What's the Bottom Line?
Central Bank Profits and Monetary Policy

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Abstract

This study empirically examines the sources of profits for central banks and the relationship between monetary policy and central banks' profits. Case studies on the U.S. Federal Reserve, the Swiss National Bank, and the Reserve Bank of Australia demonstrate that policy rates and foreign exchange rates are crucial for central bank profits. We generalize this result for other central banks using balance sheets and income statements for 116 central banks between 1996 and 2024. Furthermore, this study reveals that central banks distort monetary policy to avoid realizing potential losses. We provide evidence that central banks worldwide put depreciation pressure on their local currency and undershoot their interest rate targets due to profit concerns.

JEL Classifications: E58, E52, O24, E43
Keywords: monetary policy, central banks, interest rate, foreign exchange rate, central bank balance sheet.

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Although in principle, balance-sheet considerations should not seriously constrain central bank policies, in practice, they do. - *Ben S. Bernanke*

(Remarks made before the Japan Society of Monetary Economics, 2003)

1 Introduction

The monetary policy's objective is to stabilize inflation and unemployment rates at desired levels (e.g., Taylor, 1993, 1999). In standard monetary policy, central banks' profit concerns play no role. However, there is considerable evidence that central banks care about their profits. Goncharov et al. (2023) document that central banks are discontinuously more likely to report slightly positive profits than slightly negative profits. Jeanne and Svensson (2007) document that independent central banks are concerned about their balance sheet and the level of their capital. There can be several rationales for central banks to take their balance sheets and profits into consideration. Goncharov et al. (2023) show that central banks manage profits amid greater political pressure and when governors are reappointable. Moreover, central banks may wish to maintain their independence from the government. A negative profit might require a capital injection from the government and put the bank at the government's mercy. Also, if a central bank and financial institutions have similar asset positions under quantitative easing (QE), the central bank's financial health is aligned with the financial institutions' solvency. Given that central banks worldwide may have profit concerns, it naturally leads us to ask "What is the source of their profits?" Moreover, "Do profit concerns impact monetary policy?" We answer these two questions in this paper.

The first objective of this paper is to empirically demonstrate the sources of central bank profits. Contrary to general perception, seigniorage revenue does not contribute to a central bank's accounting profits because currency in circulation and bank reserves are liabilities for a central bank. Thus, increasing base money will increase its balance sheet size but not profits.

Although many factors can influence central bank profits, this study focuses on the two factors most central banks control — the foreign exchange rate and the policy rate. We start by examining three case studies. The first case of the Swiss National Bank (SNB) exemplifies the central banks with large amounts of foreign reserves and the importance of the foreign exchange rate to central banks' profits. Since a central bank holding foreign reserves must still prepare its financial statements in local currencies, this case demonstrates that the depreciation of local currency leads to a re-evaluation gain on its reserves. The larger the reserves, the greater the gain. Our second case study on the Federal Reserve of the United States (the Fed) is at the other end of the spectrum, as it has almost no foreign reserves. We demonstrate how the policy rate plays a crucial role in determining the Fed's profits. Policy rates can affect profits differently depending on asset structure. In the case of the Fed, we find opposite effects before and after the start of the QE in 2008. High interest rates increase the Fed's profit before the QE while it decreases it after the QE. Finally, another important aspect of central bank profits is how they realize capital losses on long-term domestic assets. A central bank can realize losses only when securities are sold; this is the case for the Fed. It can also use mark-to-market valuation on its long-term domestic assets. This is the case for our final case study — the Reserve Bank of Australia (RBA). This case demonstrates how mark-to-market valuation can further impact the relationship between policy rates and central bank profits. In particular, we see that hiking interest rates reduce profits through capital loss on long-term assets.

We further generalize our results on the sources of profits by constructing panel data of balance sheets and income statements for 116 central banks from 1996-2024. First, we confirm that foreign exchange rates significantly affect central bank profits worldwide. In particular, local currency depreciation leads to profit through re-evaluation gain on foreign reserves. Our data covers 1,672 bank-year observations. The net foreign asset to total asset ratio for the median observation is 68%. Given that central banks generally hold large amounts of foreign reserves, a slight fluctuation in the exchange rate significantly impacts the reported profit. We also confirm that a change in the policy rate affects profits but in different magnitudes, depending on the asset structure of the central bank. In general, high interest rates are correlated with lower profits. For central banks with long-duration assets, high interest rates further increase losses.

The second objective of this paper is to provide evidence that profit concerns affect monetary policies. We demonstrate that profit concerns directly impact how central banks intervene in the foreign exchange market and set policy rates.

