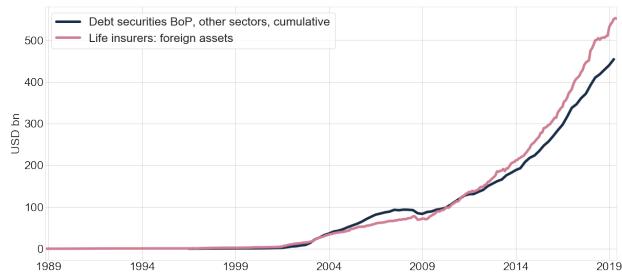


Fig. 5. Comparison of cumulative BoP debt purchases and life insurers' foreign assets, Source: CBC

C. *The Rise of the Life Insurers*

Taiwan's economy's high savings rate of 35% of GDP reflects a relatively limited social safety net for workers in the private sector, comparatively conservative fiscal policies, as well as Taiwan's aging population. High savings, paired with modest rates of domestic investment, naturally gives rise to the need to invest surplus savings abroad. Taiwan's ability to sustain a large Current Account surplus has been aided by relatively low domestic interest rates, as well as regular interventions by the central bank in spot FX markets. Whereas CNY has appreciated substantially since 2009, TWD has not. In fact, in real effective terms, Taiwan's exchange rate has depreciated by about 20 percent over the last twenty years. Other Asian countries also tend to have excess savings, but the size of its surplus makes Taiwan an outlier even in its region.⁷

Taiwan is not included in the IMF's annual *External Sector Report*. Two private sector evaluations – by William R. Cline⁸ of PIIE and by Robin Brooks of the Institute of International Finance⁹ – of TWD's valuation with similar modeling setups as the IMF, put its current undervaluation against USD at approximately 20%, with even higher historical values¹⁰.

⁷See for instance Setser, B., 2016, '*The Return of the East Asian Savings Glut*', CFR discussion paper.

⁸Mr. Cline produced regular Estimates of Fundamental Equilibrium Exchange Rates for the Peterson Institute for International Economics until November 2017. Updates are continued at his website [Economics International Inc.](#)

⁹Regular updates on the IIF's FEER models can be found at [iif.com](#).

¹⁰In Mr. Cline's public November 2017 version, TWD was undervalued by 33% against USD.



Fig. 6. Source: Bank of International Settlements

Countries subscribing to a mercantilist growth model – i.e. sacrificing current consumption in order to generate trade surpluses – ultimately face the unenviable task of having to direct large funds into overseas markets.

Taiwan's aging population, the ultimate benefactor of perennial trade surpluses, faces an imperfect climate allocating capital safely in domestic markets for eventual retirements. A domestic government bond market exists, its size at USD 190bn (combined with a lack new net issuance due to a comparatively hawkish fiscal stance) is however far too small to allow the deployment of larger capital bases at reasonable rates of return. The domestic corporate bond market is even smaller at USD 60bn and equally characterized by only subdued growth. The USD 300bn capitalization of the domestic stock market is notable, but the lack of diversification across sectors and its high beta to global growth relegates it however in attractiveness for safety-oriented savers. Lastly, real estate is priced very competitively at an average price to income ratio of 9.

All factors combined leave overseas markets as the only viable alternative to absorb large quantities of funds. Since households are far from optimally equipped to manage large foreign fixed income portfolios, they transfer this task to the life insurance industry, which then takes on the challenge to allocate money overseas – and is tempted, no doubt, by the opportunity apparently created when international interest rates exceed local ones, conjuring the illusion of easily arbitrable profits¹¹.

The CBC provides an elementary dataset on the balance sheet of Taiwan's life insurers, which helps to emphasize the growth the industry has experienced this cycle. Assets have more than quadrupled since 2009, crossing the USD 900bn mark in the spring of 2019. The accumulation of foreign debt accounts for over 75% of the overall asset increase, with holdings of domestic portfolio investments basically unchanged. As a result, the foreign asset share has increased from the low 20s

up to 60% today. A similar dataset, assembled by the Taiwan Insurance Institute, puts this share even higher, at ~70%.

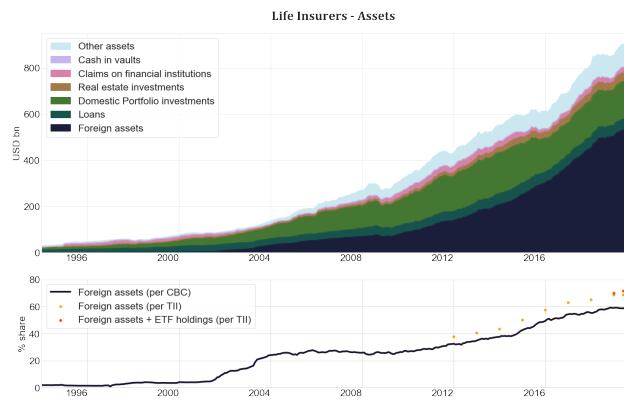


Fig. 7. Life Insurance Industry - Assets, Source: CBC

The liability side of the balance sheet is less exciting: Insurance reserves expectedly explain the greatest share; equity accounts for around 5% of assets in recent years, resulting in a leverage ratio of ~20.

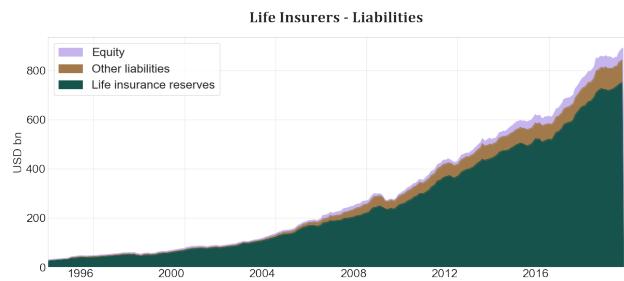


Fig. 8. Life Insurance Industry - Liabilities, Source: CBC

In order to later dissect the entirety of the CBC's actions, it is unfortunately necessary to dive deeper into insurers' management of their overseas debt holdings, the associated regulations and ultimately their approach to FX risk-taking. To this end, the following three sources will be merged to create the broadest possible understanding:

- the already utilized CBC dataset,
- information provided by the Taiwan Insurance Institute,
- financial statements, investor documents and conference calls of the insurers. The majority of Taiwan's insurers are owned by larger financial holding companies, of which a hand full are publicly traded, releasing the above information. These account for between 60 and 70% of total industry assets. Triangulation, aided by anecdotal help for the privately held institutions, makes it possible to form a good perspective of how the entire industry is behaving.

One fact that becomes clear relatively quickly is the high degree of similarity in the insurers' business models. North American issuers continue to be the largest target of lifers' overseas bond buying, followed closely by allocations to the

¹¹See the post '[FX-hedged yields, misunderstood term premia and \\$ 1tn of negative carry investments](#)' for an in-depth discussion regarding the risk of relying on overly simplistic analytical frameworks when comparing FX-hedged overseas debt with local alternatives. The primary concern is over-reliance on the starting yield curve rather than more accurate formulations of term premia embedded in the curve.

burgeoning Asian dollar bond market. Europe's average share has decreased over the years, to 25% today.

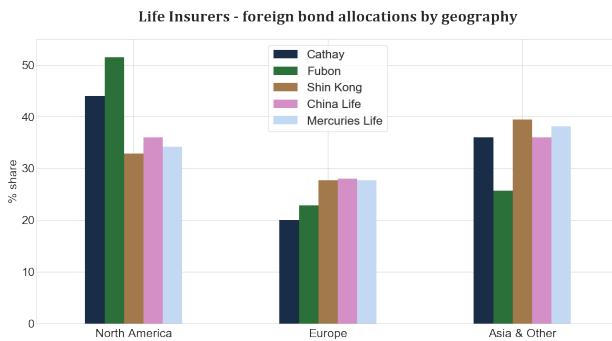


Fig. 9. Foreign bonds purchased by geography, Source: life insurers financial statements

The geographic dispersion of the insurers' bond portfolios though is a misleading picture of the insurers' currency risk assumed: US dollar denominated bonds account on average for 95% of the insurers' foreign bond portfolios¹². Like life insurers elsewhere, Taiwan's firms acquire bonds of long duration, trying to match the long-dated nature of policy claims; the average duration of the overseas bond section exceeds 10 years for all reporting companies. In the international context, Taiwan's lifers show a clear preference for non-sovereign debt, with corporate exposures of up to 80% not unusual, as well as large exposures to Agency debt securities.

Overseas investments by Taiwan's insurers requires prior regulatory approval¹³, which has strongly influenced the shape of preferred vehicles selected to access foreign debt over time. While the exact foreign investment quotas are set discretionarily based on company specific details, 45% of assets has for a long time been the acknowledged limit set by Taiwan's Financial Supervisory Commission (FSC). With most insurers converging to this limit during 2016, loopholes (more or less deliberately) left open by regulators have been employed ever since to further increase the foreign debt share.

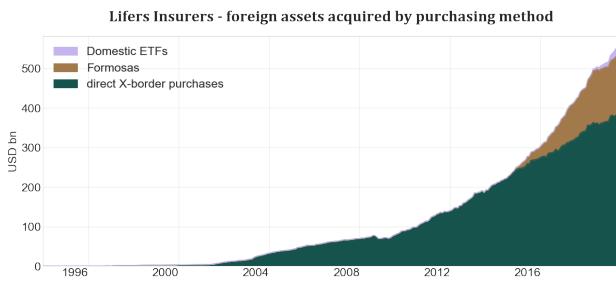


Fig. 10. Foreign bonds acquired by purchase method, Source: CBC, insurers' disclosures, own calculations

¹²This situates lifers among the primary foreign investors in Yankee/Eurodollar issues by European companies, as well as the fast growing Asian Dollar debt market.

¹³See the current 'Insurance Act.' [here](#), especially Article 146-4.

Formosa bonds, i.e. bonds denominated in foreign currencies issued by international firms, but listed on the Taipei Exchange, marked the first opportunity to further increase overseas allocations. Such securities are classified as domestic products by the FSC, regardless of their otherwise very different appearance. As a result, many of the prime IG issuers from the US and Europe flocked to Taiwan during 2016-2018 to accommodate lifers' thirst for long-dated and high-yielding assets. Such issues (typically featured a relatively short call period) were the main channel for insurers to access foreign bonds during this period, the size of the USD-denominated Formosa market grew from zero to about USD 150bn (of which lifers hold more than 90%), before new regulations¹⁴ were introduced during 2018. These, among other things, imposed an indirect cap on Formosa holdings by limiting the combined share of a) 'genuine' foreign bond holdings plus b) Formosa holdings to 145% of an insurer's overseas investment quota. This results in a new overall cap of 65% for foreign assets.

During 2018, with the regulatory changes in the air, a better vehicle had to be developed ... and was found in the form of locally listed, TWD-denominated bond ETFs, which then in turn acquire foreign debt securities. In contrast to Formosa bonds, these are not only listed in Taiwan, but also are denominated in the home currency. Of course, since the assets underlying the ETFs are foreign currency-denominated and FX risk is not hedged by ETFs directly, currency movements are simply transmitted to the TWD-listed price. This leaves insurers with the same FX exposure as when overseas bonds are purchased directly. Everyone in Taiwan is aware of the trick and for the time being its tolerated by regulators. ETFs have been the primary vehicle for insurers to acquire overseas debt since mid-2018, the value of purchased foreign bond ETFs currently stands at ~USD 25bn and led to a boom in new listings of such products, the number of which now approaches 80. Squaring the circle, many life insurers acquire ETFs not from an outside issuer, but from the ETF desk in the equity division of the bank subsidiary part of the same holding company as the insurer itself.

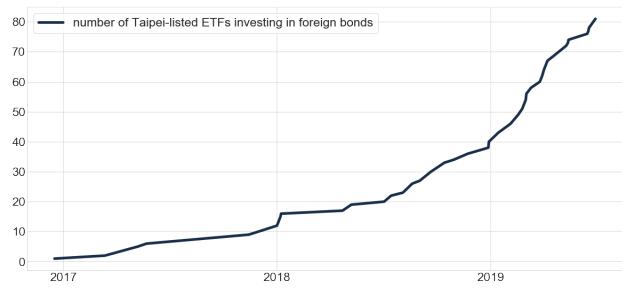


Fig. 11. Number of Foreign bond ETFs listed on the Taipei Exchange, Source: Taipei Exchange

Lastly, the immensely important subject of FX risk management involved in managing foreign bond portfolios has to be

¹⁴See the 'Regulations Governing Foreign Investments by Insurance Companies' update last year [here](#), especially Article 10.

addressed. Regular life insurance policies, which in Taiwan constitute the preferred saving vehicle of households, are overwhelmingly denominated in the policy holder's home currency, so that at the conclusion of the contract, funds can be used by policy holders to acquire goods and services in the domestic economy. Life insurers with substantial holdings of USD-denominated debt have to carefully manage FX mismatches and have three tools at their disposal to do so:

- **FX policies:** Insurers can offer foreign currency denominated policies, which either partially or fully transfer the FX risk to policy holders. This is usually a cheap way of reducing FX imbalances, but is constrained by the buyer's willingness to assume the FX risk instead. The TWD's relative stability vs. USD certainly helps selling this case to prospective clients.
- **FX hedges:** Insurers can hedge the FX risk by acquiring TWD in the FX forward or futures market. Alternatively, they can enter into FX swap or Cross-Currency Swap contracts, which correspond to collateralized borrowings. In either case, the FX risk is laid off to the market, but the pricing of the hedges (manifesting itself as a negative X-CCY basis¹⁵) depends on market conditions and is costlier than FX policies.
- **Open FX position¹⁶:** Insurers can also keep the FX risk on their own balance sheets. This option is constrained by the insurers' high leverage, limiting the ability to absorb large FX swings, high risk-based capital charges for open FX exposures and the regulatory mandated requirement to build up a precautionary FX reserve account.

Insurers, as shown in Fig. 12, rely on all tools in managing their FX risk, the relative importance changing however over time. The share of classic FX hedges has declined from 80 to 60%, yet with the stupendous rise in the value of foreign bond holdings, the demand for FX hedges nevertheless increased steeply. This is clearly visible in various metrics of the onshore FX derivative market illustrated in Fig. 13.

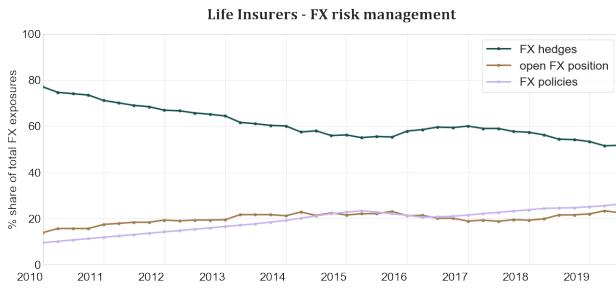


Fig. 12. Risk management of FX exposures. Source: own calculations based on insurers financial statements & investor documents

¹⁵The cross-currency basis is the deviation in the pricing of FX markets for future delivery from theoretical values based on Covered Interest Rate Parity.

¹⁶Some insurers only report their open FX position together with proxy hedges. Anecdotally, the use of proxy hedging has decreased meaningfully compared to insurers incipient ventures abroad pre-2008. Unsurprisingly, if other FX crosses show meaningful volatility vs. USD, a proxy hedge is hardly effective and creates needless basis risk.

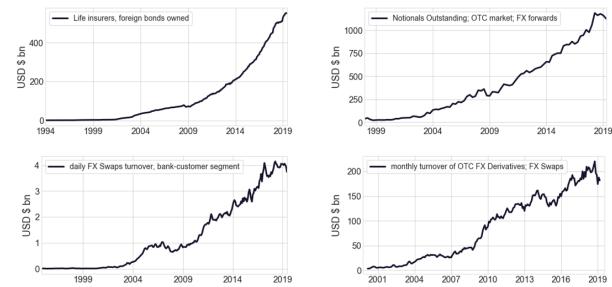


Fig. 13. Insurers' FX hedging demands visible in onshore FX derivative markets, Source: CBC

FX risk taking by insurers themselves, as well as their clients via FX policies, have both increased relative to the start of the decade. The growth in sales of FX policies was steady, currently releasing insurers of 25% of their overall FX risk taken; insurers own relative FX positions were more volatile and pro-cyclical, growing larger during the USD appreciation until 2016, followed by a swift reversal as a result of FX losses due to TWD strength. Since 2018, with acquisitions of FX-unhedged foreign bond ETFs, insurers open FX position has started rising again, today matching the 2015 heights at about 23%.

D. Sizing the lifers FX hedges: two sources

Since lifers' FX hedges will play a crucial role in this story, it is worth openly discussing the difficulties in pinning down their exact size.

One way to attain an estimate of the size of the life insurance sector's FX hedges is by applying the percent share in Fig. 12 to the CBC released series of insurers' foreign assets. While the calculation per se is sound, there exists some uncertainty created by the limited numbers of insurers reporting during the early years of this decade, as well as the privately held nature of some. Extrapolations based on the limited sample may not exactly represent the FX management across all insurers. On the positive side, insurers' disclosures include all FX-hedges, independent of whether they were executed domestically or offshore via non-deliverable forwards (NDFs).

A second method to derive an estimate is to rely on a regular footnote in the aggregate life insurance statistics released by the CBC, stating the size of FX hedges established. Available at a monthly periodicity, this source includes all life insurers but has two disadvantages. Historical footnotes are not part of the CBC's statistical database, so that quite some extrapolation is required to use the small number of historical values obtained. Furthermore, it is unclear whether hedges in offshore markets are taken into account by the CBC.

The results of both methods are presented in Fig. 14 & 15 and agree that the share of FX derivative hedges decreased between 2012 and 2016, stayed about flat into 2018, before declining further. The micro-constructed series continuously exceeds the CBC indication, likely due to the inclusion of hedges in

the offshore market¹⁷. The early values in the CBC series appear surprisingly low and do not align with indications from the small number of insurers providing information back then.

Translated into nominal USD values, the two methods put lifers' position in classical FX derivative hedges at USD 220bn and USD 285bn respectively, with values near USD 250bn seeming a good compromise.

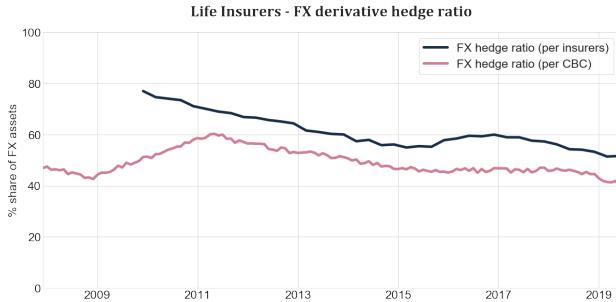


Fig. 14. Classical FX hedging as a share of foreign assets. Source: CBC, insurers' disclosures, own calculations

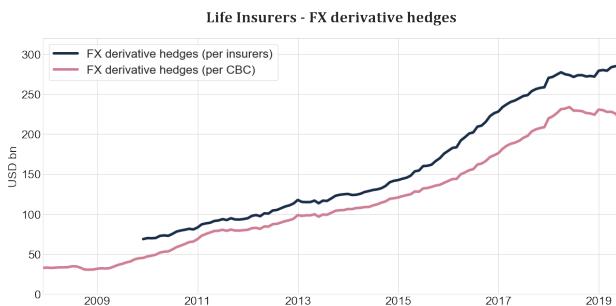


Fig. 15. Estimated amount of classical FX hedges entered by Taiwan's life insurers. Source: CBC, insurers' disclosures, own calculations

E. The missing FX risk taker

The significant amount of FX hedges established by the life insurance sector challenges simplistic views of Taiwan's Current Account recycling mechanism. In the Bank of International Settlement's words, it is necessary to "break[ing] free of the triple coincidence in international finance"¹⁸, which in this case implies a more subtle differentiation between 'asset recycling' and 'FX risk recycling'.