First, we show that profit concerns directly impact central banks' foreign exchange policies by focusing on the central banks with relatively large proportions of foreign reserves. Note that the more foreign reserves a central bank has, its profits become sensitive to the foreign exchange rate movement. We find asymmetric currency intervention behavior depending on reported profits. When central banks report positive profits, they are equally likely to increase or decrease foreign reserves in the same year. In contrast, when they report losses, we rarely observe a decrease in foreign reserves, which would have increased losses through the local currency's appreciation. This indicates that central banks' profit concerns constrain their policy actions. Our results provide evidence that profit concerns do affect central banks' monetary policies; that is, the central banks whose profits are sensitive to exchange rates don't intervene to appreciate local currency amid losses.

We further strengthen the results by considering the accounting rules that central banks use. In our dataset, which consists of 116 central banks, we observe that around half of them use local accounting principles, while the other half use the International Financial Reporting Standards (IFRS). In general, central banks using IFRS enjoy less accounting discretion, and more importantly, it's harder for them to hide losses. Note that, unlike private firms, central banks do not treat accounting rules as exogenously given but as something they can choose. As a result, it's reasonable to conjecture that central banks choosing to apply IFRS have fewer profit concerns than their non-IFRS counterpart. Our results provide evidence for this conjecture. We find that central banks using IFRS are less likely to manage profit than central banks using local accounting principles. Moreover, we provide evidence that profit concerns from central banks using local accounting principles *and* having large foreign reserves indeed have an important effect on their foreign exchange policies. Central banks using local accounting principles and having large foreign reserves are highly unlikely to make interventions that cause the local currency to appreciate (and lead to further losses) when reporting a loss. Meanwhile, they are equally likely to intervene to appreciate or depreciate the local currency when earning a positive profit. To conclude, choosing to apply local accounting rules is an indication of profit concerns, and we show that such concerns do have an effect on foreign exchange policy.

Our results indicate that central bank profit concerns indeed impact foreign exchange policies. To provide more intuition regarding the data we see, we set up a simple simulation to explain the rationale behind the intervention asymmetry around profit zero. The simulation results match the data and explain how central banks with profit concerns and imperfect controls over their profit can generate the data we obtained. Moreover, as an additional piece of supportive evidence, we build a simple model and estimate it using our central bank panel. The results show that the more foreign reserves a central bank has (which causes depreciation to be more profitable), the more likely it will intervene to depreciate its local currency (or to offset an appreciation shock). The results are displayed in the Appendix.

Moreover, this paper shows that interventions in the foreign exchange market to increase profit are particularly likely right before central banks release their financial statements, pointing to a causal effect of profit concerns on intervention. Each central bank could potentially have a different fiscal year-end. We found that central banks are more likely to intervene in the foreign exchange market and increase their profit in the last fiscal month.

Finally, apart from foreign exchange interventions, we also focus on the impact of profit concerns on the domestic policy rate. We measure each central bank's target interest rate using the Taylor rule (Taylor (1993)) and two other alternative rules commonly used in the literature[1]. We then measure the distance between the actual interest rate and these targets. We found that the gap widened towards the fiscal year's end. In particular, we show that central banks undershoot their interest rate target towards the end of their fiscal year. This, again, points to a causal effect of profit concerns on central bank policies.

Our empirical findings have important policy implications. we show that central banks' profit concerns could become a constraint on their monetary policy. This constraint could prevent the central bank from taking the optimal policy action to fight inflation and stabilize the economy. Many theoretical models also point out this fact. For example, Sims (2005) shows that the central bank's concern about its net worth can lead to self-fulfilling hyperinflationary equilibria. Berriel and Bhattarai (2009) show that profit concerns lead to larger output gap variance, while Negro and Sims (2015) and Benigno and Nisticò (2020) demonstrate that profit concerns lead to higher inflation. On the other hand, however, there may also be some favorable aspects of profit concerns. Wang (2023) show that when the nominal interest rate is at the zero lower bound, the central bank's profit concern may provide a solution to escape a liquidity trap. To conclude, the policy implications of central bank profit concerns could be very different and depend on the economic situation.

The rest of the paper is organized as follows. Section 2 provides the review of the literature. Section 3 discuss the data source. Section 4 provides results on how the foreign exchange rate and the policy rate affect central banks' profit. In section 5 we provide evidence that profit concerns affect how central banks conduct their foreign exchange policies. We then demonstrate how profit concerns affect central banks' decisions on the policy rate in section 6. Section 7 concludes.

[1] Balanced-approach rule proposed by Taylor (1993) and Inertial rule provided by the Fed website:https://www.federalreserve.gov/monetarypolicy/policy-rules-and-how-policymakers-use-them.htm

2 Literature Review

Our paper is closely related to the literature that studies central bank asymmetric foreign reserve intervention. The seminal study by Calvo and Reinhart (2002) points out that many emerging countries have a "fear of floating" between the 1970s and 1990s. Depreciation trigger fears of financial distress and/or inflation pass through. As a result, countries intervene aggressively when facing depreciation pressure but not appreciation pressure. Benlialper and Cömert (2016) also demonstrate this asymmetric fear of depreciation. However, much recent research shows that emerging countries have "fear of appreciation" and asymmetrically intervene with the foreign exchange market (e.g., Pontines and Rajan, 2011; Pontines and Siregar, 2012; Levy-Yeyati et al., 2013; Chen, 2016; Keefe and Shadmani, 2018). In particular, central banks tend to intervene in the currency market when facing appreciation pressure but not depreciation pressure to insure against a potential currency crisis or to stimulate trade and growth. Our study provides an alternative explanation for the intervention to prevent currency appreciation.

Our study also adds to a growing literature that focuses on the relationship between monetary policy and the central bank's profit and balance sheet concerns. Negro and Sims (2015) and Benigno and Nisticò (2020) theoretically demonstrate that central banks' profit concern leads to higher inflation, while Berriel and Bhattarai (2009) show that the profit concern lead to higher output gap variance. Empirically, Goncharov et al. (2023) and Klüh and Stella (2008) document the correlation between profit concern and high inflation/low interest rate, but the results are inconclusive. For example, a central bank's weak financial condition can lead to a higher inflation rate only in developing countries (Adler et al., 2016) or only when fiscal support from the government is absent (Pinter, 2018). Benecká et al. (2012) find no such correlation. Our study contributes to this debate by demonstrating that not all central banks are the same; some central banks have a negative relation between profit and interest rates while others have a positive relationship. We also note that a profit-concerned central bank is not necessarily motivated to generate higher inflation rates because its profit does not depend on seigniorage revenue (an increase in base money).

Finally, this research is related to the vast accounting literature on real earnings management. Companies often alter reported earnings by manipulating actual business activities rather than through accounting practices. This type of earnings management is intended to meet certain financial targets or expectations, often to influence perceptions of the company's performance by investors, analysts, or other stakeholders (see Thomas et al. (2022), Caskey and Ozel (2017), Roychowdhury (2006), Graham et al. (2005), and Erickson et al. (2004), for example). This research contributes to this literature by demonstrating that central banks worldwide are no exceptions and they also exhibit a pattern of real earnings management. In particular, they would use monetary policies to avoid reporting losses.

3 Data

Our analysis focuses on national central banks that have the potential to alter their monetary policies due to profit concerns. As a result, central banks that belong to a currency union (e.g., The Banque de France) are excluded from this paper. We also exclude data on supranational central banks (e.g. European Central Bank) and local central bank branches for the same reasons. This yields a panel of 116 central banks from 1996 to 2024. Tabel (1) provides an overview of the central banks covered by this research.

Within our panel, 95 countries have income statement data available. These data are from S&P Capital IQ Pro and of annual frequency. Not all countries have data in all years. On average, each of the 95 countries has 16.3 years of income statement data availabel.

One main focus of this research is how central bank profit concerns impact monetary policies. In particular, how profit concerns influence foreign exchange intervention (FXI). The FXI measurements are based on Adler et al. (2024). The traditional FXI is typically proxied by using the change in the stock of the central bank's foreign reserves, measured in USD. Adler et al. (2024) improves upon traditional proxies in several dimensions. First,