In terms of asset recycling, it was clearly first done through the CBC's FX reserve accumulation, then, since 2010, largely by lifers' overseas debt investments. The CBC also clearly took on the foreign exchange risk associated with its portfolio. But to the extent life insurers have hedged their portfolios,

¹⁷Possibly also since the privately held insurers included in the CBC definition are generally considered more aggressive, thus running larger open FX positions.

¹⁸Avdjiev, S, R McCauley and H Shin (2016): "Breaking free of the triple coincidence in international finance", Economic Policy, vol 31, no 87, pp 409–51. Also available [here](#).

they have shifted the foreign exchange risk to another party.

Conclusive statistics on the currency composition of Taiwan's trade is scarce¹⁹, but ample anecdotal evidence and FX pass-through to export/import prices²⁰ makes it safe to state that the largest share of Taiwan's Current Account transactions are denominated in currencies other than TWD, mostly in USD.

This in turn implies that Taiwan in its entirety assumes FX risk equal in size as surpluses on the Current Account, as Taiwan is receiving more dollars and other foreign currencies that it needs to pay for its imports. More specifically, from 2009-2018, Taiwan's cumulative Current Account surplus amounts to USD 570bn. The CBC takes on 190bn of FX risk via the net increase in its reserves during the specified time frame. Of the USD 440bn increase in FX risk taken by life insurers as a byproduct of acquiring overseas assets, about USD 120bn and USD 100bn of FX risk was taken by policy holders via USD-denominated policies and lifers themselves as open FX position respectively. The remainder and by far largest portion of USD 240bn, insurers laid off via classical FX derivatives including FX forwards, FX swaps and Cross-Currency Swaps.

These hedging transactions raise two fundamental questions about the core workings of Taiwan's FX market:

- Who provides lifers the FX hedges?
- If lifers do not take the largest portion of the FX risk resulting from Current Account surpluses, who is?

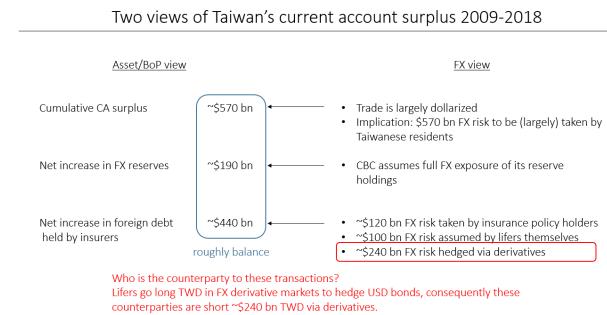


Fig. 16. Asset recycling vs. FX risk recycling

The opacity of over-the-counter (OTC) derivative markets impedes easy tracking of who ultimately assumes this large amount of FX risk and normally this is where the story would end. In this particular case however, the size of lifers' hedges are so large (~40% of GDP), that with the right tools and bit of legwork, a relatively clear picture can ultimately be constructed.

¹⁹The CBC compiled statistics on 'Export and Import Foreign Exchange Proceeds and Payments' might be the best data available and shows, as expected, a low TWD share in export and import transactions, at 6.5% and 19% respectively in the tracked sample.

²⁰In a simplistic two variable regression framework, explaining changes in Taiwan's overall export price index by the USD/TWD exchange rate and the price of WTI crude, a 1% rise in USD causes a 0.6% rise in Taiwan's export prices after two months.

III. A QUICK PRIMER ON FX HEDGING

THIS chapter is intended to give a brief overview of the derivative instruments institutional investors have at their disposal when hedging FX exposures. It is far from exhaustive regarding the exact factors involved in pricing the instruments²¹, but should provide the big picture intuition as well as highlight the fungibility of the various hedging methods.

A. Initial situation

Staying with the topic of this essay, the issue will be framed from the perspective of a Taiwanese life insurer selling a TWD-denominated policy to a domestic customer and, due to lack of alternatives, decides to allocate all of the received premiums to overseas fixed income instruments. The FX risk of these are then hedged via a variety of methods.

B. Physical hedging

Going back in time to before the advent of liquid FX derivative markets, the only way for an insurer to balance FX exposures would be by creating FX-offsetting on-balance sheet positions. In an initial step, the insurer would take TWD deposits it received, convert these into USD in the FX spot market and subsequently acquire a USD-denominated bond. Following this transaction, the insurer is exposed to an obvious FX mismatch: the asset it owns is denominated in USD, while its corresponding liability is TWD-denominated. It can neutralize this risk by borrowing USD funds (in a size equal to the policy written) from an overseas bank, convert these into TWD in the FX spot market and keep them either on deposit with banks in Taiwan or acquire a TWD-denominated safe asset. Now, the insurer holds a USD bond and a TWD deposit, which are matched by equally-sized liabilities, a TWD insurance policy and a USD bank loan.

Since matching FX risks purely on-balance sheet is a cumbersome process, practically all end users today rely on the derivative solutions that follow.

C. FX forwards I

Forward FX markets developed as a natural add-on to the spot market. Instead of exchanging currencies now, participants agree today to exchange a fixed amount at a designated exchange rate on a future date. Given that forwards are priced off the prevailing values in FX spot, they (assuming regular market conditions) exhibit extremely high correlations with FX spot markets, especially at short tenors. Thus, an insurer which has built up the initial FX imbalance as in the prior example, simply enters into a long TWD, short USD position in the forward market, which at trade initiation has a zero market value. This position, due to its high correlation with

FX spot, will balance any FX profits or losses generated by the on-balance sheet FX mismatch, insulating the insurer from FX swings at the aggregate level.

D. Cross-Currency Swaps (CCS)

Cross-currency swaps are the modern incarnation of the physical hedging previously analyzed and are best approached as collateralized lending with foreign currency collateral. Upon receiving TWD funds as a result of selling a TWD-denominated policy, the insurer, instead of exchanging TWD for USD in the spot market, searches for a lender willing to provide USD by pledging its TWD deposits as collateral. Once a counterparty is found, currencies are swapped in a symmetrically-collateralized process, after which the insurer acquires the desired USD-denominated bond. During the contract, the insurer will – in a cross-currency basis swap, the most commonly traded variant – have to pay its counterpart USD Libor rates, while it will receive TWD interbank rates in return. At termination, the exact amount of funds swapped initially is handed back. Since the insurer only borrowed USD, which it will hand back at termination after it sells the USD-denominated bond, it was at no time exposed to FX risk.

E. FX forwards II: FX swaps

Hedging via FX forwards can also be approached through the collateralized lending lens. To do so, spot and forward transactions are paired²² and conducted with a single counterparty. In such a case, the transaction is referred to as an FX swap. As in a CCS, funds are exchanged at initiation, however no interest payments are affected during the contract. Instead, the closeout of the trade is set (at the time the trade is established) based on (primarily) interest rate differentials in the two currencies, usually leading to a different exchange rate at close out.

F. Dealer intermediation and fungibility

All of the above instruments are traded over-the-counter (OTC), requiring end users to enter them with dealer banks. These will intermediate supply and demand across their client base, match orders via the interbank market or utilize their own balance sheets to facilitate clients' hedging demands. From the dealer's view, the products are fungible, as the smallest decomposable fragment of each are quasi-linear exposures to FX risk and interest rate risk (in both currencies). As seen, an FX swap can easily be decomposed into a forward and spot transaction; decomposition of a CCS is similar but requires an additional position in interest rate swaps. Lastly, it should be noted that FX forwards/swaps are largely used by institutions hedging risk on the asset side of their balance sheet (usually at relatively short tenors rolled over indefinitely), while CCS are longer-term and preferably used by institutions hedging the risk of foreign currency debt issuance.

²¹This chapter is loosely based on a (slightly) longer treatment of the same subject in the following post, '[FX-hedged yields, misunderstood term premia and \\$ 1tn of negative carry investments](#)'. For a more exhaustive treatment, see any markets focused finance textbook.

²²When not paired officially, the contract is not referred to as an FX swap, but the collateralized lending angle still holds, even if executed with different counterparties.

Taiwan's onshore derivative market allows the trading of all of the above products, of which lifers show a clear preference for FX swaps. In addition, Non-Deliverable Forward (NDF) USD/TWD contracts are traded in offshore markets, which lifers tend to access opportunistically²³, when favorable pricing conditions arise.

as well as versatile overseas investors (with flexibility in their cash management) arbitraging negative bases is the typical case.

- Institutions, which wish to purposefully acquire a long USD, short TWD exposure. The demand can be of speculative nature or by an official institution stabilizing or intervening in the FX market.

IV. SEARCHING FOR COUNTERPARTIES: FOREIGNERS, BANKS & CORPORATES

THE search for the counterparties to lifers' FX hedges is a daunting endeavor. Since there exists no central, publicly available dataset detailing exposures across all relevant actors, a multitude of adjacent sources have to be combined to create an understanding of the underlying activity.

Three factors help in this regard:

- First and foremost, the sheer size of lifers' FX hedges (USD 250bn) virtually guarantees that other firms & sectors will be impacted by either supplying or facilitating their hedging demands.
- The life insurance sector is undoubtedly the largest buyer of FX hedges, thus the task is more or less limited to figuring out the supply side of the hedging transactions.
- Since FX hedging is done via OTC markets, firms or sectors without access to it can quite quickly be eliminated from the discussion.

A. Three Types of Counterparties

The institutions that could take the other side of lifers' FX hedges can roughly be subdivided into three groups:

- Institutions, which coincidentally have an opposing on-balance sheet FX exposure as lifers and thus equally require an FX hedge to reduce risks. One example would be corporates, with debt issued at beneficial rates in foreign currencies, 'domesticizing' such issuance via FX derivatives. Another would be banks with large domestic FX deposits but little business abroad which decide to lend in local currency and balance their FX exposures via derivatives.
- Institutions, which initially have no unbalanced FX exposure, but will facilitate lifer demands for a fee (i.e. a negative cross-currency basis). To do so, they will deliberately mismatch their on-balance sheet exposures, but will (including the derivative transaction with the insurer) remain overall FX neutral. Domestic and foreign banks,

An economy is oftentimes partitioned into the following sectors: the central government, the monetary authority, the banking sector, non-financial corporations, the rest of the world, households and other financial institutions. Of these, three sectors can be excluded with a relatively small effort. *Central governments* typically only enter the FX arena when they have issued debt in foreign currencies – which Taiwan has not – and otherwise leave FX issues to the central bank. *Households* do, in all but exceptional circumstances, not have direct access to OTC markets, which requires an ISDA (or ISDA-like) agreement and are the domain of larger institutions. Even if parts of the personal wealth management business (family offices etc. of locals) is included within the household sector, their seize should be immaterial to the discussion at hand. Taiwan has a range of *other financial institutions* apart from life insurance companies including Credit Cooperative Associations, Credit Departments of Farmers' and Fishermen's Associations, Chunghwa Post Co., Money Market Mutual Funds and Trust and Investment Companies. All of these are domestically focused institutions (with no or minimal foreign business) and have not grown by much during the past decade. They are thus not natural counterparties to the lifers' hedging needs.

This leaves the rest of the world, the banking sector, non-financial corporations and the monetary authority.

B. The Foreign Sector

Foreign institutions occupy a special place in the provision of FX hedges, as they are the only sector able to supply quasi unlimited amounts to counterparties. This is due to their ability to secure cheap funding in their base currency, in this case USD. In Japan and the Euro Area, both like Taiwan large purchasers of overseas FX-hedged debt, foreigners are the prime supplier of FX hedges. But Taiwan emerges as a somewhat different beast.

Of the three types of counterparties described in the first section of this chapter, the second category – the arbitrageurs – are the most potent overseas force able to provide lifers the required FX hedges²⁴.

²³In 2014, the CBC deregulated access to global NDF markets by overseas branches of Taiwanese banks. Given these are frequently owned by a common holding company as the life insurers and facilitate their trading, the ease of accessing NDFs by lifers for hedging purposes has increased substantially. Nonetheless, the offshore market remains less liquid than its onshore equivalent, featuring higher bid-ask spreads as well as higher volatility, thus situating it as an opportunistic outlet rather than a mainstay in lifers' FX hedging.

²⁴From the regulatory setup already – which will be examined in greater detail in a later chapter – strong reasons exist to assume traditional FX arbitrageurs are not active in Taiwan in large sizes. This is due restrictions imposed on all incoming foreign funds, limiting their deployment to fixed income and money market instruments to 30% of the overall amount.

If a Taiwanese lifer enters into an FX swap to acquire USD-denominated debt, this can work as follows: An institution with ample USD funding (for instance a U.S. bank) recognizes a large negative cross-currency basis in Taiwan's FX market, enabling it to profit by lending USD via FX swaps. So at initiation, the U.S. bank exchanges²⁵ USD for TWD with the life insurer²⁶. Now, with TWD deposits on its balance sheet, the U.S. bank attempts to allocate these funds to the safest TWD-denominated asset available – after all, its profit arises from the peculiarities of pricing in FX markets and not from excessive risk taking in Taiwan²⁷. Preferred safe assets include government bonds & bills, repurchase agreements secured by the former or deposits directly with the central bank.

The reason for spelling out the sequence of actions the U.S. bank takes is that while the FX swap transaction is more or less invisible (since it's an OTC transaction), the bank's subsequent transactions in search for safe assets in TWD markets is not. It can be followed with some precision in Balance of Payments statistics – in theory not only in Taiwan's, but also in the corresponding entries in counterparty host nations.

In Japan's case for instance, where similar to Taiwan, life insurers, Japan Post Bank and Norinchukin Bank have acquired very large amounts of FX-hedged²⁸ U.S. debt in recent years, the collateral reinvestment of arbitrageurs is clearly visible in the BoP as foreign demand for JGB bills & bonds, JPY-repos and deposits held directly with the Bank of Japan. All these dynamics are common market knowledge and anecdotal evidence for these activities is ubiquitous when institutions involved are consulted.

Taiwan looks different. Taiwan's International Investment Position (IIP), shown in Fig. 17, does not feature large foreign holdings of debt securities. Taiwan in fact has a range of regulatory impediments that make it difficult for non-residents to hold its domestic debt securities. Instead, foreign residents hold a USD 300bn and increasing claim in the 'Debt Instruments' section in the 'Other Investment' category. This category is commonly composed of currency and deposits foreigners hold with banks, other overseas loans and trade credit. In Taiwan, these account for USD 186bn, USD 30bn and USD 87bn respectively at the end of 2018. If these were all TWD-denominated and the result of the search for collateral by FX counterparties, the puzzle surrounding lifers' FX hedges would be solved.

²⁵This might occur via the U.S. bank's local subsidiary or, if executed from U.S. headquarter, be intermediated by local Taiwanese banks.

²⁶At termination of the contract, this exchange would be reversed, but for the moment it is assumed the transaction is rolled indefinitely, as it is beneficial to all parties.

²⁷Which, in all likelihood, is not among the core competencies of the U.S. bank.

²⁸See for instance page 46 of the October 2017 [BoJ Financial Stability Report](#) for an assessment of FX hedges established by Japanese institutions.

International Investment Position (End-Period Stocks)												
	In millions of US dollars											
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Assets												
Direct investment	151,157	163,530	170,021	190,803	213,062	229,846	267,658	296,527	302,582	308,831	321,640	350,592
Equity and investment fund shares	147,612	160,018	166,533	187,375	209,537	226,337	264,146	292,994	297,989	303,205	315,398	343,523
Debt instruments	3,545	3,512	3,688	3,628	3,522	3,569	3,512	3,533	4,593	5,626	6,442	7,069
Portfolio investment	247,276	187,283	241,181	302,927	365,254	389,301	428,367	484,559	579,436	636,487	788,919	839,796
Equity and investment fund shares	136,908	68,077	107,549	126,000	162,709	166,264	186,070	209,432	214,441	225,840	234,670	246,223
Debt instruments	116,369	111,611	131,759	156,759	176,166	181,111	189,626	204,309	214,049	214,864	219,441	226,782
Financial derivatives	116,555	13,606	10,089	11,359	9,069	8,351	5,505	6,998	7,334	5,901	4,067	3,840
Other investment	175,621	187,178	199,910	223,071	245,248	267,777	325,343	359,847	384,383	386,682	413,201	387,847
Other equity	43	42	42	89	89	89	89	84	89	78	82	80
Debt instruments	175,580	187,136	199,968	222,962	245,159	267,688	325,254	359,763	384,303	386,604	413,119	387,767
Reserve assets	275,071	296,389	352,967	387,206	396,590	408,452	421,941	423,831	430,711	438,984	456,658	466,792
Total assets	852,640	847,986	974,548	1,115,566	1,161,244	1,203,727	1,448,634	1,571,385	1,666,446	1,776,885	1,984,685	2,088,672
Liabilities												
Direct investment	47,666	44,151	54,435	61,508	53,493	58,363	64,233	67,005	65,334	83,048	93,949	92,387
Equity and investment fund shares	43,971	41,990	53,136	60,638	52,556	57,560	63,475	67,769	64,768	80,563	92,954	91,589
Debt instruments	1,693	2,161	1,299	882	937	803	758	657	566	2,485	995	799
Portfolio investment	213,235	110,114	203,071	234,669	196,900	234,080	263,319	307,853	277,484	324,156	420,906	363,975
Equity and investment fund shares	209,425	104,408	197,606	214,646	187,491	224,421	255,299	298,875	267,907	321,058	418,029	361,491
Debt instruments	1,430	1,346	5,649	1,651	1,653	1,653	1,653	1,653	1,653	2,227	2,227	2,205
Financial derivatives	3,859	15,240	9,000	10,130	10,000	8,300	6,687	7,200	10,178	7,917	3,317	5,704
Other investment	121,268	118,376	121,678	133,078	183,769	200,161	240,621	254,800	234,740	253,208	283,544	306,295
Other equity	-	-	-	-	-	-	-	-	-	-	-	-
Debt instruments	121,268	118,376	121,678	133,078	183,769	200,161	240,621	254,800	234,740	253,208	283,544	306,295
Total liabilities	386,819	287,899	388,474	479,354	444,162	506,904	574,655	632,788	583,736	668,229	801,916	768,365
Net International Investment Position	464,621	560,096	585,694	636,812	719,082	802,823	873,599	938,594	1,000,710	1,108,556	1,182,769	1,200,502

Fig. 17. Taiwan's International Investment Position from 2007-18, Source: CBC

National statistical bodies do not normally release the currency composition of cross-border borrowing & lending directly, but they do collect the data and submit these to the Bank of International Settlements (BIS). The BIS compiles these submissions across the globe into two large databases, the *Locational* and *Consolidated* Banking statistics. Taiwan, as well as all relevant counterparty countries, report to the BIS, so that it is possible to work out the currency composition of the IIP accounts.

The USD 186bn claim foreigners hold on Taiwan's banking system can be reconstructed using cross-border borrowings reported by Taiwan's banks in the BIS Locational Banking Statistics survey. The correlation between the two series (Fig. 19) is very high, indicating a large overlap in the underlying exposures and thus allowing extrapolation of the currency details the BIS provides to the IIP. These indicate that over 92% of claims foreigners have on Taiwan's banks are denominated in currencies other than TWD, mostly in USD, which accounts for USD 172 bn (or 84%) at the end of 2018. This fact alone makes it highly unlikely foreign arbitrageurs are active in Taiwan in sizes large enough to meet lifers' FX hedging needs.

Currency denomination of Taiwan's banks cross-border liabilities
reported in BIS LBS table A5

TWD	USD	EUR	JPY	GBP	CHF	other
8.3%	84.0%	3.1%	2.1%	0.3%	0.2%	2.1%

Currency denomination of global banks' claims on counterparties
in Taiwan reported in BIS LBS table A6.1

TWD	USD	EUR	JPY	GBP	CHF	other
-	85.9%	3.6%	3.2%	0.3%	0.3%	6.7%

Fig. 18. Currency decomposition of the 'other liabilities' category in Taiwan's International Investment Position at the end of 2018, Source: Bank of International Settlements

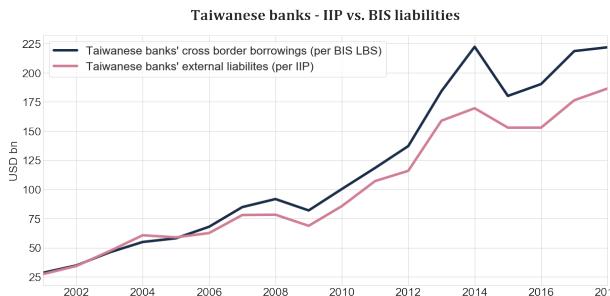


Fig. 19. Source: Bank of International Settlements, CBC

By the nature of the foreign arbitrageur's business model, it is very unlikely that funds extended as trade credits, or to the non-financial sector generally, are part of FX arbitrage trades. As a precaution, Fig. 18 also contains the currency composition of global banks' claims on all counterparties in Taiwan. Were trade credits for instance denominated in TWD entirely, they would boost the 'other' category²⁹, which at 6.7% makes this an unlikely proposition. This is also in line with the consensus, stating that trade credit is overwhelmingly USD-denominated.

Lastly, it is also possible to show that Taiwan's currency market behaves very differently than the markets in Europe and Japan. A cross-currency (X-CCY) basis is the deviation in price an FX derivative exhibits relative to the no-arbitrage indication based on interest rate differentials in the two currencies involved. As long as natural hedging demand and supply are of similar size, the X-CCY basis does not veer far from zero, as dealers can efficiently match up buyers and sellers. If, as is the case in Taiwan, Japan and Europe, the natural level of demand for FX hedges (all into USD in this case) exceeds natural supply, institutions in these nations have to offer an extra compensation to counterparties to nonetheless facilitate transactions. This extra compensation manifests itself as a negative X-CCY basis.

As outlined in a quarterly BIS review article³⁰, the level of the basis can be thought of to depend on a) the level of the demand-supply differential, b) the willingness of arbitrageurs to facilitate transactions. This in turn depends on the financial openness and regulations of the target market, as well as comparative returns on other nearly risk-free assets on offer for arbitrageurs. At the end of the day, the level of the X-CCY basis of a country is determined by country specific factors; in the short-term however, the business model of the arbitrageurs takes precedent.

In practice, this means that from the perspective of an arbitrageur (say, again, a flexible Treasurer at a U.S. bank), different FX basis markets (here JPY and EUR) directly compete with one another, but are also affected by common factors related to the overall business model of the arbitrageur (e.g.

²⁹There is not a singular TWD category in this dataset.

³⁰Borio, C., R. McCauley, P. McGuire, and V. Sushko, 2016, '[Covered Interest Parity Lost: Understanding the Cross-Currency Basis](#)', BIS Quarterly Review, September, pp. 45–64, Bank for International Settlements, Basel.

their funding sources, regulations in the arbitrageur's home jurisdiction, yields on other investments etc). For this reason, the shorter-term dynamics of X-CCY bases in currencies in which hedging is facilitated by a common set of arbitrageurs should show a high degree of co-movement. For Europe and Japan, this is empirically the case. The r^2 of regressing the EUR³¹ 3m X-CCY basis on the JPY equivalent in level-terms from 2012-19 is 0.82, while the r^2 of monthly changes is a still high 0.64.

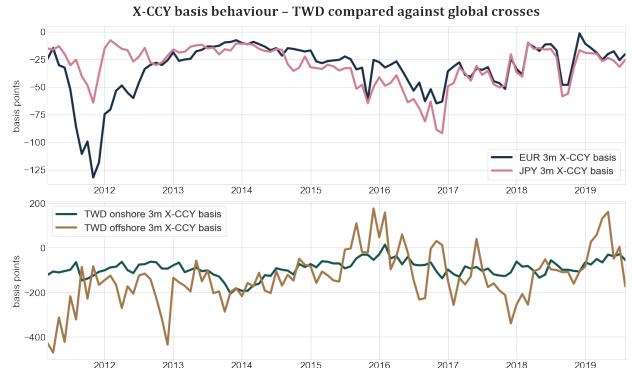


Fig. 20. Comparison of the X-CCY basis behavior in Taiwan with global equivalents. The idiosyncratic behavior of TWD bases indicates a different set of drivers (i.e. a different set of counterparties) than in EUR and JPY markets, which global FX managers, flexible (often U.S. or French) bank Treasurers and non-financial corporations hedging foreign bond issuance dominate. Results at longer tenors are similar.

Taiwan's market by contrast looks different. The TWD basis in both onshore and offshore markets does not show any correlation with moves in the EUR and JPY X-CCY basis. This again showcases the unlikeliness of the 'regular' international arbitrageurs present in Taiwan, providing FX hedges to lifers.

An entirely different possibility to consider relates to the large foreign holdings of Taiwanese equities also shown in Fig. 17. If all such holdings were FX-hedged, the problem would equally be solved. Since FX hedging equity portfolios is not the norm, especially helped in this case by the TWD's stability relative to USD, the possibility of this to be true seems remote. All of the larger USD-denominated Emerging Market equity funds are offered as non-hedged version first and foremost. FX-hedged ETFs do exist, but further cement the point: Blackrock's broad iShares Emerging Markets ETF (EEM) currently has assets under management of USD 25.5bn, while the currency-hedged version (HEEM) merely posts holdings valued at USD 180mn.

A last but unlikely proposition would state that foreigners provide FX hedges to lifers without creating an offsetting TWD position in cash markets in Taiwan, i.e. going long TWD outright via derivative markets. Such a behavior lacks a solid

³¹By convention, X-CCY bases are quoted against USD, with negative values reflecting the extra annual cost a foreign institution has to pay their USD-based counterparty to enter a transaction.

foundation, since an outright FX bet (of large size nonetheless, to match lifers) does not fit the business model of any overseas institution well. The opacity of OTC markets does not allow for direct refutation; the concluding method discussed next however affirms the expressed view.

As a concluding assessment, if foreigners – regardless via which of the outlined channels – provided hedges to Taiwanese lifers, such transactions should also leave a mark on the derivatives section in Taiwan's Balance of Payments and its International Investment Position.

The accurate accounting of derivatives in the BoP is a lengthy subject. In brief, the accounting for FX hedges works as follows:

- As per chapter 5.80 in the IMF's BoP manual³², "*Transactions and positions in financial derivatives are treated separately from the values of any underlying items to which they are linked.*", implying that the hedges themselves are always accounted for separately from the exposure to be hedged.
- Per 5.82, "*many [...] derivatives contracts are settled by payments of net amounts in cash, rather than by the delivery of the underlying items. Once a financial derivative reaches its settlement date, any unpaid overdue amount is reclassified as accounts receivable/payable.*", implying that settlement of exposures can take place via delivery of securities/assets or by cash payments of equal value and that the timing of these can be delayed, thus not immediately affecting the BoP, but rather being reported as contingent claims or liabilities in the IIP.
- Per 5.84-5.89, "*There are two broad types of financial derivatives—options and forward-type contracts.*", the latter category also encompassing futures and swaps.
- Per 5.90, "*At the inception of a forward-type contract, risk exposures of equal market value are exchanged, so a contract typically has zero value at that time. As the price of the underlying item changes,[...] the classification of a forward-type contract may change between asset and liability positions.*" This means that before the ultimate termination of a forward contract, it will give rise to contingent claims/liabilities in the IIP, the BoP only being affected³³ once closeout occurs.
- Referencing FX swaps directly, 5.92: "*At the time of settlement, the difference in the values, as measured in the unit of account at the prevailing exchange rate, of the currencies swapped are allocated to a transaction in a financial derivative, with the values swapped recorded in the relevant other item (usually other investment).*", meaning the currency aspect of FX swaps & CCS are recorded in the same way as vanilla FX forwards.

³²The sixth edition is available from the IMF [here](#).

³³As also stated in 5.90, periodic settlements can restore a zero market value prior to the conclusion of contract. In some countries, the U.S. most notably, statistics on collateral exchanges (with equivalent effects to intermediate settlement) before trade conclusion are also collected, providing the most comprehensive perspective.

If foreigners provided FX hedges to lifers, the profits and losses these create whenever exchange rates fluctuate and their ensuing settlement should be observable in the derivatives section of the BoP and IIP, both shown in Fig. 21.

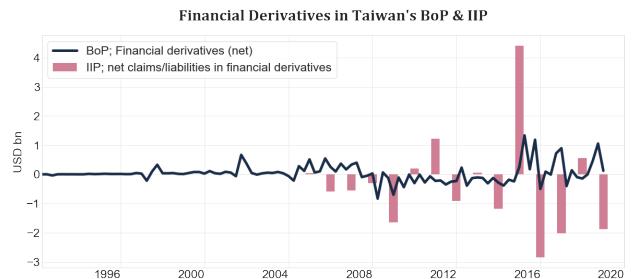


Fig. 21. Taiwan's derivatives PnL in the BoP and IIP. Positive values in the BoP series denote net cash inflows due to settlement of derivative contracts with foreigners. Positive values in the IIP series denote contingent claims on foreigners resulting from derivative transactions. Source: CBC

First, given the anecdotal lack of large derivative transactions in other product categories (equity, interest rates & credit) with foreigners, such FX transactions should be the primary driver of the derivatives section in Taiwan's BoP. Furthermore, since most of lifers hedging transactions have a maturity of $\leq 1y$ and involve USD, a simple regression of current quarter FX returns plus appropriate lags³⁴ should explain a sizable portion³⁵ of Taiwan's derivative BoP section.

Explaining Taiwan's derivative PnL by FX movements

Δ USD/TWD	42.4 (26.7)	45.4 (27.6)	49.9 (27.8)	50.1 (28.4)
" " (lag 1)		14.0 (27.6)	21.6 (28.4)	21.5 (29.0)
" " (lag 2)			30.4 (27.6)	30.2 (28.7)
" " (lag 3)				-0.8 (28.9)
R^2	0.07	0.08	0.11	0.11

Fig. 22. Taiwan's quarterly BoP derivatives PnL from 2010-2018 regressed on quarterly changes in the USD/TWD exchange rate, including up to three quarter lags. Standard errors in parenthesis.

The results of such analysis using the overall derivatives time series³⁶ is shown in Fig. 22 and corroborates the considerations in the prior sections. The explanatory power of the exercise is low (even if including a full year of FX movements) and none of the coefficients are statistically significant. Furthermore, given that lifers are long TWD in the forward market, one would expect the coefficients to be

³⁴Due to the settlement only occurring at trade conclusion. For instance, if a 1y forward experiences a mark-to-market positive shock in Q1 of its existence, the accounting in the BoP (if the exchange rate then stays at that level) only occurs at the end of Q4.

³⁵Given that lifers hedges have grown substantially, the coefficients would capture the average over the entire 9y period, which, while not referencing a particular quarter, would nonetheless be expected to be highly statistically significant.

³⁶The same analysis can also be repeated with the sectoral time series included in Taiwan's BoP. The results are functionally similar.

negative³⁷. Size-wise, the BoP entries furthermore come in at levels much lower than would be expected by multiplying the size of lifers' FX hedges by the relevant exchange rate movements during the respective quarters.

Second, the same analysis can be repeated at an annual frequency³⁸, incorporating BoP and IIP data. A year's derivatives PnL is calculated by adding the cash settlements during the four quarters from the BoP to the change in the value of the derivatives position in the IIP. Here too, a clear correlation with changes in the USD/TWD exchange rate is not discernible.

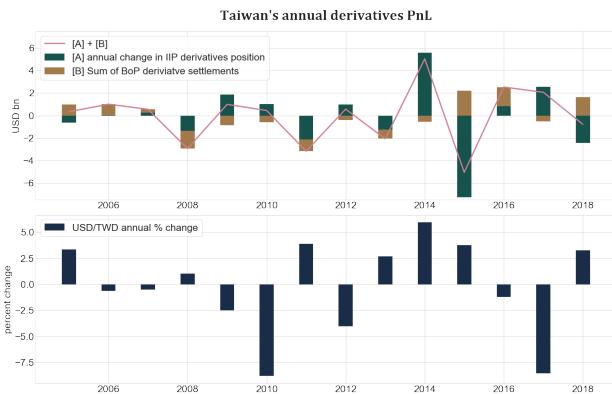


Fig. 23. Taiwan's annual derivatives PnL. Again, no obvious correlation exists with movements in the USD/TWD exchange rate.

Putting all the pieces together, it seems unlikely in the extreme that foreigners provide lifers the majority of FX hedges, necessitating at least one other actor to fill this position.

C. Taiwanese Banks

Domestic banks are, second to foreigners only, best equipped to manufacture FX hedges for customers. The '*manufacturing perspective*' is key, as banking institutions are in almost all cases unable to take FX risk outright³⁹ – highly leveraged bank balance sheets are rather optimized to taking on duration and (limited amounts of) credit risk. Given this fact, the following equation is usually a good baseline for assessing a bank's overall FX exposures, as well as that of individual currencies:

$$\text{On-balance sheet FX position} + \text{derivatives} \approx 0 \quad (1)$$

In consequence, if a bank has large net exposures to FX derivatives, it is almost always true that its on-balance sheet FX position tilts in the opposite direction. Of course, causality can run both ways:

³⁷I.e. rises in TWD vs. USD would create a positive derivatives PnL, and vice versa.

³⁸Taiwan unfortunately only releases its IIP once per year.

³⁹As opposed to duration or IG credit risk, the degree of FX volatility is much less predictable, exposing highly levered institutions to potentially perilous amounts of risk if overall FX exposures stray far from zero. Regulations are rightly punitive to open FX exposures but institutions typically limit such risk taking on business grounds already.

- A bank, for whatever reason⁴⁰, finds it has substantial FX exposure in its on-balance sheet section. The subsequent addition of FX derivative hedges neutralizes these, and the transactions truly serve as 'hedging devices' for the bank itself.
- Alternatively, a bank faced with large & one-sided customer demands for FX derivative hedges can decide to manufacture these hedges itself⁴¹, by purposefully mismatching its on-balance sheet assets/liabilities to remain overall FX neutral.

But no matter which way causality runs, the result is the same: FX assets⁴² exceeding FX liabilities requires an FX short position via derivatives to neutralize FX exposures, while FX liabilities exceeding FX assets requires a corresponding long FX exposure.

In order to construct the USD balance sheet of Taiwan's banking sector, the previously consulted BIS *Locational* and *Consolidated Banking Statistics* results for Taiwan are drawn upon again. A seminal BIS working paper⁴³ from 2009 lays out in detail how this source can be used to gain insight into the currency exposures of a country's banking system. In brief, the on-balance sheet exposures to the major currencies of a country's banking system can be decomposed into three categories:

- Cross-border assets/liabilities: These are positions booked by all offices of the selected country worldwide on entities located in a country other than itself, and in all currencies. For instance, Taiwan headquarter lending USD to a manufacturing company in Japan.
- Local Positions in Foreign Currencies: These are claims/liabilities booked by the foreign affiliates of a country's banks vis-à-vis residents of the affiliate's host country. For instance, the Australian subsidiary of a Taiwanese bank lending USD to an Australian manufacturing company.
- Domestic claims/liabilities in Foreign Currencies: These are positions booked by domestic banks on local residents in foreign currencies. For instance, a Taiwanese bank borrowing USD from a Taiwanese household.

Information for the first category is found in the *Cross-border* section in the Locational Banking Statistics, the other categories in the *Local Positions in Foreign Currencies* section. In contrast to the referenced BIS paper, the analysis here has to be conducted at the geographic country level, rather than the broader nationality (of the banking entity)

⁴⁰Common reasons include differentials in the price of funding in jurisdictions around the globe, specific regional knowledge on the lending side or, lastly, arbitrage opportunities created by differences in regulations.

⁴¹Because such transactions are balance-sheet heavy and regulatorily inefficient, banks resort to the manufacturing only if large imbalances in orderflow exist, no (foreign) arbitrageurs step in in sufficient quantities and the compensation (via a negative X-CCY basis) is appropriately sized.

⁴²FX assets here meaning any asset denominated in a currency other than the bank's base currency. In Taiwan's case specifically, replace FX with USD.

⁴³McGuire, P and G von Peter (2009): '*The US dollar shortage in global banking and the international policy response*', BIS Working Papers, no 291. Especially the *Data Appendix*.

level, as Taiwan does not submit the latter⁴⁴. In practice, this should not distort the results too much, as Taiwan's banks do the largest share of their business from Taiwan headquarters, with affiliates of relatively minor importance in an international comparison.

Fig. 24 shows the result of compiling the numbers according to the laid-out plan. Panel one shows that for the largest time since 2000, Taiwan's banks kept on-balance sheet USD exposures broadly in balance, with slightly more FX liabilities than assets on average. Since 2017, USD liabilities, i.e. cross-border borrowings and FX deposits from Taiwanese residents, have grown faster than USD assets⁴⁵, resulting in an imbalance of USD 60bn as of March 2019.

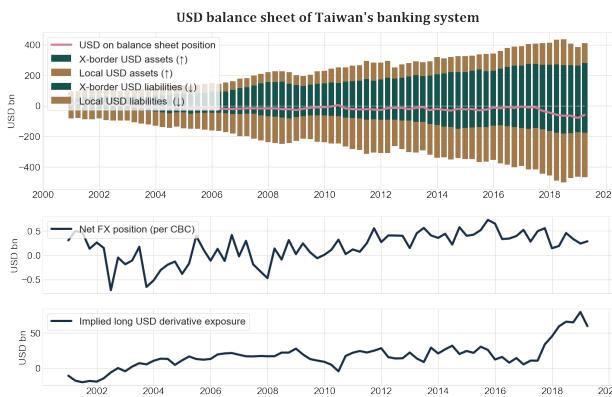


Fig. 24. Source: Bank of International Settlements, CBC

Panel two shows a time series obtained from the CBC, depicting the net FX position of the Taiwanese banking system. As expected, the aggregate position does not stray far from zero. Given that USD is by far the most transacted foreign currency in Taiwan, this time series is largely a reflection of USD positions.

Panel three combines the prior two panels and extracts the net USD FX derivative position according to Equation 1. A mirror image of the first panel, it shows Taiwan's banks were net long USD in FX derivatives for most of the time since 2000, i.e. providers of FX hedges to other actors. The provision of hedges has picked up substantially since 2017 and stands at the same referenced value of USD 60bn as above. This USD 60bn explain about 25% of lifers' overall demand for FX hedges – a substantial portion, but far from the whole story.

D. Non-financial Taiwanese corporations

Non-financial corporations establish FX derivative positions for two primary purposes:

⁴⁴This means use of '*Locational Banking Statistics by residence*' rather than '*Locational Banking Statistics by nationality*'.