Table 1. Sample composition by country

Country	IC	FX	PG	LFM	Country	IC	FX	PG	LFM
Afghanistan	11	147	0	3/12*	Lithuania	0	180	182	12
Albania	12	289	0	12	Macao	13	237	0	12
Algeria	0	285	0	3	Madagascar	0	288	0	12
Angola	18	289	0	12	Malaysia	19	289	93	12
Argentina	25	289	0	12	Malta	0	93	96	12
Armenia	12	289	18	12	Mauritius	7	278	166	6
Australia	12	289	0	6	Mexico	11	289	0	12
Azerbaijan	12	289	0	12	Moldova	13	289	0	12
Bahamas	18	287	0	12	Mongolia	16	275	0	12
Bahrain	24	287	0	12	Morocco	13	275	0	12
Bangladesh	20	281	0	6	Mozambique	13	288	0	12
Belarus	12	289	0	12	Myanmar	8	244	0	9/3*
Bolivia	13	283	0	12	Namibia	13	289	0	12
Bosnia and Herzegovina	24	265	0	12	Nepal	13	288	0	7
Botswana	23	287	0	12	New Zealand	27	289	0	6
Brazil	20	289	118	12	Nicaragua	16	289	0	12
Brunei Darussalam	0	263	0	12	Nigeria	12	283	0	12
Bulgaria	22	289	279	12	North Macedonia	13	276	0	12
Cambodia	0	283	0	12	Norway	27	289	326	12
Canada	27	289	315	12	Oman	12	289	0	12
Chile	26	289	216	12	Pakistan	13	286	0	6
China	0	289	22	12	Panama	0	289	0	12
Colombia	13	289	240	12	Papua New Guinea	22	281	0	12
Costa Rica	10	289	138	12	Paraguay	13	289	0	12
Croatia	10	276	0	12	Peru	23	288	213	12
Cyprus	0	96	72	12	Philippines	16	289	16	12
Czech Republic	13	289	327	12	Poland	18	289	301	12
Democratic Republic of the Congo	0	272	0	12	Qatar	0	289	0	12
Denmark	18	289	326	12	Romania	18	286	242	12
Dominican Republic	18	288	0	12	Russian Federation	24	289	147	12
Ecuador	13	289	18	12	Rwanda	13	289	0	6/12*
Egypt	18	288	0	6	Saudi Arabia	12	228	0	6
El Salvador	15	288	0	12	Serbia	12	216	0	12
Estonia	0	132	0	12	Singapore	23	288	0	3
Ethiopia	0	257	0	6	Slovak Republic	0	108	104	12
Georgia	13	289	0	12	Slovenia	0	84	63	12
Ghana	14	289	0	12	South Africa	24	289	0	3
Greece	1	12	33	12	Sri Lanka	22	276	0	12
Guatemala	10	289	0	12	Sudan	11	216	0	12
Guinea	0	256	0	12	Sweden	28	289	326	12
Guyana	12	288	0	12	Switzerland	28	289	156	12
Honduras	16	289	0	12	Taiwan	13	289	0	12
Hong Kong	13	289	315	12	Tanzania	18	182	0	6
Hungary	24	288	327	12	Thailand	24	288	245	12
Iceland	13	289	243	12	Trinidad and Tobago	15	289	0	9
India	14	289	0	3/6*	Tunisia	21	289	0	12
Indonesia	23	289	0	12	Turkiye	13	289	217	12
Iraq	13	278	0	12	Uganda	13	232	0	6
Israel	24	289	9	12	Ukraine	13	289	0	12
Jamaica	19	288	0	12	United Arab Emirates	14	289	0	12
Jordan	12	289	0	12	Uruguay	22	289	160	12
Kazakhstan	23	289	0	12	Uzbekistan	0	134	48	12
Kenya	24	289	0	6	Venezuela	19	221	0	12
Korea	19	289	287	12	Vietnam	0	275	0	12
Kuwait	13	289	0	3	West Bank and Gaza	9	216	0	12
Latvia	0	168	189	12	Yemen	5	253	0	12
Lebanon	0	276	0	12	Zambia	22	275	0	12
Libya	0	289	0	12	Zimbabwe	4	276	0	12

"IC" is the number of annual income statement data available for each central bank. "FX" is the number of monthly foreign exchange intervention observations obtained for each central bank. "PG" is the number of monthly policy gap observations obtained for each central bank. "LFM" indicates the last fiscal month for each central bank, with * representing the central bank that changed its last fiscal month during the sample period.

it accounts for both spot and derivative transactions. Moreover, it adjusts for the foreign reserves' valuation changes and periodic dividend payments. These are not FXI since they do not entail buying or selling foreign currency but are often ignored by the traditional proxies. Lastly, the new FXI measurement also adjusts reserve changes for a broader range of operations with residents and non-residents. Consider a central bank that borrows from the IMF or accepts foreign currency deposits from commercial banks. These operations increase foreign reserves for the central bank but are not interventions. The traditional FXI proxy ignores these aspects, while the new estimate fully adjusts for these and other similar operations. Finally, the FXI observations are of monthly frequency, and all the countries in our panel have data on FXI. On average, each central bank has 266 months (22.2 years) of data.