⁴⁵In terms of causality, this would indicate a mix of the two directions outlined. FX deposits from residents are hard to decline, but if appropriate USD assets cannot be sourced, translation into TWD and domestic lending paired with FX hedges might be the most profitable investment. On the other hand, USD cross-border borrowings are largely voluntary, thus indicating an arbitrage intention, when paired with FX hedges.

- Hedging bonds issued in a different currency. If a corporation has no natural FX revenues or FX assets, hedging is usually done for the entire maturity via a cross-currency swap.
- FX hedging of future export & imports invoiced in a foreign currency. While some FX hedging of this sort, usually via FX forwards or options, is common for most companies, such transactions only grow large when absolutely necessitated by a company's business model, e.g. large, multi-year projects with payment in FX only at contract conclusion⁴⁶.

The upper limit for FX hedges resulting from bond issuance is easily established by compiling the universe of USD-denominated bonds⁴⁷ issued by Taiwan's non-financial corporations. Non-financial corporations issued up to USD 20bn in the run up to the financial crisis, which were however mostly repaid by 2010. No significant net issuance has occurred since then. With no more than USD 7bn outstanding, such issuance can only play a minor role in supplying FX hedges to the life insurance sector.

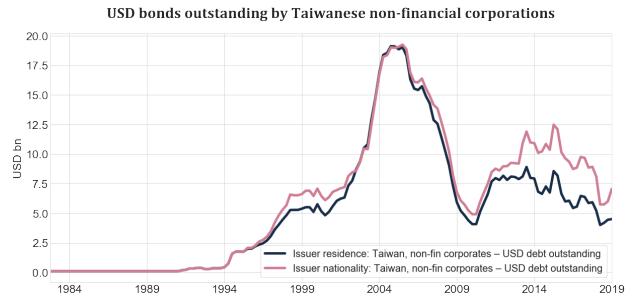


Fig. 25. Source: Bank of International Settlements

FX hedging of future exports and imports in large sizes is equally unlikely, if only for the fact that Taiwan's position in the ICT value chain is a high turnover business, with relatively short payment cycles.

An analysis of the 2018 year-end financial statements of the ten largest publicly traded non-financial companies in Taiwan tends to confirm this notion. As in most countries, publication of notional positions in derivatives is not obligatory, yet companies in which FX hedging forms an integral part of a business model tend to disclose these nonetheless. Of all covered entities, only Hon Hai has larger exposures in FX derivative markets. It has USD 2.5bn debt securities outstanding and holds an aggregate long FX derivatives position of USD 12.9bn, obligating it to exchange TWD for USD in the future. Among the other companies, it is usually

⁴⁶The best historical example of such a condition are Korean shipbuilders pre-crisis, receiving large USD-based orders payed upon delivery. This exposed builders to FX risk for one to two years, which they resolved by selling USD forward to Korean banks.

⁴⁷Non-financial corporates in Taiwan have in addition borrowed ~USD 8bn from international banks. In contrast to bonds, where it is the ample liquidity of overseas markets attracting foreigners and as a result necessitating an FX hedge, borrowings from banks can be tailored to a client's needs, implying FX hedges for loans from overseas banks are much less common than on the bond side.

mentioned that opportunistic FX hedging might occur, but no numeric disclosures are provided, most likely due to negligible sizes. This is confirmed by the commonly small claims & liabilities resulting from derivative transactions in companies' balance sheets.

Company	FX fwds	CCS	USD bonds outst.
TSMC	-0.13	-	0.00
HON HAI	4.30	8.60	2.50
FORMOSA PETROCHEMICAL	-	-	0.00
CHUNGHWA TELECOM	0.00	-	0.00
FORMOSA PLASTICS	-	-	0.00
FORMOSA CHEMICALS & FIBRE	-	-	0.00
NAN YA PLASTICS	-	-	0.00
LARGAN PRECISION	-	-	0.00
MEDIATEK	-0.11	-	0.00
UNI-PRESIDENT ENTERPRISES	0.00	-	0.00

Fig. 26. USD FX derivative exposures by Taiwanese non-financial corporates. Expressed in USD bn, where positive values in the first two columns denote a long USD position. Source: 2018 company annual reports

Since Taiwan's trade with the rest of the world is mostly denominated in USD or other major currencies, it appears unlikely that foreign non-financial corporations engage in larger FX hedging in TWD markets. While disclosures of internationally operating firms with supply chain exposures to Taiwan do not allow a proper analysis, if such transactions were common, they should be visible in the Taiwan's Balance of Payments. Since the prior analysis of Taiwan's BoP did not detect larger net FX derivative transactions with the rest of the world, FX hedging of trade-related transactions by firms abroad is deemed insignificant.

Put together, non-financial Taiwanese companies might be a marginal supplier of FX hedges due to Hon Hai's exposures, but are not systematically doing so at scales large enough to match lifers hedges at USD 250bn.

In summary, the three typical providers of FX hedges examined in this chapter do indeed provide lifers a portion of their FX hedges. Domestic banks appear to provide around USD 60bn, with the numbers for the foreign sector and non-financial corporations meaningfully lower, and most probably not exceeding USD 20bn each. Even in the most optimistic scenario, these three sectors do not even cover 50% of lifers USD 250bn FX hedges.

V. SEARCHING FOR COUNTERPARTIES: THE CENTRAL BANK OF THE REPUBLIC OF CHINA

TAIWAN'S life insurers do not fully FX hedge their overseas bond portfolios, but they still have large hedging needs – one that neither Taiwan's banks nor offshore investors appear to meet completely. The obvious additional counterparty, directly or indirectly, is Taiwan's central bank (the Central Bank of the Republic of China, or **CBC**). Taiwan's central bank, unusually, does not disclose its position in FX derivative markets, and thus its true foreign exchange exposures. But its true exposures can be estimated using similar statistical techniques applied in evaluating an investment fund's underlying positions from its profit and loss statements. Based on profits and losses which Taiwan's central bank does disclose, it appears that its true FX exposures exceed its disclosed foreign exchange reserves by USD 130bn, and perhaps as much as USD 200bn. The gap between the central bank's estimated FX exposures and its disclosed foreign exchange reserves increased significantly after 2012, when Taiwan's life insurance industry started to rapidly increase its holdings of dollar denominated bonds.

A. The CBC: In its own words

Taiwan's central bank does not supply quantitative information about its activities in FX swap and FX forward markets, as it – almost uniquely among the world's large central banks’ – does not follow the IMF's reserve template (the IRFCL). But at various times over the past fifteen years, it has hinted at its activities in its annual reports⁴⁸. Before the global financial crisis, it often noted its activity in FX swap markets.

2003:

- "The Bank carried out swap transactions and foreign currency call-loan transactions to provide banks with sufficient foreign exchange liquidity to meet their corporate clients' funding needs."

2004:

- "[...] trading volumes of foreign exchange swaps, options, and forwards all recorded growth rates of above 60 percent. [...] trend that banks tended to use the interbank swap market to adjust their currency composition, and that businesses inclined to utilizing financial derivatives to hedge the increasing risks they faced."
- "In addition, foreign exchange swaps with banks were used extensively [by the CBC] to absorb excess liquidity."
- "Moreover, the Bank actively carried out foreign currency swap transactions."

2005:

- "The trading volumes of cross currency swaps and foreign exchange swaps recorded the highest growth

⁴⁸Which can be found [here](#).

rates of 124.0 percent and 33.3 percent, respectively. The increase was mainly because domestic insurance companies increased their overseas investments and utilized cross currency swaps and foreign exchange swaps to hedge risks, and because banks used the interbank swap market to adjust their currency composition."

- "[...]some banks used foreign exchange swaps in place of call-loan transactions."

2006:

- "*In addition, foreign exchange swaps with banks were also used continuously to reduce excess liquidity. At the end of the year, its outstanding balance decreased from the previous year, mainly because the needs for hedge by insurance companies declined.*"

2007 - 2018:

- "[...] the Bank continued to carry out foreign currency swap transactions with banks and extended foreign currency call loans to banks so as to facilitate corporate financing smoothly".

Narrative-wise, it is hard to capture the situation better than the CBC did before the crisis. The lifers' overseas investments increase demand for FX hedges and that demand is accommodated by domestic Taiwanese banks. They in turn use the interbank FX market to adjust their currency exposure. But for the banks in aggregate to reach FX neutrality in the interbank market, a net supplier of FX swaps is required ... and found in the CBC itself, supplying FX swaps to "absorb excess liquidity". To review, the CBC would typically receive Taiwanese dollars in exchange for USD in an FX swap.

It is unfortunate the CBC has said relatively little since 2006. Back then, demand by lifers was in its infancy. But the central bank's descriptions of its pre-crisis activity invites questions about the size of its post-crisis exposures.

B. Central Bank + FX Swap = ... balance sheet shrinkage!

A central bank's FX derivative exposures can, in theory, be estimated based on information it does disclose, even if it does not disclose its full exposures. To see how, it helps to start with the impact of FX forwards and FX swaps on a central bank's balance sheet. The goal here is to highlight why disclosure of on-balance sheet foreign exchange reserves do not actually show a central bank's true foreign exchange position if it is active in FX swap markets.

A central bank's toolbox when it comes to FX derivative markets includes both, intervention via FX forwards and FX swaps. Of these, FX forwards provide the most flexibility. They can be entered outright, deliberately creating FX exposures, or in conjunction with an asset to be hedged, then resulting in an FX neutral package. FX swaps formalize this neutralization by conducting the spot and forward transaction with the same counterparty, a process best described as symmetrically collateralized lending. Because of the logistical ease of this pairing, hedgers typically show a preference

for FX swaps, while outright FX exposures (including FX interventions) are usually conducted via forwards⁴⁹.

With this in mind, it would seem sensible for the CBC to intervene in FX derivative markets using FX forwards, with local banks as counterparties. If intervention occurred that way, it could be termed a 'pure derivative' intervention since, upon initiation, a forward transaction entails no exchange of principal. This contrasts with FX swaps or cross currency swaps, which do. Given that forwards are traded in the over-the-counter market and the CBC does not release detailed information about its FX reserves using the IMF's IRFCL template, such exposures would remain effectively hidden.

However as the previous section has shown, the CBC relies heavily on FX swaps⁵⁰. Although the use of forwards and swaps is rather different for private sector institutions, it turns out that for central banks, the balance sheet impact of an FX swap is the same as the balance sheet impact of an FX forward. This is due to the accounting treatment of domestic currency on the liability side of the monetary authority's balance sheet.

Why this is the case is best illustrated by a sequence of stylized T-account examples.

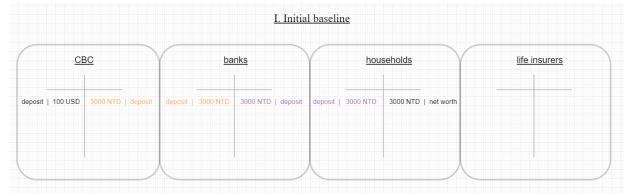


Fig. 27. Initial baseline of a stylized four sector economy.

Fig. 27 shows the highly abstracted baseline condition of a four sector model of Taiwan's economy, including the CBC, the banking sector, households and life insurers. In all examples, the USD/TWD exchange rate is arbitrarily set to 30. In this state, the only prior action which has occurred is an accumulation of USD 100bn FX reserves by the central bank. The reason for this intervention was limiting upward pressure put on TWD by a large Current Account surplus. It is assumed that the CBC holds these dollars on deposit with a bank outside Taiwan, which is thus not shown in this model.

⁴⁹Since FX swaps can be decomposed into its individual components, it is of course possible, in theory, to transform a package of these into having outright FX exposure, by adding further spot or forward transactions.

⁵⁰Given that lifers rely on FX swaps to hedge the largest part of their FX exposures, the most probable reason for the CBC to intervene via swaps is to ease the burden on the banking system, which can simple match up the demand for FX swaps by lifers with the supply of the CBC. If the CBC only wrote forwards to banks, they would need to decompose the swap into its components, requiring balance sheet space and thus (slightly) increasing the cost for lifers. Specifically, banks would need to expand their balance sheets by borrowing additional TWD, exchange these for USD. This would create balance regarding the CBC leg. They would then swap-lend USD to lifers, in return for TWD. At trade conclusion, these are reversed, the bank again has an on-balance sheet mismatch, leaving it long USD, which is countered by its long TWD position obtained by the forward transaction with the CBC.

During the intervention, the CBC took USD from foreigners and gave them TWD, which they in turn used to acquire Taiwanese goods. Ultimately, these funds ended up with the household sector, paid out as wages by firms producing the products sold. Households deposit these TWD 3000bn with the banking system (corresponding assets & liabilities marked in the same color, in this case purple). For banks, these represent excess funds created by the CBC's FX intervention. As such, the banking system is flush with excess funds on its asset side, which it (has to) redirect(s) to the central bank, which is providing the banking system deposit accounts for excess liquidity⁵¹. The insurance industry has not entered the game yet.

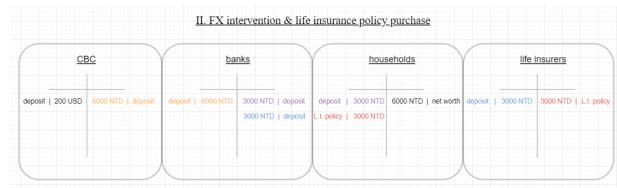


Fig. 28. Simulating further FX interventions.

Fig. 28 simulates what happens when the CBC again intervenes in FX markets, but households this time acquire a life insurance policy instead of just holding deposits with banks. Importantly, in this intermediate stage, lifers do not yet invest abroad (which comes next), but hold deposits instead. Starting on the left side, the CBC again intervenes in the FX market to counter a large Current Account surplus, which would push TWD upwards. The volume is again USD 100bn, the equivalent of TWD 3,000bn. Households receive this latter sum and purchase life insurance policies (red). Lifers deposit the amount with banks (blue), which in turn increases their deposits with the CBC by TWD 3,000bn to TWD 6,000bn.

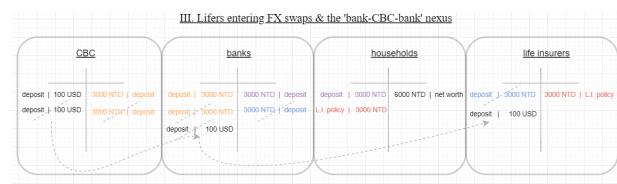


Fig. 29. FX swap provision by the CBC to lifers via the banking system.

Fig. 29 seeks to depict the complicated dynamics set off when lifers start to acquire FX-hedged USD-denominated debt. Starting on the right-hand side, a lifer decides to structure its FX neutral overseas investments via FX swaps, which it requests a quote for and then enters with the local banking system. From a lifer's view, the FX swap requires it to deliver

⁵¹In this case, it is assumed banks simply keep excess TWD liquidity on deposit with the CBC. Other modes of sterilization like CBC bills, repos or government bond issuance are equally conceivable.

TWD funds to the bank, while receiving USD in return⁵². It delivers the blue colored funds to the bank, which is shown as a dotted line crossing out this asset on lifers' balance sheet. The banks equally cross out this deposit on the liability side of their balance sheet. Banks are yet to deliver lifers USD, which the FX swap requires them to do. Because the banking sector does not have any USD funds natively on its balance sheet, it will instead itself enter an FX swap with the CBC. Mimicking the 'bank-lifer' transaction, the banking system will deliver TWD funds to the CBC, while the CBC delivers USD to banks. The first half of this transaction is marked by the crossing out of the orange asset entry on banks' balance sheet, matched by the CBC's elimination of the corresponding orange liability to banks. Now, the CBC is still required to deliver USD to banks, which it has no problem to do, by wiring them the USD FX reserves obtained in the prior stage II., as a result of FX intervention. This transfer is noted by crossing out USD 100bn of FX reserves on the CBC's balance sheet. Upon receiving these exact funds via the FX swap entered with the CBC, banks immediately send them on to lifers, due to the swap contract which started the entire process. Lifers can then, in a final but trivial step (not shown), use the received USD funds to acquire USD-denominated overseas bonds.

While cumbersome to follow in detail, boiled down to basics, this sequence of events is simply the banking system acting as dealer, matching demand by an initial customer (lifers here), with supply by another (special) customer, the CBC.

What is highly peculiar though, is what happens when the CBC entered into the FX swap with the banking system: its balance sheet shrank. Banks deliver TWD, thereby eliminating (or in the CBC's words, *absorbing*) excess TWD funds, previously kept on deposit with the CBC. Even more interestingly, the moment the CBC wires banks USD funds to fulfill its obligation of the swap contract, the size of its FX reserves shrinks. It in this case halved.

An outside observer, unaware of the swap contract and only able to see the CBC's balance sheet, would erroneously equate its visible FX reserves of USD 100bn with its total FX exposures of USD 200bn. Once the FX swap trade is unwound, the CBC would get back USD 100bn it swap-lent to banks and the observer would suddenly⁵³ have to double her initial estimate to then arrive at the correct USD 200bn figure. Unfortunately, if the CBC rolls the swap exposure continuously (which is to be expected as lifers' demand

⁵²This explanatory sequence seeks to understand the logical chain of transactions required to provide lifers with FX swaps. It is possible the sequentiality might (falsely) suggest longer time distances between these steps. This is not the case. In practice, once an insurer enters into the first transaction with the bank, the subsequent transactions are all entered simultaneously (or immediately thereafter) in order to achieve same day settlement, leaving the intermediating bank FX neutral at all times.

⁵³This upward revision would then accurately portray the size of the CBC's FX exposures, but the jump in reserves the observer sees when the swap is unwound does not reflect the timing of the CBC's intervention accurately. The increase in FX exposures took place in step II., which was however obscured, since in step III. immediately thereafter, the CBC's balance sheet shrank due to the swap transaction.

for hedges is permanent), the outside observer will never correctly figure out the true size of FX intervention conducted by the CBC.

Although tough to spell out coherently, these dynamics are well-known to folks dealing with such issues. In order to counter such opacity, the IMF explicitly requests countries to report the '*forward leg of currency swaps*' as net FX exposure, thus ensuring comparability with the more straightforward intervention via forwards only. After all, the simple process of lending FX reserves to other actors should not affect outside viewers' understanding of the degree of FX interventions a central bank has undertaken. The Bank of International Settlements also discussed these dynamics back in 2011⁵⁴.

C. Modeling central banks' 'true' FX exposures

Compensating entirely for the lack of full disclosure from Taiwan's central bank is impossible, yet with a bit of sleuthing, it is nonetheless possible to get a very good idea of the CBC's derivative interventions in FX markets

In the prior section, it was noted that:

$$FX \text{ exposure} = FX \text{ reserves} + \text{forward/swap position} \quad (2)$$

Because of the existence of FX derivative exposures, a central bank's overall FX exposures taken need not equal its on-balance sheet FX reserves. Simple rearranging to solve for the FX derivative exposure shows that it is just the difference between the overall FX exposure and declared FX reserves.

$$\text{forward/swap exposure} = FX \text{ exposure} - FX \text{ reserves} \quad (3)$$

Recasting it this way implies that figuring out a central bank's overall FX exposures yields the same result as knowing its derivatives position directly.

A key selling point of derivatives of any sort is the ability to efficiently establish exposures to some economic factor without the requirement of a large initial cash outlay. Aside from a small initial margin, delivered to a counterparty or clearing house, derivatives are bets on some factor entered at zero market value. Despite being recorded off-balance sheet, derivatives provide effectively⁵⁵ the same PnL to its holder as the equivalent position in a cash market. For instance, the return of an E-mini S&P 500 future (a derivative) is highly similar to that of the SPDR S&P 500 ETF (an exchange traded index fund & a cash instrument), both reflecting exposure to a common index, the S&P 500.

This equivalence in returns of exposures taken either via a cash position or derivatives is highly useful when combined

⁵⁴ Moreno, R (2011): '*Foreign exchange market intervention in EMEs: implications for central banks*', BIS Papers, vol 57, pp 65–86.

⁵⁵ Basis risk is the non-negligible edge case.

with methods of statistical performance attribution. These are frequently applied to comprehend exposures taken by investment funds. For instance, consider an exceptional equity fund manager who publishes a daily Net Asset Value per fund share, but does not publicly release its holdings. For simplicity, further assume that it is known that this manager only trades 10 stocks for which he has established superior insights and exhibits low portfolio turnover. Under such conditions, it is trivial⁵⁶ to recompose the manager's portfolio by analyzing the daily co-variation the 10 individual stocks have with the manager's overall PnL.

Formally, this can be expressed through a rather simple set of linear equations, in which the manager's PnL is the dependent target variable, while the individual stock returns act as independent explanatory variables. Regressing the former on the latter yields coefficients⁵⁷ for each of the stocks, presenting the relative size they take in the portfolio.

Crucially, this exercise leaves unknown 'how' the portfolio manager attained the exposure to the individual stocks – most likely by acquiring them in the cash market, but it is equally possible it was attained by a linear derivative, such as a Total Return Swap. For the outside observer trying to understand the fund manager, the 'how' exposures are attained is clearly secondary to 'what' exposures are taken and in 'which' size.

Transferring this thinking over to the estimation of the overall FX exposures a central bank takes appears promising. If this situation can be expressed mathematically along similar lines as the factor decomposition above, it would seem to open the door to figuring out a central bank's overall FX exposures.

A first requirement in setting up the modeling effort is to find the target variable to be explained. Unfortunately, the business of central banking is not managed on narrow PnL considerations of the institution's books, but rather based on macroeconomic effects its actions will generate eventually in the broader economy. As a result, central banks do not typically release high-frequency PnL indications.

Central banks do often release information about their balance sheets at a monthly frequency, allowing for the creation of a PnL proxy from the equity statement as shown in equation (4):

$$\begin{aligned} C.B. \text{ local ccy PnL} = & \quad C.B. \text{ local ccy equity [at } t = 0] \\ & - C.B. \text{ local ccy equity [at } t - 1] \end{aligned} \quad (4)$$

⁵⁶In the simplest of all cases, assume the value of a fund share always increases 0.5% for every 1% move up in stock A, and vice versa. It is clear then that the manager's exposure to stock A is $0.5 \times 100 = 50\%$ of AuM.

⁵⁷As with most regressions, it is not only coefficients which are returned, but also confidence intervals for these, as well as global goodness-of-fit characteristics for the entire exercise.

The local currency PnL of a central bank can, as a first order approximation, be estimated by subtracting today's equity value (found on the liability side of its balance sheet) from that at time t-1. As with private sector institutions, there exist times when this relationship does not hold, but it provides a good perspective under normal conditions.

Next up is the question of what the independent, explanatory variables should be. The answer to this question hinges a lot on the asset side of a central bank's balance sheet. The balance sheet of the Federal Reserve or the European Central Bank is almost exclusively focused on domestic assets, whereas many EM central bank balance sheets are dominated by large amounts of FX reserves. Taiwan clearly belongs to the latter group, so equation (5) is inspired by factors dominating the PnL of members of that group.

$$\begin{aligned}
 C.B. \text{ local ccy PnL} = & \quad \text{FX PnL} \\
 & + \text{FI } \Delta \text{PnL} \\
 & + \text{FI arbitrage PnL} \\
 & + \text{equity PnL} \\
 & + \text{other activities} \\
 & + \text{errors}
 \end{aligned} \tag{5}$$

Here, the *FX PnL* measures the FX exposure taken mostly via the accumulation of FX reserves, but also resultant of FX derivative exposures. Since the C.B.'s PnL is expressed in local currency, a, say, appreciation of the currencies the FX reserves are denominated in will naturally give rise to an accounting profit for the central bank. For central banks with large FX reserves or derivative exposures, the FX PnL should be the most dominant factor of all.

The fixed income PnL is split into two categories. The *FI Δ PnL* recognizes profits or losses as a result of mark-to-market fluctuations of bonds held as FX reserves. If the 5y U.S. Treasury bond yield declines by half a percentage point, that boosts the bond's market value by more than two percent, leaving a C.B. with a positive PnL. The *FI arbitrage PnL* deals with interest income and expenses. On the income side, these are interest payments received on FX reserves; correspondingly, interest paid out on local currency excess funds deposited by the banking system (or other sterilization tools) compose the interest expense expenditure. Given that interest rate levels typically change only slowly, the PnL contribution of this category would be much steadier than *FI Δ PnL*, which reflects changes in bond yields.

Some central banks also hold a small portion of their FX reserves in overseas equities. Profits and losses of these will be booked in the *equity PnL* section. *Other activities* denotes PnL contributions by factors not explicitly mentioned. These could be gains or losses on domestic policy operations. It also includes irregular transactions with other government entities, for instance the transfer of FX reserves to a sovereign wealth fund, deployment of funds for bank recapitalization or any other (usually) rare action, which can however significantly

affect the C.B.'s PnL when occurring.

The remaining *error* category can be thought to contain two types of errors. Factual errors result from when the C.B. inadvertently comes to faulty conclusions about the state of its operations. This could be the result of incorrect or stale market data, unavailable prices in public markets or computer errors. The second sort of error are errors in the mark-to-market representation of its balance sheet. For instance, a central bank may decide to value its equity holdings at book value and not incorporate market fluctuations, even if easily possible.

If a central bank's balance sheet information is of sufficiently high quality (i.e. insignificant errors and no or rare 'other activities'), equation (6) follows:

$$\begin{aligned}
 C.B. \text{ local ccy PnL} \approx & \quad \text{USD PnL} \\
 & + \text{EUR PnL} \\
 & + \text{JPY PnL} \\
 & + \text{other FX PnL} \\
 & + \text{USD duration PnL} \\
 & + \text{FI arbitrage PnL} \\
 & + \text{equity PnL}
 \end{aligned} \tag{6}$$

The *FX PnL* can be expanded to include all the major currencies composing FX reserves⁵⁸. Importantly, for the stated independent variables, it is straightforward to source real world data. For the FX components, the key measures are the month-end exchange rates. Changes in the yield of 5y Treasury bonds can serve as a proxy for the *USD fixed income duration PnL*. The *equity PnL* can be proxied by MSCI World returns⁵⁹. The *FI arbitrage PnL* is the only variable not possible to input directly⁶⁰, but since it should be inherently slow moving, the residual of the regression should capture at least parts of its behavior.

In order to dynamically understand the evolution of a C.B.'s exposures, consecutive rolling linear regressions can be run at a monthly timeframe. Grossing up the coefficients so as to represent the notional size of exposures and translating them into USD will then allow for direct comparison of a central bank's FX exposures with the official FX reserve figures.

D. From theory to practice – Modeling the CBC's FX exposures

Can this methodology be used to answer the initial question: Just how large is the CBC's FX intervention via its swap book?

⁵⁸ And, in all likelihood, the denomination of FX derivative exposures.

⁵⁹ Or, if known, more suitable regional indices reflecting the C.B.'s allocation.

⁶⁰ This would require knowledge about the currency composition and asset composition of the central bank's FX reserves. Since these are however only uncovered via this exercise, it is easiest to treat the *FI arbitrage PnL* as residual of the regression.

Confirming the classification of the CBC as a typical EM central bank, Fig. 30 shows the asset side of its balance sheet. It is dominated by FX reserves, which account for more than 85% of total assets. This implies that FX will be the major PnL driver.

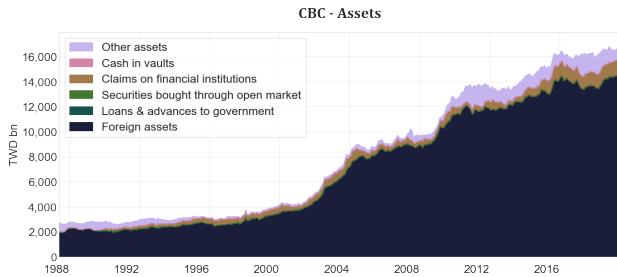


Fig. 30. Source: CBC

On the liability side, there is the customary 'currency issued' segment, followed by two broad sterilization tools for domestic liquidity created by FX interventions: TWD deposits placed by the government and banks account for 25% of liabilities, overshadowed however by the preferred tool of CBC issued Certificates of deposit, which are functionally similar and account for 44%.

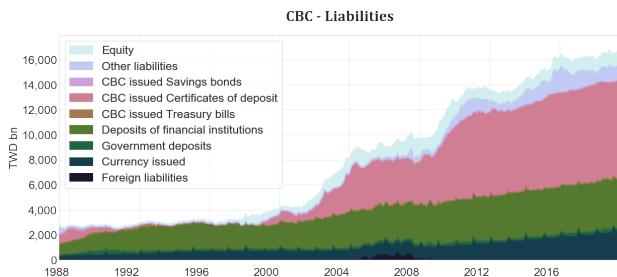


Fig. 31. Source: CBC

The all-important equity figure⁶¹ currently accounts for ~7% of liabilities and is portrayed by the uppermost area in the Fig. 31. This position however obscures important dynamics which only become visible when mapped individually against the USD/TWD exchange rate, shown in Fig. 32.

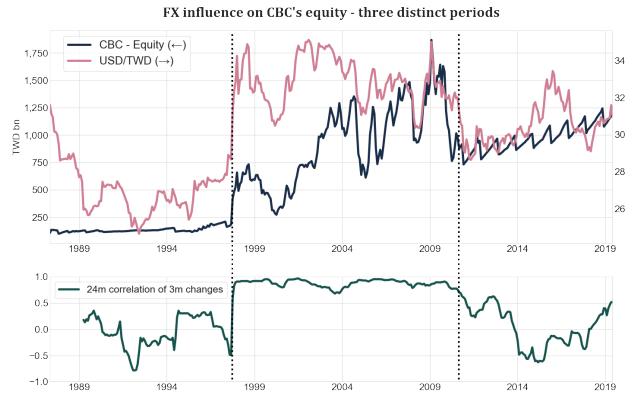


Fig. 32. Source: CBC, own calculations

Given the size of Taiwan's holdings of foreign assets, changes in the exchange rate between the Taiwan dollar and the US dollar, the most dominant FX reserve currency, should in theory exert a notable effect on the CBC's equity statement – and at times it does. Fig. 32 can be segmented into three distinct time periods. The first, lasting from the first available data until summer 1997, shows no correlation between changes in the USD/TWD exchange rate and the CBC's PnL. The reason here is straight-forward: the CBC did not at the time mark-to-market its FX reserves⁶².

During the Asian crisis in 1997 and the devaluation of Taiwan's currency, authorities decided to switch to a mark-to-market regime, which helpfully boosted the value of FX reserves when expressed in local currency. From then on and through the 2000s, changes in the exchange rate clearly affected the CBC's equity statement and, as a result, changes in the two variables were highly correlated⁶³.

In autumn 2010, just when lifer acquisitions of overseas debt and hedging demands increased, another structural break occurs. The equity's correlation to FX movements breaks down entirely and instead enters a pattern of predictable periodicity: gradual rises from January through November and sudden falls during December, which do not quite reverse the uptrend, resulting in a slow drift upwards. To our knowledge, the CBC has not addressed this structural break in its accounting.

Taking the equity's behavior literally would mean the CBC had disposed of the FX risk of its reserve holdings within a matter of months during 2010⁶⁴. Another possible reason

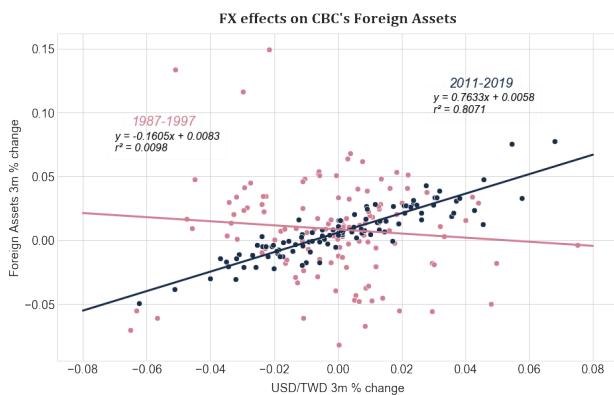
⁶²As also evidenced by the lack of volatility in the equity time series. The same lack of volatility is also found in the value of FX reserves on the asset side of its balance sheet.

⁶³Because the CBC's balance sheet more than quadrupled during this time-frame, directly calculating the correlation of the upper panel is inadvisable. A much better view is attained by calculating rolling window correlations on the changes in the variables, thus capturing the time-varying nature of the CBC's FX reserve holdings. As a result of this growth, in the late 2000s, even small fluctuations in FX markets already had a marked impact on the CBC's equity.

⁶⁴Which is highly doubtful, would clearly have been felt by market participants at the time, plus the central bank would clearly have had an incentive to provide the public clarity around such a large shift in policy.

⁶¹Which would be equivalent to the CBC's net worth, if viewed from a private sector angle.

could be that the CBC reverted back to the old regime and relinquished mark-to-market accounting. The repetitive pattern already makes that seem dubious and a more thorough investigation of the behavior of the valuation of FX reserves on the asset side confirms this. Despite the structural break in the equity's accounting, FX reserves (stated in local currency) are still marked-to-market, as shown by the blue dots in Fig. 33. This contrasts the behavior from 1987-1997, when the valuation of FX reserves showed no reaction to swings in FX markets, clearly indicative of the FX reserves being valued at the initial (and by now stale) exchange rate.



If FX reserves are still marked-to-market, but the CBC's equity does not reflect their PnL, some other balance sheet categories should, assuming assets and liabilities still balance overall.

In the prior discussion of the CBC's balance sheet, one item on each side was left out: 'other assets' and 'other liabilities'. Supposedly designed as residual items, these, according to the CBC's annual balance sheet⁶⁵, are composed of "accrued interest receivable, property plant & equipment, and deferred assets" and "accrued interest payable, bills and bonds sold under repurchase agreements" respectively.

As such, they should be of little importance to the issue at hand. As shown in Fig. 34, the opposite is the case. The upper panel depicts the expected irrelevance throughout much of the 2000s: low overall values and little volatility. That changes in 2009, with both time series increasing substantially thereafter, paired with much higher absolute volatility levels.

⁶⁵ Available [here](#).

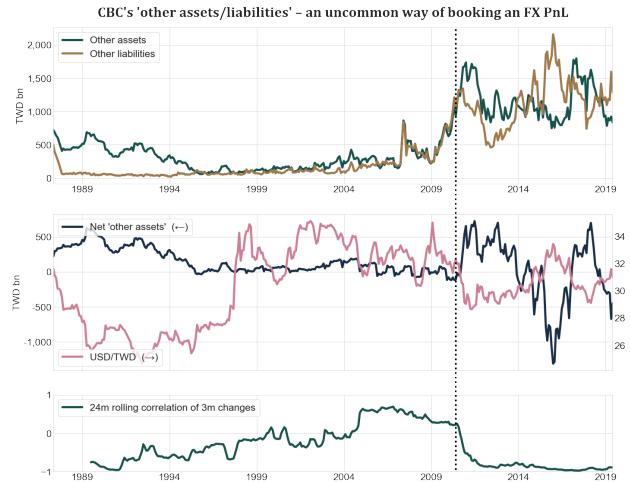


Fig. 34. Since 2010, the CBC appears to book its FX PnL via its 'other assets' and 'other liabilities'.

The most significant change however is the behavior these series exhibit when netted against another to create a 'net other asset' position (middle panel). Throughout much of the 1990s and 2000s, the net position hovered just above zero with little volatility. This changed in ... autumn 2010, the same time the equity's correlation with FX markets breaks down. By now perhaps unsurprisingly, the fluctuations of the 'net other asset' series is far from random – **it can almost entirely be explained by changes in the USD/TWD exchange rate**.

Why is this the case and why is the correlation shown in the bottom panel negative? As none of the items making up the 'other assets' or 'other liabilities' inherently contain any FX components, much less of a size to generate the swings the 'net other asset' series shows, it seems inevitable to conclude the CBC uses these two categories to book the FX PnL of its reserve holdings and derivative exposures. This also explains the negative correlation. The 'net other asset' series simply serves as contra account to the FX PnL, thus, whenever FX reserves on the asset side are, for instance, boosted by a rise in USD, the 'net other assets' series decreases by an (almost⁶⁶) commensurate amount, ultimately explaining the lack of reaction of the bank's equity statement to FX swings.

Once this argument is accepted, it is straightforward to correct for the accounting aberration. The 'net other asset' position's sign is reversed and then added back to the equity statement. Fig. 35 shows the results, which from 1997 onwards are almost perfectly in line with expectations from the USD/TWD exchange rate. The average rolling correlation between the 3m changes in the two variables from 1997 through 2019 is 0.9, implying that more than 80% of the variation in the CBC's PnL can already be explained by a one factor model.

⁶⁶It is not exactly equivalent, since the CBC's equity statement is not flat but exhibits the previously described pattern.



Fig. 35. By correcting for the FX PnL booking in the net 'other assets' category, the CBC's true equity statements are uncovered.

E. Model calibration: the 'USD-EUR' model

The explanatory variables included in the model to infer FX exposures of the Central Bank of the Republic of China are month-end exchange rates for the major reserve currencies (USD, EUR, JPY, CAD, CHF, GBP, AUD), 5y U.S. Treasury yields as a proxy for duration exposures and the total return produced by the MSCI World index as a proxy for equity exposures.

Setting up the regression framework, three questions require an answer:

- How many and which variables to include in order to maximize explanatory power while keeping model complexity⁶⁷ low?
- What length should the window size of the rolling regressions be?
- Since the regression is run on relative changes in the variables, what lookback period should be chosen to calculate these?

In order to find the best combination of the above factors, a global optimizer is applied. Results are subsequently evaluated to also ensure grounding in a solid economic rational. The optimal solution turns out to be in line with what intuition suggests.

- Only USD and EUR are included as explanatory variables.
- The rolling window size is set to 22 months.
- The lookback period to calculate changes is set to 3 months.

Each of these results will be quickly illustrated, while holding the remaining parameters at their optimal values.

Variable selection: To determine the explanatory power of individual variables, the CBC's PnL (given optimal other conditions, i.e. 22m window size, 3m changes) is regressed on each, and the average r^2 over the entire time period from

⁶⁷The risk of an overly complex model would lie in spurious factors distorting the effects assigned to truly significant variables. Since this entire exercise is predicated on measuring a central bank's FX exposure by the size of the coefficients of variables in a regression framework, inclusion of variables should be carefully weighed.

1999-2019⁶⁸ is presented by the green bars in Fig. 36. The brown bars detail the percentage of time the variable in this univariate regression is statistically significant at the 1% level and correctly signed⁶⁹.

In terms of results, USD is clearly the most important currency, as would be expected for a central bank that manages its currency primarily against the dollar. It is practically always statistically significant at the 1% level and explains ~80% of the variation in the CBC's PnL. The other currencies are of lesser explanatory value. EUR comes in second, followed by CAD, CHF and JPY. British pounds, Australian dollars, as well as the equity and duration factors⁷⁰ hold little explanatory powers.