Another focus of this research is the policy gap. That is, the gap between the prevailing policy rate and the rate implied by the Taylor rule. To compute the Taylor rule we need data on unemployment and inflation. Unemployment and inflation rates data are of monthly frequencies and are collected from IMF's International Financial Statistics. Monthly policy rate data comes from Macrobond. The construction of the policy gap and the Taylor rules are discussed in Section 6. 36 countries have data on the policy rate gap, with an average of 183 months (15.2 years) of observation per country.

An important aspect of the dataset is the fiscal year end for each central bank. Different central banks would report their profit in different calendar months. This research documents the last fiscal month for all the 116 central banks included in the dataset. The information is obtained manually from each central bank's financial statements or website. 21 out of the 116 central bank's fiscal years do not end in December, with June being the most common alternative. Moreover, 4 central banks change their fiscal year during the sample period.

Other data used in this research included central bank balance sheets, exchange rates, foreign reserves, and central bank de jure independence. Balance sheet, foreign reserves, and exchange rates data are of monthly frequencies and are collected from IMF's International

Financial Statistics. Dincer and Eichengreen (2014) provides information on central bank de jure independence.

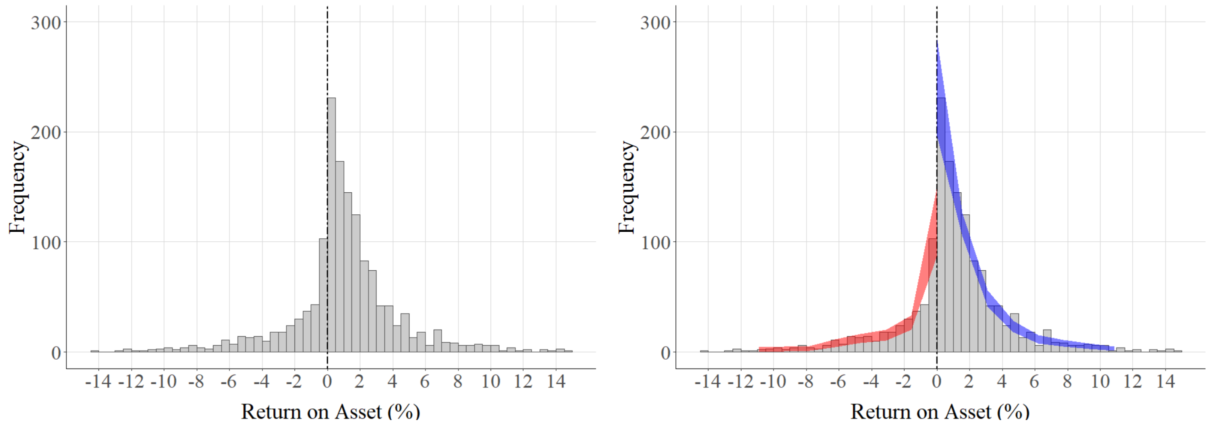
4 Sources of Central Bank Profits

This section investigates the sources of central bank profits. To analyze central banks of different sizes, we measure central bank profit using the return on assets (RoA): The ratio of periodic net income over the beginning-of-the-period total asset. First, we look at the central banks' profit distribution and demonstrate evidence of profit management. We then demonstrate that both the *domestic policy rates* and *foreign exchange rates* are essential factors for central banks' profit. We demonstrate this first by using case studies from the Swiss National Bank (SNB), the Federal Reserve of United States (Fed), and the Reserve Bank of Australia (RBA). We then use a rich cross-country panel to estimate how those key factors impact central bank profits. Our results show that CB profit positively correlates with local currency depreciation and negatively correlates with the domestic policy rates.

4.1 Central Bank Profit Distribution

Of the 116 central banks in this study, 95 have income statements available. There are 1,550 bank-year observations (around 16.3 years of data per central bank) on annual net income. To compare central banks of different sizes, we measure central bank profit using the return on assets (RoA): The ratio of periodic net income over the beginning-of-the-period total asset. Figure 1 shows the histogram of central bank profits. The left panel is the histogram of central banks' RoA, which demonstrates that central banks are discontinuously more likely to report a small positive profit than a small negative profit. The right panel is the same histogram with the local polynomial density estimator proposed in Cattaneo et al. (2020), where the shaded area represents a 95% confidence interval. The confidence intervals

Figure 1. The Distribution of Central Banks' Return on Assets



The left panel shows the histogram of central bank profits as measured by the return on assets (periodic net income over the beginning-of-the-period total asset). The right panel displays the same histogram with the local polynomial density estimator proposed in Cattaneo et al. (2020), where the shaded area represents a 95% confidence interval. *Data Sources:* S&P Capital IQ Pro.

do not overlap at RoA $= 0$, indicating that the jump at zero is statistically significant. Note that in a standard central banking model, profits are supposed to be entirely irrelevant. Any profit level, including zero, is not a fundamentally important number, and the central bank profit distribution should be smooth. Therefore, a discontinuity in the profit distribution at zero should be considered a sufficient condition for central bank profit concerns. The discontinuous behavior is a clear sign of profit management and is first discussed in Goncharov et al. (2023). The results here are consistent with their findings. In the next section, we explore the method used by central banks to achieve this "jump". Namely, we'll see evidence of how central banks use monetary policies to avoid reporting losses.