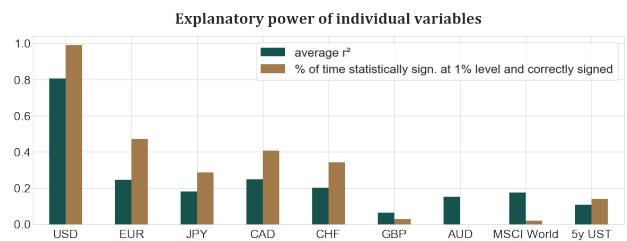


Fig. 36. Significance of individual explanatory variables. Attained by regressing changes in the CBC's true PnL on changes in each variable across all 22m rolling windows.

The inclusion of USD in the optimal solution is without question, but which other factors to include? Even though four other currencies exhibit reasonably attractive univariate regression results⁷¹, it turns out that EUR alone accounts for the lion share of improvements when other variables are added. Fig. 37 shows the univariate result of USD discussed previously on the left, followed then by the addition of another single currency. The addition of EUR increases the average r^2 from 80 to 93% and, even more importantly, both currencies are statistically significant at the 1% level and correctly signed the entire time.

⁶⁸That is, each month, a regression is run using the past 22 months of data, creating a single r^2 value for this particular segment. This exercise is repeated for every consecutive month, sliding the rolling window one month forward. Averaging all attained r^2 values provides a good estimation of a factor's importance in explaining the CBC's PnL.

⁶⁹By correctly signed, it is meant that an increase in the relevant currency vs. TWD leads to a positive PnL for the CBC – as would be dictated by the CBC being long foreign currencies. For equity and duration factors, correctly signed implies a long exposure. This sign restriction can guard against spurious correlation.

⁷⁰The lack of observable long exposure to U.S. bonds is notable (this also holds when adding the duration factor to the optimal USD & EUR setup) and counter to the duration exposure of other central banks. It could be due to the CBC not marking its FI holdings to market. The more likely reason however is that the CBC relies on very short-dated assets, as confirmed on its website: "The bulk of these foreign exchange reserves are deposited in overseas banks[...]."

⁷¹It is important to keep in mind that because the USD variable is highly significant, a currency (say X) with low volatility (or at the extreme, a peg) when crossed against USD would score highly in this exercise simply because USD/TWD would be highly correlated with X/TWD. None of the currencies is highly correlated with USD, but it might be a factor for CAD.

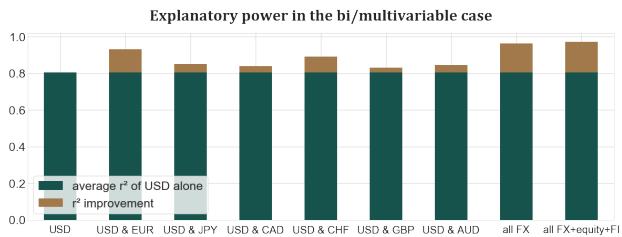


Fig. 37. Significance of variables in the bi/multivariate case. Beyond USD, only EUR meaningfully increases explanatory power.

As is customary, the addition of currencies other than EUR also increases the explained variance, but none exceeds the 90% mark⁷². As a test whether it is advisable to add further currencies to USD & EUR, the r^2 for setups including (1) all currencies, as well as (2) all variables, including the equity and duration factors, is calculated. In these, r^2 reaches values beyond 95%, but the results become increasingly unstable in the coefficients and thus unsuitable for the purpose at hand⁷³. For these reasons, USD & EUR – not coincidentally the two largest currencies in global FX reserve portfolios – will be the only variables considered in this initial model in order to map the CBC's FX exposures.

Rolling window length: In setting the rolling window length used in the regression, two factors have to be weighed. The shorter the timeframe, the more up to date the resulting coefficients will be. A 12m window for instance incorporates only more recent data than a 24m window, thus providing a better estimation of most recent FX exposures. On the other hand, a too short window might not contain sufficient information (i.e. degrees of freedom) for the regression to confidently figure out the true size of coefficients for the USD & EUR variables. This is especially relevant as in calm FX markets, with little changes from one month to another, the effective degrees of freedom can vastly undershoot the stated window length⁷⁴. To select the optimal lookback window, the average month-over-month volatility of the sum of the USD & EUR coefficients of the regression will be calculated. The coefficients should change over time, reflecting the evolution of the CBC's FX exposures, but too jumpy and mean-reverting behavior would be indicative of a too short window.

⁷²CHF comes close, but its quasi peg to EUR is the much more likely reason than outsized exposures to CHF.

⁷³This materializes by the regression maximizing the explanatory power by utilizing the entire cross section of variables it is provided. As a result, it tends to create 'long-short' positions in multiple variables, which are highly unstable. For instance, if in one specific 22-month time frame, the AUD-CHF exchange rate has some coincidental predictive power for the CBC's PnL, the regression would assign very large positive values to AUD and the opposite to CHF. Given that these are most likely spurious, they would be 'unwound' in a later period. Such misattributions can also affect the coefficients of truly significant variables, thus it is best to just limit model complexity and stay with the USD and EUR variables. Regularization methods might be of help in a single static regression; in the rolling window context, however, their application is less helpful.

⁷⁴For instance assume a 12m window is selected. If however FX markets are unchanged during, say, 5m of these, the effective window is rather 7m. Including the two explanatory variables and the intercept, that is only 4 degrees of freedom, potentially opening the door to too high month-over-month volatility in the coefficients.

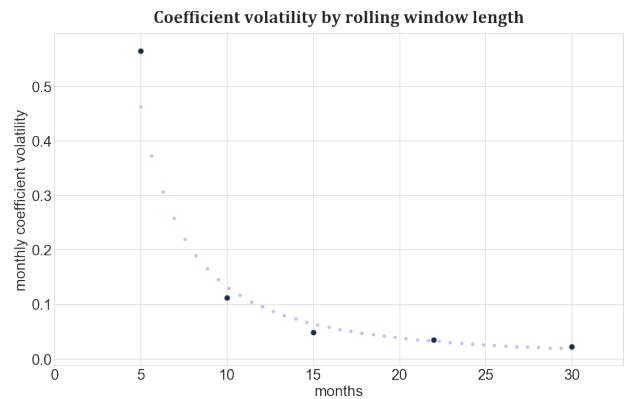


Fig. 38. Coefficient volatility with respect to the length of the rolling window follows a power law. The optimal length, weighing coefficient volatility and timeliness, is 22 months.

Fig. 38 displays the result and, as expected, volatility in the coefficients decreases with the length of the rolling window. 22m represents the optimal balance between coefficient volatility and time delay. It follows that the calculated coefficients in a 22 month window best approximate the FX exposures at the middle of the window, i.e. 11 months prior to the latest available data.

Rate of change lookback period: As the regression is run on relative changes in the respective variables, the lookback period to calculate these presents a final tuneable parameter. In a world without friction, a one period lookback should suffice, as all assets/exposures are marked-to-market continuously. If this is not the case however, a longer lookback period might deliver better results. As before, the longer the lookback period however, the less up-to-date the coefficients will be.

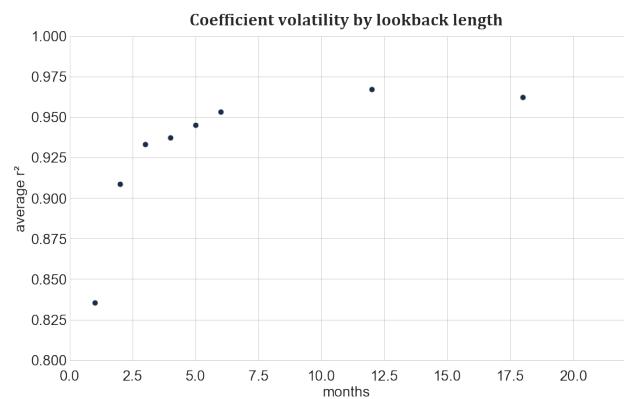


Fig. 39. A 3m lookback period for the calculation of changes in the variables further increases explanatory power.

Fig. 39 shows the average r^2 of the regressions when varying the length of the lookback period, while leaving the other tunable parameters at their optimal values. The one-month lookback period already explains the largest portion of the CBC's PnL, yet results improve noticeably when lengthening the window to two and three months. Thereafter, improvements still occur up to the twelve-month point, but are much

less pronounced. One way of explaining these improvements is that lagged FX returns still contain explanatory power for the CBC's PnL. By lengthening the lookback period, most of the lagged FX effects can be efficiently incorporated in the regression, without giving up any degrees of freedom⁷⁵.

Economically, the most likely explanation for the phenomenon is that the CBC does not mark-to-market all its exposures. For instance, given it holds large balances of short-dated claims on banks, it is possible it only accounts for FX swings in these whenever they are rolled over. The same concept is also conceivable for its FX swap exposures, which may equally only be marked-to-market when rolled over. The usually short tenors of both of these instruments align well with the significant improvements seen from the one month to the three-month lookback window, and the slowing thereafter.

Recapping the entire model setup:

- The three ingredients to the model are the previously constructed 'true' equity statement of the CBC and two FX crosses, USD/TWD and EUR/TWD.
- For each of these, the 3m rate of change will be calculated. For the CBC's equity, the 3m rate of change is expressed as the difference between its current value and that three months earlier. This is the target variable to be explained. For the FX crosses, which serve as independent variables, the rate of change is calculated as the percentage change in each cross during the prior three months.
- Beginning with the 22nd observation, a bivariate regression will be run over these 22 data points and the following characteristics will be saved: the coefficients for USD/TWD, EUR/TWD and the intercept (as well as their standard errors) plus the r^2 as an overall goodness-of-fit measure for this 22 month period.
- The window is then slid one month forward, and the steps in the prior item will be repeated, now for data points 2-23. This process is then repeated until the window covers the latest available data point.

The results of this modeling setup are portrayed in Fig. 40.

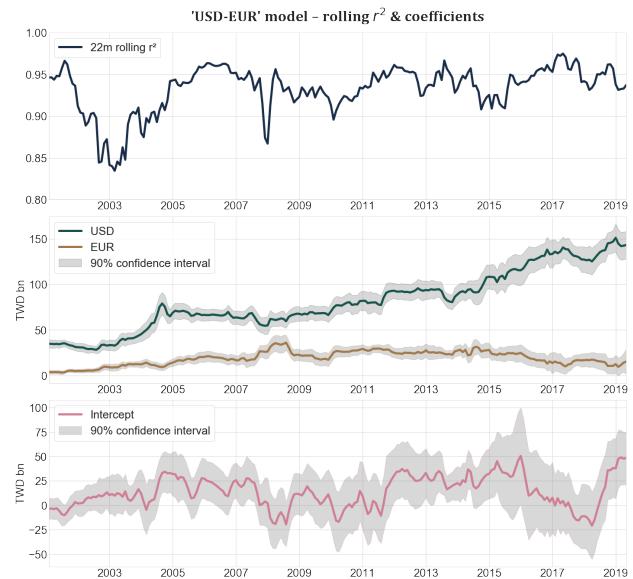


Fig. 40. Results of the 'USD-EUR' model run from 2001-2019. An imaginary vertical line through the three panels shows the regression results for a particular 22m period.

Panel one pictorially confirms the model's strong explanatory power regarding the CBC's PnL. Only during rare moments in 2003 and 2008 does the r^2 dip below 90%. Paired with the economic justification for the correlation between these variables, such high levels underline the suitability of the chosen model structure.

Panel two contains the most important results of the model: the evolution of coefficients for USD and EUR, representing the respective FX exposures in each. These should be interpreted as the CBC's FX PnL resulting from the respective currency appreciating by 1% against TWD. For example, the first available USD coefficient is close to TWD 40bn, meaning a 1% appreciation in USD/TWD leaves the CBC with a local currency gain of this size. By multiplying the coefficient times 100, the CBC's FX exposure in the respective currency is attained.

There are three distinct periods of increasing USD risk taking: during 2003-2004, from 2009-2012 and, more surprisingly, given the modest change in Taiwan's stated reserves, from 2013 through today. The EUR exposure in contrast is a story of rise and subsequent decline. From practically no EUR exposure in 2001, the CBC increased its EUR exposure continuously up until 2008, reaching its highest relative share to USD at 70%. Thereafter, its EUR exposure remained flat through 2014, after which its balances began to decline – a behavior in line with many other FX reserve managers. Standard errors for both coefficients are of relatively small sizes, here displayed as 90% confidence intervals for the expected range of the actual coefficients.

Panel three shows the evolution of the intercept of the regression. It is positive for most of the time, meaning the CBC's overall PnL is slightly above what is indicated by movements

⁷⁵This would occur for instance if the FX effect of each currency were to be split into three components: the current 1m rate of change, as well as two lagged versions of it, reflecting changes one or two months prior.

in FX markets. As stated in the model setup earlier, this is indicative of a positive 'FI arbitrage PnL', meaning a positive interest rate differential between what the CBC receives on its FX reserves and what it pays on sterilization instruments in its local currency.

A first comparison of the model's implied FX exposures and CBC official FX reserves will require the coefficients portrayed in Fig. 40 to be transformed in three ways to ensure comparability.

- The USD and EUR coefficients are added to yield a time series representing the CBC's total FX exposure in these two currencies.⁷⁶
- The original coefficients are denominated in TWD, so a translation into USD is necessary. Since the regression runs over the prior 22m time frame, the average USD/TWD exchange during this period is used.
- Since the regression is run over a 22m time frame, the attained coefficients best reflect the FX exposure at the middle of this period. Thus, the calculated FX exposures are shifted 11m backwards in time.

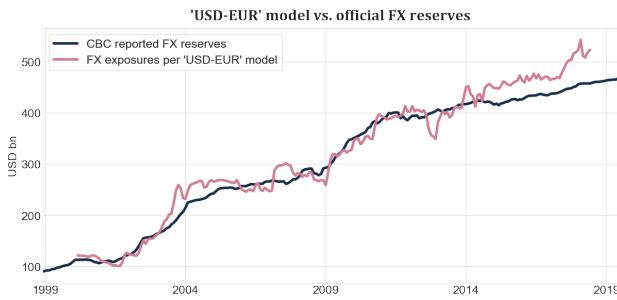


Fig. 41. Summing up USD and EUR positions, a first comparison of FX exposures vs. official FX reserves is possible.

Corroborating the abstracted indications obtained during the setup phase, Fig. 41 shows just how suitable this model of relying on the CBC's PnL to draw inferences about its FX exposure is. The created time series of the CBC's FX exposures is highly correlated in level terms with the CBC's officially released FX reserves. Slight deviations during 2003, 2007 and 2012 exist, are however short-lived and tend to be corrected in the ensuing months.

This pattern breaks starting in 2014, after which the indicated FX exposures of the CBC continuously exceed the level implied by its FX reserves. This is exactly what would be expected if a central bank is indeed intervening in FX markets to weaken its currency via FX derivatives - in this case by swapping FX obtained from outright interventions with a local counterparty. The difference between the calculated FX exposure and reported FX reserves in turn

⁷⁶To be precise, the regression not only captures the FX exposures arising from USD or EUR allocations, but also any other currency's unorthogonal variation with either. This topic will be explored shortly, in the context of accounting for the currencies not directly included in the regression discussed here.

represents the central bank's estimated FX derivative exposure.

In Taiwan's case, the results implied by USD and EUR currency factors alone indicate excess FX exposures created via FX swaps of ~USD 65bn as of mid-2018. Already a meaningful sum, this amount is set to grow further when incorporating the remaining currencies which were so far set aside in this section's model.

F. AUD, JPY & Co – Incorporating remaining FX exposures

In order to comprehend the entirety of a central bank's intervention in FX markets, all its FX exposures have to be aggregated. As shown in the left half of Fig. 42, this requires the summation of (1) the FX exposures in each currency it holds as on-balance sheet FX reserves, as well as (2) any exposures arising from transactions in FX derivatives. Given that FX reserves are predominantly denominated in USD or EUR, these currencies naturally form the largest portion of FX exposures created by accumulating on-balance sheet FX reserves. Despite this primacy, a group of other currencies (including AUD, JPY, GBP, CAD, CHF, AUD, CNY) have in the past decade almost doubled their share in the currency composition of global FX reserves reported in the IMF's COFER survey, now accounting for ~18%. No currency denominations are available for interventions via FX derivatives, yet anecdotal evidence strongly suggests these mostly are conducted against USD. In Taiwan's case, this is practically guaranteed, as the CBC provides FX hedges to lifers, which, as shown in chapter II., conduct their foreign business almost exclusively in USD – and thus require USD FX hedges.

Optimally, all individual FX exposures would be measured in a single step, which would be synonymous to the inclusion of all currencies in the regression exercise in the prior chapter. Unfortunately, this is practically infeasible for a simple reason: While the USD and EUR exposures of the CBC are large enough to trace effects on its PnL, the remaining currencies account for a much smaller share of FX exposures and are thus not reliably picked up by the models in the previous section. Further, the inclusion of many correlated currencies may, at times, raise serious issues of multicollinearity. For these reasons, it was decided to only include USD and EUR variables in the main model and postpone the inclusion of other currency exposures until now.

As most central banks, the CBC does not provide a breakdown of the currency composition of its FX reserves. In its monthly FX reserve statements, it nonetheless frequently references FX market moves in JPY, GBP and other currencies affecting the valuation of its FX reserves when expressed in USD⁷⁷ and states its FX reserve "composition is similar to those of other major central banks around the world."⁷⁸ Consequently, it will be assumed the CBC's allocation of currencies other than USD and EUR in its on-balance sheet FX reserves follows the global

⁷⁷See for instance [here](#).

⁷⁸Quoted from [here](#).

average of all central banks, values for which are obtained from the quarterly IMF COFER survey.

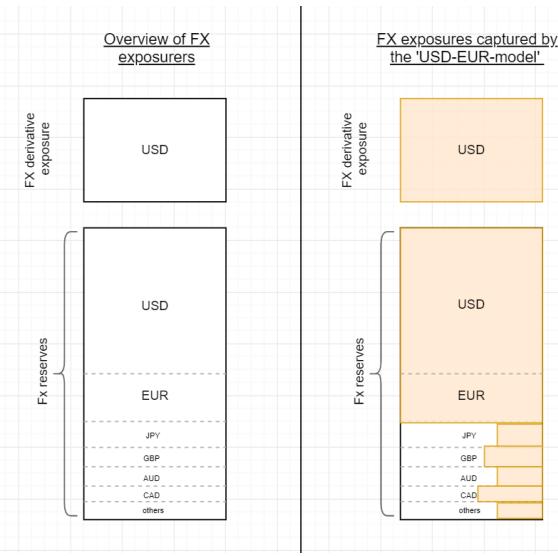


Fig. 42. Left: Theoretical FX exposure assumed by a central bank by currency and instrument type. Right: Orange-colored portions show categories covered by the 'USD-EUR' model, while white colored ones are not included yet.

The incorporation of currencies other than the euro and the dollar is slightly more difficult than a cursory look might suggest. This is due to possible correlation effects between the referenced currencies crossed against TWD, which may lead to portions of other currencies indirectly already being accounted for by the 'USD-EUR' model in the prior section. The right-half of Fig. 42 serves to indicate such dynamics: The 'USD-EUR' model certainly covers FX exposures resulting from FX reserves kept in either of the two currencies, plus the FX derivative exposure taken via FX swaps, which are USD-denominated. In addition, and depending on how correlated a given currency is with the USD and EUR variables during a specific time frame, varying portions of the smaller currencies' shares may also already be accounted for by the 'USD-EUR' model.