4.2 Case Studies

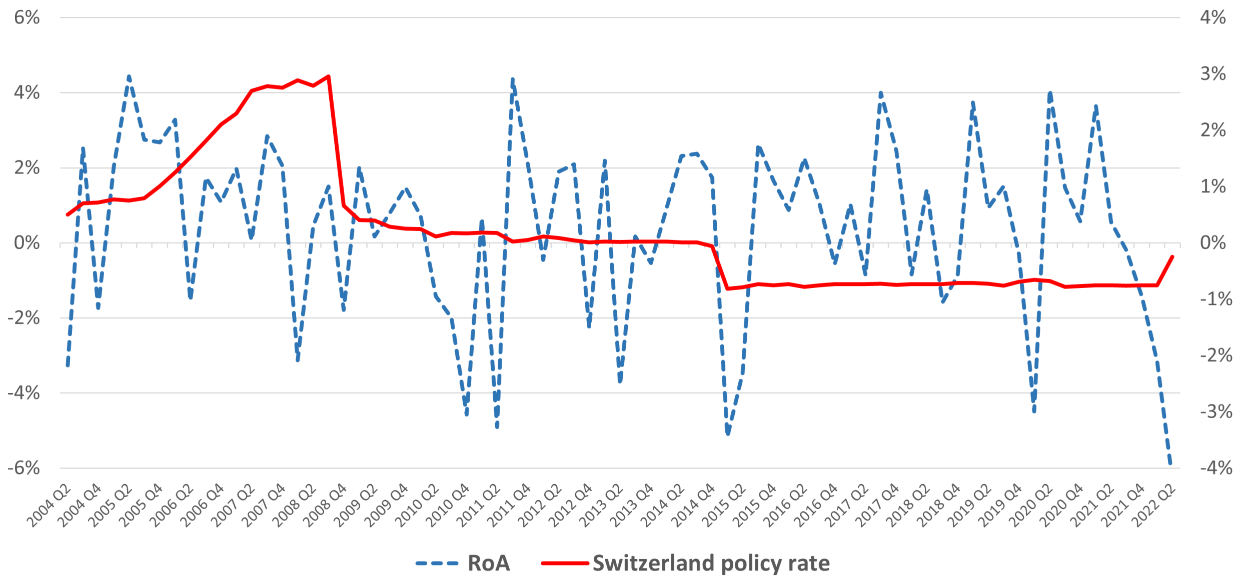
We start by showing the two case studies about the Swiss National Bank (SNB) and the Federal Reserve of the United States (Fed). These two central banks provide two extreme cases because the majority of SNB's assets are foreign reserves, whereas the Fed has almost no foreign reserves on its balance sheet. As a result, the SNB's profit is determined mainly by foreign exchange rates, whereas it has minimal effect on the Fed's profit. In contrast, the domestic interest rate is the key factor for the Fed's profit, while it has only a negligible effect on the SNB's profits. Most central banks can be considered a convex combination of these extreme cases, including our third case study on the Reserve Bank of Australia (RBA).

4.2.1 Swiss National Bank's Profits and Foreign Exchange Rates

The SNB's asset-to-GDP ratio was around 20% prior to 2008. Since then, SNB has significantly increased its assets, mostly in the form of foreign currency investments. As of 2022, its total asset-to-GDP ratio is approximately 140%. SNB's asset composition has been very stable since 2008, mainly composed of foreign currency investments (85% - 90%) and gold (5% - 10%). As of 2022, SNB's foreign currency investment is composed of foreign government bonds (64%), foreign corporate bonds (11%), and foreign corporate stocks (25%).

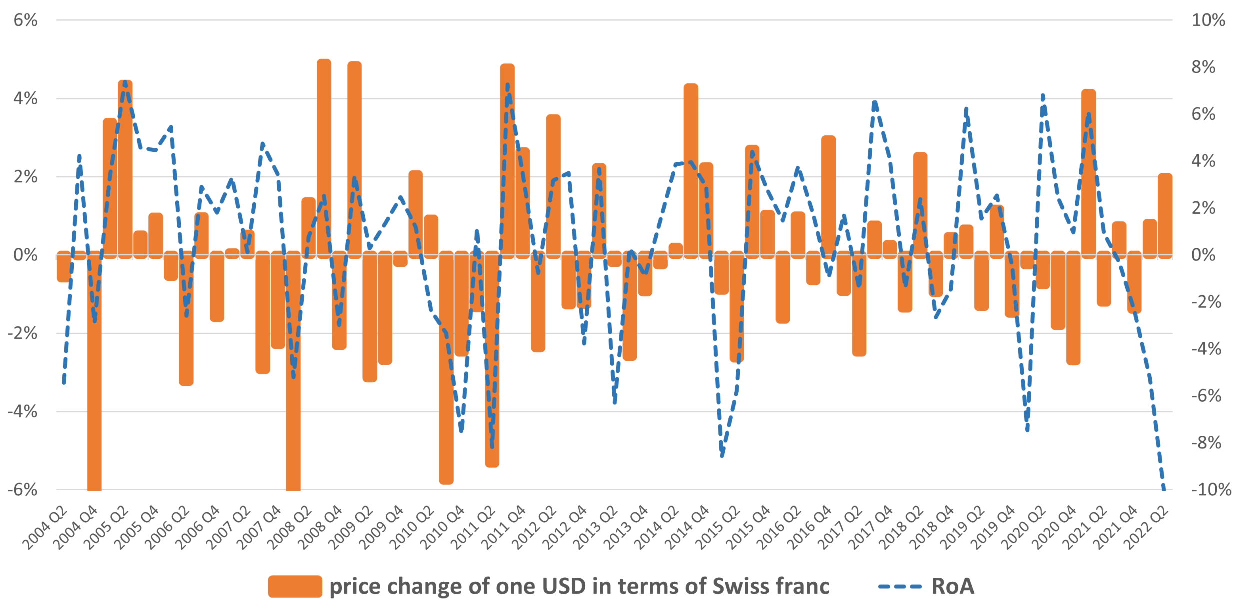
Figure 2 depicts the SNB's RoA and the policy rate between 2004Q2 and 2022Q2. SNB's profits are not highly correlated with its policy rate. The domestic interest rate does not play a significant role in determining SNB's profits because less than 5% of the SNB's assets are domestic during the sample period. Figure 3 depicts the SNB's RoA and local currency depreciation rata (against the USD). From Figure 3 we can see that SNB's RoA is positive when the Swiss franc depreciates against the USD, with only a few exceptions. This is due simply due to accounting rules and can be explained as follows: A central bank that holds foreign reserves must still prepare its financial statements in local currencies. Local currency depreciation would then lead to a re-evaluation gain on foreign reserves, and the larger the foreign reserves, the greater the gain. Since more than 95% of SNB's assets are denominated in foreign currency, the exchange rate is the main driving force for its profit. An exception is the SNB's losses in 2022 despite the depreciation of the Swiss franc. This is due to the significant price drop in foreign stock that SNB holds during 2022. Overall, the foreign exchange rate is the key driver of SNB's profits: Depreciation of local currency leads to profit due to asset reevaluation gain while appreciation lead to losses.

Figure 2. SNB: Profits and Policy Rate



This figure shows the Swiss National Bank's return on assets (dotted line, left axis) and the policy rate in percentage points (solid line, right axis) between 2004 Q2 and 2022 Q2. *Data Sources:* Swiss National Bank.

Figure 3. SNB: Profits and Foreign Exchange Rates



This figure shows the Swiss National Bank's return on assets (dotted line, left axis) and changes in foreign exchange rates (bars) between 2004 Q2 and 2022 Q2. The foreign exchange rate is expressed as a percentage change in the price of one USD in terms of Swiss franc. For example, +2% indicates that the value of one USD increased by 2% in terms of Swiss franc in a given quarter. Thus, a positive change represents the depreciation of the Swiss franc against the USD. *Data Sources:* Swiss National Bank.