The dynamics may be best illustrated by an example. From mid-2012 through mid-2014, strong demand to convert EUR into CHF, as a consequence of the Euro crisis, led the Swiss National Bank to 'floor' the EURCHF exchange rate at 1.20 CHF per Euro. As a result, the FX pair spent these two years in a very narrow channel just above the 1.20 floor, with minimal volatility. A byproduct of this temporary quasi-peg and the ensuing tranquility in this specific FX cross is that EUR and CHF will exhibit an extremely high correlation, when measured against a common third currency, e.g. EUR/TWD and CHF/TWD show very high co-movements.

The problem of the correlation is that while the 'USD-EUR' model explicitly accounts for FX exposures in these currencies, the indistinguishable returns of EUR/TWD and CHF/TWD will make it also measure exposures to the latter cross, and hence allocations of FX reserves denominated in CHF. For this reason, simply adding COFER implied CHF

FX exposures to the 'USD-EUR' model could lead to potential double counting and overstatements of overall FX exposures. Instead, the correlation effects of each currency with USD and EUR variables will have to be considered as well. Equations (7) and (8) show the procedure formulaically,

$$\begin{aligned} \text{CBC total FX exp.} &\approx \text{'USD - EUR' model} \\ &+ \sum_{i=1}^N \text{FX exp. from ccy } i \end{aligned} \quad (7)$$

where N is the number of currencies FX reserves are held in apart from USD and EUR. A single currency's contribution is then calculated as

$$\begin{aligned} \text{FX exp. from ccy } i &= \text{ccy } i \text{'s share in IMF COFER} \\ &\times \text{unexplained variance of ccy } i \\ &\text{by USD \& EUR variables} \\ &\times \text{size of CBC's FX reserves} \end{aligned} \quad (8)$$

Per Equation (7), the CBC's overall FX exposures at a specific point in time are the already known coefficients for USD and EUR, supplemented by the FX exposures from other currencies FX reserves are held in. Equation (8) details the calculation of the contribution of a single currency i in this basket at a specific point in time. The starting point is the currency's share in the IMF COFER survey. This value is multiplied by currency i 's uncorrelated movement with the USD & EUR variables, calculated as $1 - r^2$ of a bivariate regression of currency i 's returns during a specific 22-month time frame on USD and EUR returns⁷⁹. If a currency is highly correlated with USD or EUR, $1 - r^2$ will be small, thus lowering the (additional) contribution of this currency. In fact, it is not really lowering the currency's contribution, as much as avoiding double counting of exposures which, due to high correlations, have already been accounted for by the 'USD-EUR' model. Lastly, the percentage share will have to be scaled by the current size of the CBC's FX reserves to attain a nominal USD value.

As an example, at the end of 2017, GBP made up ~5% of FX reserves in the IMF COFER survey. During the 22-month time frame which is divided into equal parts by December 2017, 17% of the variation in GBP/TWD can be explained by movements in USD/TWD and EUR/TWD. Subtracting this figure from 100% and multiplying by the COFER share yields $0.05 \times 0.83 = 0.0415$, which is the percentage of official FX reserves to be added on top of the 'USD-EUR' model to account for not yet included GBP exposures. Multiplying this

⁷⁹This process can also be approached visually, from a linear algebra perspective. For any particular 22-month period, the USD and EUR variables form a plane in a 22 dimensional space. By solving the linear equation, this plane is mapped (as best as possible) to a line representing the CBC's PnL. If a third currency is highly correlated with USD, EUR or a combination thereof, the currency's return vector lies largely in the plane spanned by USD and EUR returns – consequently it does not add much new information to the system's column space and its correlated exposures would have been picked up by the USD and EUR variables anyway. Instead of calculating $1 - r^2$ for each currency, it would also be possible to calculate the third currency's length orthogonal to the 'USD-EUR' plane and divide it by its entire length.

share by the size of the CBC's reported FX reserves of USD 451bn in December 2017 results in a nominal value of USD 18.71bn.

Repeating this process systematically for all currencies included in the IMF COFER survey and for every single month starting in 2001 yields the following results:

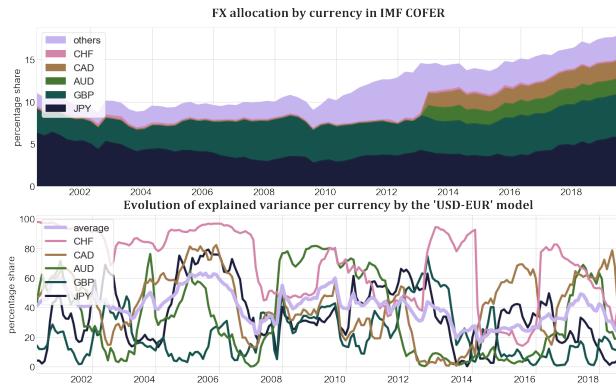


Fig. 43. Upper panel: FX reserve allocation to other currencies according to the IMF COFER survey. Lower panel: Evaluation of co-movements of other currencies with USD & EUR returns.

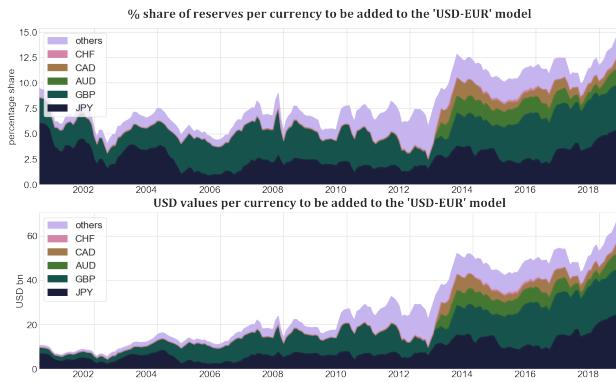


Fig. 44. Upper panel: Each currency's share to be added to the 'USD-EUR' model. Lower panel: Above panel, multiplied by the size of FX reserves at each point in time to yield nominal USD values.

The top panel in Fig. 43 shows the allocation to currencies⁸⁰ other than USD and EUR in the IMF COFER survey; the lower panel shows the evolution of explained variance of returns by the relevant currencies crossed against TWD by USD/TWD and EUR/TWD returns. Also shown is the average of these time series, which will be applied to the 'other' currencies category, which is not described in more detail in the IMF COFER survey.

The upper panel in Fig. 44 shows the percentage share of FX reserves per currency to be added on top of the

⁸⁰In recent years, allocations to CNY-denominated assets have risen and are currently stated at 1.95% of COFER-reported FX reserve assets. Since Russia accounts for a large portion of such holdings and Taiwan is for geopolitical reason unlikely to hold Mainland Chinese assets, allocations to CNY assets in the IMF survey will be replaced by scaling up the other here included currencies proportionally.

'USD-EUR' model, calculated as the upper panel in Fig. 43 \times (1 - the lower panel). The bottom panel in Fig. 44 translates these into nominal USD values by multiplying by the respective size of Taiwan's reported FX reserves at each point in time.

In a final step, these additional FX exposures to other currencies will be added on top of the 'USD-EUR' model, in order to create the final result presented in Fig. 45.

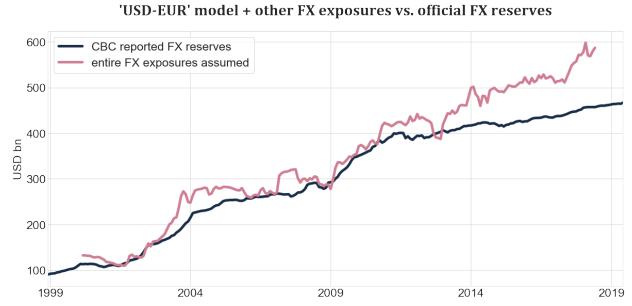


Fig. 45. Incorporating allocations to all currencies FX reserves are held in, the gap between the CBC's official FX reserves and its actual FX exposures further increases.

As in the 'USD-EUR' model before, the measured overall FX exposures of the CBC are tightly correlated with its official FX reserves up through 2010 – the time period before lifers became active buyers in foreign markets & acquirers of large amounts of FX hedges. Thereafter, the time series clearly diverge. From 2011 through mid-2018, the CBC's FX reserves increased by USD 70bn only; the measured FX exposures in contrast by USD 160bn, a difference of USD 90bn.

As discussed, deviations in these time series can be attributed to FX exposures assumed via FX derivatives. With the background of the prior chapters, including the obvious demand for FX hedges by lifers and the lack of (sufficiently large) counterparties to their position by private sector actors, it seems self-evident that the continued rise in the CBC's FX exposures is explained by it taking the other side of lifers' FX hedges via currency interventions in the FX swap market. Based on the central tendency produced by the latest estimate for mid-2018, the CBC's FX swap book – and ipso facto its hitherto undisclosed FX interventions – amounts to ~USD 130bn.

G. Testing the CBC's FX swap book for significance

The modeling results displayed in Fig. 45 show the central tendency produced when estimating the CBC's overall FX exposure. For every month, the same model setup described in prior sections is run using 22 months of data to calculate the USD and EUR coefficients, to which exposures in other currencies are later added, after their co-variation with the directly included currencies is stripped off.

As with any statistical model, knowledge of the central tendency is a required first step, should however be immediately followed by testing results for statistical significance. If for instance the model's errors are large, it could be conceivable that the gap between the CBC's FX exposures and its published FX reserves is attributable to statistical errors rather than a genuine divergence in reality.

There are several ways to show that the model results – and in consequence the divergence between the two time series – are of high quality and unlikely due to pure chance.

First, the r^2 values reported by the 'USD-EUR' model average north of 0.9, meaning that the true variation in the CBC's local currency PnL can be almost entirely explained by these two factors alone. Since standard errors of single coefficients in a regression are, among other things, determined by the overall fit of the entire model, it stands to reason that errors in the USD and EUR coefficients will not be overly large.

Second, the results in Fig. 45 are not the outcome of a single application of the model, but rather of many rolling window calculations. If the modeled FX exposures then exceed the FX reserve numbers permanently – particularly in windows with little or no overlap in data inputs – it is probable that the mid-point estimates are of high quality and not due to random errors. If the latter were the case, wild fluctuations (both above and below the FX reserve values) in the FX exposure time series would be expected. In reality, the modeled FX exposures exceed the reported FX reserves in more than 94% of all considered months. Further, the resulting time series is fairly steady, alleviating concerns that it is randomness creating the divergence.

Lastly and most formally, estimates for the errors of individual components of the model can be combined to create confidence intervals for the CBC's total 'true' FX exposure. If the CBC's reported FX reserves lie outside of a specific confidence interval, the CBC's FX swap interventions can be classified as statistically significant at the specified confidence level.

Standard errors for USD and EUR are readily available from the regression setup (see in Fig. 40 previously) and only have to be converted into USD and shifted back 11 months in time.⁸¹ Given no indications to the contrary, the error structure will be assumed to be uncorrelated, so the combined standard error of these is simply the square root of the sum of their individual variances.

The standard errors for the other currencies are more difficult to assess. Since the CBC does not release its currency compositions directly, the starting point for these are the point-values taken from the IMF COFER survey. How well they match the true CBC allocations is hard to say, so as an alternative, the spread of individual countries around the aggregate COFER value will be taken as a guide for the variability. Most countries of course do not release such values, but strong

⁸¹In order to align with coefficients, which were shifted back in an earlier section already.

evidence exists nonetheless⁸², indicating that the spread around the COFER implied allocations is small. Erring on the side of caution, it will be assumed that the standard deviation of the CBC's allocation to currencies other than USD and EUR is 20% of the actual allocation. For the latest available data, this implies a mid-point estimate of 18% and a standard deviation of 3.5%, which translates into a 95% interval of between 10.5% and 25%. On the downside, this seems more than conservative given the CBC's frequent mentions of the influence other currencies have on the valuation of its FX reserves when expressed in USD.

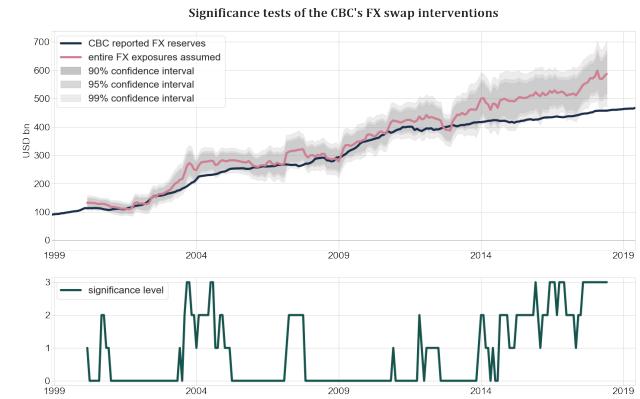


Fig. 46. Significance tests of the CBC's FX swap interventions. Values of 1, 2 and 3 in the bottom panel highlight statistical significance of the CBC's FX swap interventions at the 10%, 5% and 1% level respectively.

Fig. 46 shows the results when the estimated errors in the other currencies⁸³ (again assuming uncorrelated errors) are added to the directly obtained standard errors from the 'USD-EUR' model. The three gray-colored channels surrounding the central tendency represent confidence intervals at the 90%, 95% and 99% levels respectively. The lower panel indicates instances in which the CBC's published FX reserves lie outside a specific confidence interval, progressively indicating increasing levels of statistical significance.

Since late 2014, excess FX exposures by the CBC acquired via its FX swap book are at a minimum significant at the 10% level; since late 2015 significance increased further, coming in at the 1% level most of the time, including the last year of available data, during which this is consistently the case.

Joining these numerical results with the CBC's self-reported qualitative acknowledgment of its activities in FX derivative

⁸²Before 2015, the IMF released two additional datasets on currency allocations of FX reserve managers in Advanced and Emerging economies respectively. The allocation to other currencies in both were very similar throughout time. In addition, since 2015, three of the biggest FX reserve managers (China, Saudi Arabia and Russia) have joined the IMF panel. The inclusion of none of these shifted the overall mix in the world survey materially, implying that their allocations are about in line with countries already included in the survey.

⁸³The standard error for the other currencies is, of course, calculated by applying the 20% variation to the orthogonal variation, unexplained by the 'USD-EUR' model. The standard errors for correlated exposures are already accounted for in the uncertainty calculated for the USD and EUR coefficients.

markets, the case for hitherto non-public interventions in FX markets via its FX swap book seems overwhelming. This is particularly the case in the broader context – Taiwan’s life insurance industry has a large disclosed FX hedging need, and, as the previous chapters have illustrated, neither Taiwan’s banks nor non-residents appear to be potential counterparties for the full hedging need.

The scale of this undisclosed intervention appears quite large – at least USD 130bn, and perhaps as large as USD 200bn. Intervention on this scale over the past six years helps explain the remarkable stability of the Taiwan dollar. Taiwan’s undisclosed intervention is also large enough to materially change, among other things, the U.S. Treasury’s assessment of Taiwan in its semi-annual foreign exchange report.

The CBC does not make it easy, but it does seem to report enough information about its profits and losses from currency moves to estimate its true foreign exchange exposure. A well-grounded mid-point estimate suggests that the CBC’s undisclosed FX exposure – and thus undisclosed FX intervention – is USD 130bn, with a 90% confidence interval between USD 60bn and USD 200bn.

B. Effects on U.S. Treasury’s currency policy

The CBC, like many other central banks, claims its interactions with FX markets are ‘smoothing’ in nature “*when seasonal or irregular factors disrupt the market, the CBC will step in to maintain an orderly foreign exchange market*”⁸⁴. Alas it is difficult to square the CBC’s actual actions in the FX markets with this description. The CBC’s intervention is one-sided, large both absolutely and relative to the size of Taiwan’s economy and persistent.

The CBC has added USD 118bn to its reported FX reserves since 2009. This reported number is deceptive however as it leaves out the central bank’s derivative exposures. That has been estimated to have increased by USD 130bn since 2009, or 20% of Taiwan’s GDP.

The higher level – and different trajectory – of Taiwan’s foreign exchange interventions of course has important implications for the U.S. Treasury Department’s biannual report to Congress⁸⁵. In its current format, the FX report requires all larger U.S. trading partners’ trade and FX activities to be reviewed against three specific criteria.

- A material overall Current Account surplus, with two percent of GDP set as threshold.
- A significant bilateral trade surplus vis-à-vis the U.S., with an annual threshold set at USD 20bn.
- Persistent, one-sided purchases of foreign currencies in FX markets, defined as net FX intervention purchases of at a minimum two percent of GDP per annum and in at least 6 of the 12 preceding months.

Fig. 47 shows the Treasury’s FX evaluation dashboard for Taiwan.

⁸⁴Quoted from the CBC’s explanation of its Foreign Exchange regime [here](#).

⁸⁵Established by the Omnibus Trade and Competitiveness Act of 1988, 22 U.S.C. § 5305, and Section 701 of the Trade Facilitation and Trade Enforcement Act of 2015, 19 U.S.C. § 4421.

VI.

MERCANTILISM, EXCESSIVE PRIVATE FX RISK-TAKING & THE HEDGING BACKSTOP

A. Putting the pieces together - The case so far

TAIWAN is the only major economy which does not comply with the IMF’s standard for reserve disclosure, and thus effectively hides its FX derivatives book. Immediately after the global crisis, the central bank’s visible intervention accounted for the bulk of Taiwan’s current account surplus. But over the past years, visible intervention has been relatively small, as private financial institutions – notably Taiwan’s life insurers – have built up their foreign asset position.

Life insurers do not hedge all of the resulting foreign exchange exposure. But they do hedge about USD 250bn of their USD 465bn in foreign assets. The banking system appears to provide ~USD 60bn of the needed USD 250bn in hedges. Non-financial firms and global investors are a bit harder to track, but all evidence suggests each of these have provided less than USD 20bn of hedges. That leaves about USD 150bn of the life insurance sector’s hedging need unexplained.

The CBC has indicated in its annual reports that it is a regular participant in the FX swap market, and – like other central banks – it has sterilized FX interventions via the banking system. It has also reported that the root cause of the banks’ need for foreign exchange is often FX hedging demand by Taiwan’s large life insurance companies. The use of FX swaps would lower the CBC’s level of reported reserves (as the CBC provides foreign exchange to the financial system, while contractually committing to buy the foreign exchange back at a pre-determined price). That is why the disclosure of the forward leg of the swap in the IMF’s standard template for reserve disclosure is critical – it helps provide a guide to the central bank’s true foreign exchange position.

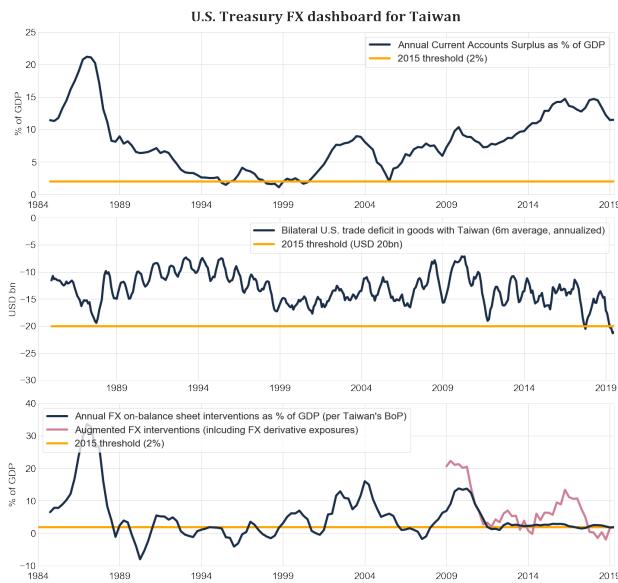


Fig. 47. U.S. Treasury's FX dashboard for Taiwan. Source: United States Census Bureau, CBC, DGBAS Taiwan

Taiwan's Current Account surplus has exceeded the two percent threshold in all but a few months since 1984. In the last six years it has been north of 10% of GDP.

The bilateral balance is not the most intellectually well grounded criteria – some, including one of the authors, have suggested that it should be deemphasized by the U.S. Treasury⁸⁶. Taiwan has recently avoided scrutiny in the Treasury's FX report in part because the U.S. bilateral deficit with Taiwan has not been close to the USD 20bn threshold (even if it likely would on alternative measures⁸⁷). But Taiwan is in a bit of a bind, as trade diversions away from China subsequent to the imposition of tariffs could easily push the bilateral deficit above the USD 20bn threshold.

The third criterion is FX interventions by a country's central bank. Treasury nets out interest income from reserve growth to estimate currency interventions, but it also includes interventions via FX derivative markets. In the absence of any disclosure by Taiwan of its derivative position, Treasury has so far measured Taiwan's FX intervention by looking at the growth of reported foreign assets on the CBC's balance sheet.

⁸⁶Setser, B, 2019, '[Make the Foreign Exchange Report Great Again](#)', Council on Foreign Relations

⁸⁷An important ongoing economic discussion is how accurately bilateral trade statistics reflect two countries' trade links. For instance, Taiwan's direct exports to the U.S. are quite small, but it delivers significant amounts of intermediate stage products to China, where final assembly frequently occurs. If China then exports the finished products to the U.S., it records the entire export as its own, even though meaningful amounts of the value added in its export content is attributable to Taiwan. Global input-output tables, while available less frequently, could help in determining the actual value added bilateral position of two economies. In such a valued added based framework, Taiwan's surplus with the U.S. is likely to exceed the directly measured values currently relied upon.

The blue line in the third panel shows Taiwan's rolling annual reserve growth as reported in Taiwan's Balance of Payments statistics. Three major intervention periods stand out, in the mid-1980s, early 2000s and after the financial crisis in 2009/10. Since late, the growth of Taiwan's reserves has hovered around the threshold of two percent of GDP, with a suspicious lack of volatility.

Utilizing the insights gained around the CBC's FX derivative interventions in prior chapters, it is possible to provide a more accurate picture of the CBC's total FX interventions. Starting in 2009, the time when lifers accelerated their overseas bond purchases, the pink line adds an estimate⁸⁸ of the CBC's derivative intervention to the blue regular FX reserve acquisitions. On this enhanced measure, Taiwan's FX intervention clearly exceeded the two percent threshold between 2014-2018. In addition, its interventions in the immediate post-crisis period in 2009 seem to have been even larger than commonly assumed.

During 2018, the enhanced measure came in below the official FX reserve figure as lifers, policy holders and depositors each assumed more FX risk themselves – though the latest available data again suggests that intervention has exceeded reported FX reserve growth.

Taiwan's central bank is likely to challenge this analysis. But it could settle the matter through complete disclosure of its historical derivatives position using the IMF's IRFCL standard – something the U.S. Treasury has long called for. Absent such disclosure, the Treasury should develop the analytical capabilities needed to independently estimate Taiwan's actual action in the market.

C. Financial stability risks from excessive private sector FX exposures

Traditionally, households and financial institutions that provide vehicles to safely invest for retirement are cautious about assuming meaningful amounts of FX risk. FX risk is, after all, much harder to control than regular fixed income exposures. Yet if risks associated with outright currency exposures never materialize to any larger degree, even cautious actors may start to take large FX risks.

Intentionally or unintentionally, the CBC's actions have inspired outright private sector FX risk taking and the partial dollarization of such institutions' balance sheets, especially in recent years. With U.S. interest rates above Taiwanese interest rates, in the absence of currency volatility, or more precisely the risk of TWD appreciation against USD,

⁸⁸This estimate combines the direct and indirect approach to figuring out the CBC's FX derivative exposures. The detailed examination in chapter V. is the best evidence that the CBC is intervening and its size, as well as the uncertainty in that estimate. Since it is however also known that the CBC acts as counterparty to lifers, the specific time-wise allocation of CBC interventions is better approached indirectly, taking lifers overall FX hedges and subtracting known (or estimated) exposures by the institutions discussed in chapter IV. The estimate depicted takes its ultimate size in mid-2019 from chapter V., while the allocation per quarter follows the indirect method.

Taiwanese actors should logically increase their allocations to USD-denominated assets.

This is exactly what appears to have happened through at least three channels:

- Taiwanese corporations and households shifted their cash holdings into (mostly domestically-held) USD deposits.
- Taiwanese households acquired USD-denominated policies, directly taking currency risk.
- Taiwan's lifers themselves assuming larger open net FX positions.

Fig. 48 quantifies the degree of FX risk taking by each of these.

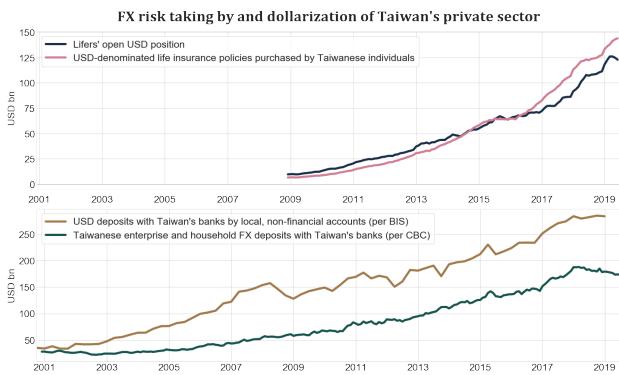


Fig. 48. FX risk taking by Taiwan's private sector, Source: CBC, BIS, own calculations

USD deposits held with Taiwan's banking system grew, depending on the source, by USD 150bn or USD 106bn. FX risks taken by households via FX denominated life insurance policies grew from practically zero in 2008 to USD 140bn. The life insurers' own open FX position increased to USD 120bn as of mid-2019. Altogether, these actors currently house FX risk of almost USD 500bn, 80% of which was accumulated this cycle. These actors, even more than the CBC directly, kept TWD from appreciating against USD.

How such large FX risk taking by typically conservative institutions in a clearly undervalued currency will evolve going forward is obviously of great interest from a financial stability perspective.

The macro implications seem twofold:

- Had the CBC not intervened by at least USD 130bn⁸⁹ in FX markets via its swap book, TWD would likely have appreciated and safety-oriented private sector actors in

⁸⁹USD 130bn is the mid-point of the modeling efforts in the prior chapter and the confidence intervals around it were discussed as well. One simple, indirect way to further evaluate where the actual exposures likely lie within the confidence band is to subtract all known FX derivative exposures established in chapter IV. from lifers USD 250bn FX hedging demands calculated in chapter II. In mid-2018, Taiwanese banks provided USD 65bn of hedges, while the foreign sector and non-financial Taiwanese firms provided (in a very generous reading of the data) ~USD 15bn each. This leaves USD 145bn to be allocated to remaining counterparties (i.e. the CBC) and is USD 20bn higher than the mid-point estimate.

Taiwan would have been much less likely to assume long USD positions. Pondering counterfactuals might not always be helpful, yet in a world in which the CBC had not intervened sizeably, a USD/TWD exchange rate in the mid 20s would not surprise.

- In the event of meaningful FX losses, cutting USD positions by purchasing TWD is probable⁹⁰. Then, the one-way street into USD would reverse and push TWD upwards, reflexively inflicting further losses on others while seriously hampering the ability of banks to provide the current quantity of hedges to life insurance companies⁹¹. Unless the CBC steps in meaningfully at such a point, a swift revaluation of TWD would be likely.

Given that Taiwan still maintains a large trade surplus⁹², the CBC appears to have itself boxed in and has, at least implicitly, written a put on USD/TWD, keeping TWD weak to shield its private sector from FX losses. For most actors, this put is merely implicit: "TWD has not appreciated in the past so why should it in the future; let's buy USD".

For life insurance companies themselves, this put might actually be rather explicit. In a relatively closed system as Taiwan, the major actors on the demand and supply side typically know each other fairly well. This is especially the case for lifers owned by a financial holding company also operating a banking subsidiary. This would apply to three of Taiwan's four largest insurers: Cathay, Fubon and Shin Kong. While conjecture for now, this is exactly the framework the Bank of Korea⁹³ used to provide FX hedges under in a

⁹⁰For lifers' open FX position and USD deposit holders, such a shift in FX exposures is straightforward. In contrast, 'redenomination' of USD-denominated policies into local currency would typically be expected to be more cumbersome. In Taiwan, where insurance policies are frequently marketed as shorter-term wealth management products (anecdotally, only ~50% of policy purchases are affected due to the provided safety features), minimum surrender periods and surrender charges are however insignificant, enabling policy holders to quickly alter FX exposures should they wish.

⁹¹Taiwanese banks used most of the increase in domestic USD deposits from 2016-2018 (see Fig. 47) to provide FX hedges to lifers. This is visible on the asset side of their balance sheet, where USD assets did not see a commensurate rise. Instead, TWD assets increased, while their net FX position, per CBC data, remained unchanged. As shown in Fig. 24, this implies an increasing long USD position via derivatives, i.e. the counterposition to lifers' FX hedges. Should households and corporates pull USD deposits and convert into TWD, banks would have to close FX hedges written to lifers to stay FX neutral, unless they can source USD funds elsewhere. Given the sizes involved, this appears unlikely and, if done in wholesale markets or via USD bonds issuance, unprofitable.

⁹²Even despite unfavorable pricing trends in semiconductor industries in 2018 and 2019.

⁹³See Sangdai Ryoo & Taeyong Kwon & Hyejin Lee, 2013 '[Foreign exchange market developments and intervention in Korea](#)', Bank for International Settlements. From page six: "As to the intervention tools used, direct interventions in both the spot and swap markets have been employed. Which instrument the authorities choose depends upon the objective of the intervention. [...] The Korean FX authorities do not publicly disclose any information related to intervention, because we believe that such information could stimulate speculative trading in the FX market. We thus intervene in the market through agents selected from among major banks. The Bank of Korea imposes a confidentiality requirement on these agent banks to maintain secrecy concerning intervention. As for the criteria used to select the agent banks, priority is given to institutions with the following characteristics: no danger of default risk, ability to provide the Bank of Korea with instant market information, and active role in the market."

similar situation.

If lifers know the CBC is the ultimate counterparty to the majority of their current FX hedges and know that it will likely continue to be so in the future, it is much easier to run larger open FX positions. In case of difficulties, the CBC would, after all, be ready and provide additional FX hedges at reasonable rates. Switching perspectives, if the CBC knows lifers are unlikely to unwind open FX positions at the first sign of trouble, Taiwan's authorities can be much more lenient in their regulation of FX exposures. Currently, this is most relevant for the regulation of FX exposures lifers acquire via domestically-listed bond ETFs acquiring foreign bonds FX-unhedged.

Any attempt to scale these risks suggests they are big: Lifers in aggregate currently hold ~65% of assets in foreign bonds, of which 22% is FX unhedged. This implies long USD exposures worth USD 123bn, or 14.3% of assets. Against that, lifers hold capital of USD 50bn, or 5.5% of assets. In a static environment without hedge adjustments, a 10% increase in TWD/USD thus inflicts losses of USD 12.3bn, or 22% of stated capital, on lifers. Larger moves are of course possible.

D. Effects of providing FX hedging services to life insurers

A final effect of the CBC's FX interventions via FX swaps concerns the pricing of TWD cross-currency basis markets. In a textbook setting, forward FX markets⁹⁴ would be only set by USD-TWD interest rate differentials, giving rise to the academically revered no-arbitrage condition. In such a state, the excess return a Taiwanese insurer would earn over TWD risk-free rates by investments abroad would only be affected by its return on duration and credit risk taken in USD markets.

In the post-crisis environment, however, deviations of the cross-currency basis from zero are not uncommon, even in developed markets. For countries with large historical cumulative Current Account surpluses and subsequent large positive Net International Investment positions, the X-CCY basis is usually negative, increasing the cost for locals acquiring foreign assets in an FX-hedged manner. In Taiwan, both the onshore and offshore X-CCY basis were deeply below zero – persistently for the former and on average even more so for the latter, but also more volatile⁹⁵ – for virtually their entire history.

As it looks likely that the CBC is the prime supplier of FX hedges to domestic life insurers, the CBC is effectively the lead price setter of TWD X-CCY basis markets, thus indirectly affecting the economics Taiwan's life insurers face when considering whether to acquire FX-hedged USD-denominated debt.

⁹⁴A broad definition of the 'forward market' is assumed here, i.e. including FX swaps and CCS. These are, as outlined in chapter III, just regular FX forwards paired with spot transactions and entered with a common counterparty.

⁹⁵The higher volatility of the offshore basis is mostly attributable to the lower liquidity of NDF markets and the higher share of speculative foreign actors present than in onshore FX markets, which require prior confirmation by Taiwan's authorities.

One way to understand how the CBC is shaping the pricing in FX hedging markets is to closely look at insurers' disclosed hedging costs. Cathay, Fubon and Shin Kong, all of which disclose their annualized FX hedging costs as a share of total foreign assets, are shown in Fig. 49.

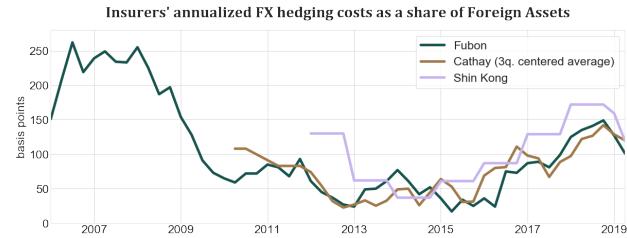


Fig. 49. Insurers' annualized FX hedging costs, Source: insurers' disclosures

In order to infer the actual pricing of the hedges, these values have to be adjusted for foreign assets not hedged in derivative markets by insurers, i.e. their open USD position and FX policies sold⁹⁶. Results are shown in the upper panel of Fig. 50, with average quarterly FX hedging costs at the 3m tenor for USD/TWD as quoted in markets shown in the bottom panel.

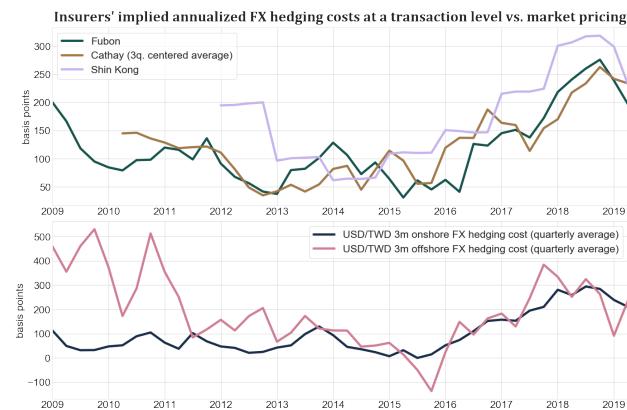


Fig. 50. Insurers' annualized FX hedging costs and market pricing, Source: insurers' disclosures, own calculations

The lifers' hedging costs are fairly obviously⁹⁷ in line with quotes from markets. The Federal Reserve's interest rate increases since 2015 are clearly visible as they changed the interest rate differentials and thus increased FX hedging costs. Some insurers, in this sample Shin Kong most notably, rely more on the offshore market and thus their hedging costs are linked to the more volatile offshore X-CCY basis.

A hasty look might suggest not much can be learned from the developments shown in Fig. 50. Insurers simply pay market rates on their hedges. But the definition of a market price in

⁹⁶In practice, this means dividing the stated annualized FX hedging costs for foreign assets by the 'share of foreign assets hedged via FX derivatives'. Information on the latter will be taken from Fig. 12 in chapter II., which will be uniformly applied to all three insurers.

⁹⁷They are lagging the actual quotes slightly since the market prices are for future instead of past hedges, as well as occasional use of longer tenors by insurers.

this context is not as straight-forward as it may appear. If the CBC always provides lifers FX hedges at market rates and such transactions constitute the dominant trade in a market, the market price is not created by the intersection of the entire demand and supply curves, but just the portion which does not have any CBC involvement.

Hypothetically, assume a case in which current demand for FX hedges is USD 100bn (of which lifers represent USD 80bn), while the supply side is also USD 100bn, of which the CBC provides USD 80bn. If the CBC-lifer transaction (intermediated by banks) is done at, say, yesterday's market price, today's price is the clearing price of the USD 20bn transactions done without central bank involvement. In this setting, the pricing pressure exerted by the net USD 80bn private sector imbalance towards acquiring FX hedges is entirely neutralized by the central bank offering trades at 'market rates'. If the USD 80bn provided by the central bank were removed, the market would still clear – but at a different price, and likely at a different volume level.

TWD X-CCY basis markets have traded deeply in negative territory almost the entire time since the early 2000s, imposing on average an extra cost of 100 and 200bps on insures hedging FX risk at the 3m tenor in onshore and offshore markets respectively. This has been among the reasons why insurers seek to either sell more USD-denominated policies or assume FX risk themselves. If the CBC did not backstop the TWD-XCCY basis markets by providing FX hedges at 'market rates', the cost of hedges for lifers would likely be much higher. In such a world, it is likely that lifers' business model of channeling domestic savings into overseas fixed income markets, a large portion on an FX-hedged basis, would be untenable.

Just as there are cases where it can make sense for a central bank to intervene, at times, in the spot market, it can also make sense for a central bank to provide cheap FX hedging services to domestic institutions, especially in cases where the central bank has large FX reserves and can do so easily. What seems special in this case is the CBC's lack of transparency.

A final hypothetical consideration is at what levels X-CCY basis markets would clear if the CBC retreated from its FX swap provision to lifers. Following the thinking in chapter IV., the foreign sector and domestic financial institutions would be expected to step up their provisions of FX hedges. The latter would likely require much deeper basis values to substantially step up arbitrage activities, simply because pure arbitrage is inefficient from a balance sheet perspective. So, as in other markets, foreigners would have to fill the gap. But Taiwan's current regulations on foreigners' activity in Taiwanese fixed income and money markets makes this virtually impossible today.

Per FSC regulations, "The total amount invested by an offshore overseas Chinese or foreign national in government bonds, corporate bonds, financial bonds, money market instruments,

*and money market funds [...] must not exceed 30 percent of the net inward remittance"*⁹⁸. Since foreign arbitrageurs necessarily need to secure safe TWD collateral to carry as an offset to the long USD position in the forward FX market, such regulation effectively makes arbitrage activities, as done in Europe or Japan, impossible. Given Taiwan institutions' large requirements for FX hedges, relaxing regulations on foreigners in this area might be worth considering.

E. Conclusion

Taiwan's central bank has been a much larger player in the foreign exchange market – and in the domestic market for providing foreign exchange swaps to Taiwan's lifers – than is apparent from looking at the modest growth in Taiwan's headline reserves. Its actions have likely been a key reason why Taiwan's dollar has remained so weak, and why Taiwan's household and financial sector have taken on so much currency risk. Taiwan, rather uniquely, has dug itself into a financial hole not by borrowing too much in foreign currency, but by investing too much of its national savings abroad – and thus leaving its population exposed to financial losses when its currency inevitably appreciates. Taiwan needs to address these financial vulnerabilities before they become even bigger, and take the needed steps to develop a new economic and financial model, one that does not balance through the accumulation of ever larger foreign exchange positions among Taiwan's households and at its central bank. Meeting international disclosure standards for its reserves is a first step in this necessary, though difficult, transformation.

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⁹⁸From the FSC's '[A Brief History of Liberalization on Foreign Portfolio Investment](#)'.