4.2.2 The Federal Reserve's Profits and the Policy Rate

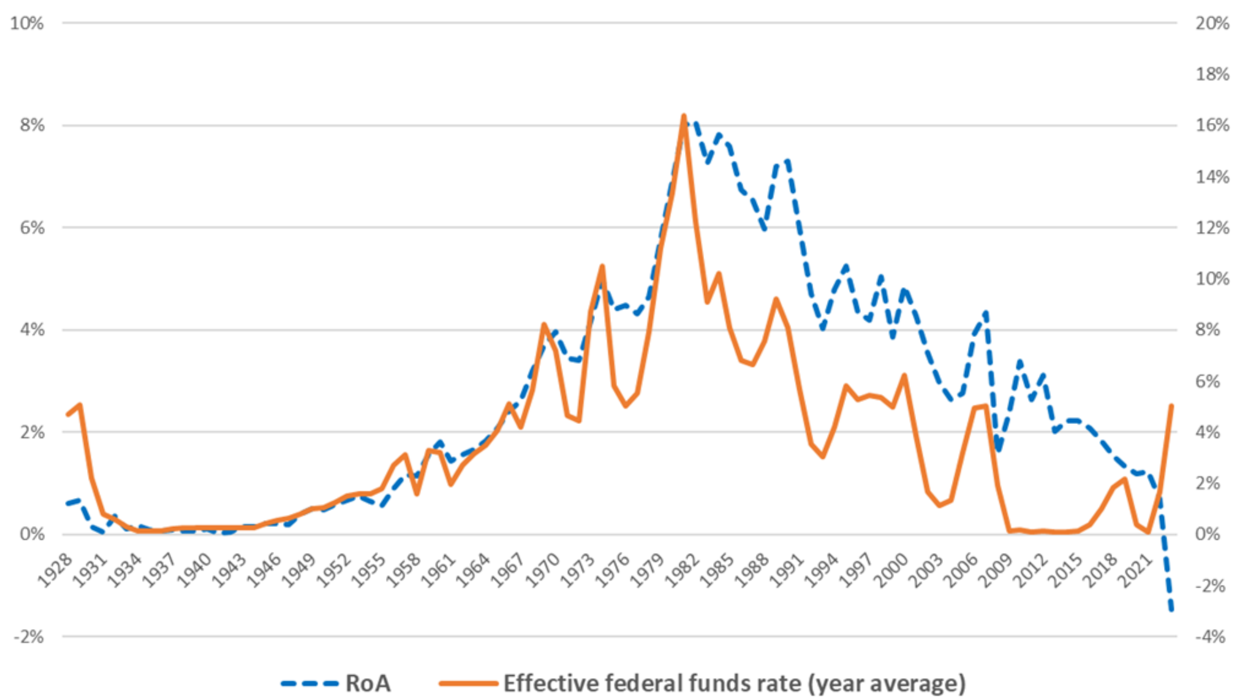
In sharp contrast to the SNB, for the past 30 years, the Fed has less than five percent of its total assets denominated in foreign currencies. Since most of its assets are domestic, the major driving force of profit for the Fed is its policy rate (Federal fund's rate). Figure 4 displays the relationship between the Fed's profit and its policy rate from 1928 to 2023. As we can see, before 2008, the Fed's profit was positively correlated with its policy rate. The situation reversed, however, after 2008. To understand this change, we must look closer into the Fed's balance sheet.

We start with the Fed's liability. Before 2008, more than 90% of the Fed's liability consisted of currency in circulation. Since 2008, this figure has dropped significantly to around 35%. It is replaced by bank reserves (money that banks deposit in the Fed) and reverse repurchase agreements (reverse repo). Regarding assets, the most significant change is the increase in maturity. Before 2008, around 55% of its assets matured in less than one year and 80% less than five. These numbers dropped to around 15% and 40%, respectively, after 2008. These balance sheet changes have important implications for the Fed's profit.

Another relevant part of the Fed's profit is that the Fed does not realize capital losses until securities are sold, and the Fed tends always to hold assets to maturity. As a result, the two key components of the Fed's profit are interest income and interest expense. The Fed's interest expense is minimal before 2008 since most of its liability is the currency in circulation, which is not interest-bearing. After 2008, however, the Fed started paying interest on bank reserves, and the majority of the Fed's liability became interest-bearing (bank reserve and reverse repo). The increase in the Fed funds rate would now increase the Fed's interest expense. On the other hand, the Fed funds rate immediately impacted the Fed's interest income prior to 2008 since most of its assets are short-term domestic assets. As the asset maturity increased dramatically after 2008, the Fed funds rate now only has a delayed and less significant effect on interest income. This is because the Fed's assets mostly consist of long-term assets that yield a fixed return. The above changes in interest income and expenses lead to the fact that before 2008, Fed's profit is positively correlated with the short-term interest rate while they are negatively correlated after 2008. Figure 5 displays the quarterly income data for the Fed from 2014 Q1 to 2024 Q1. When the interest rate rises above zero from 2015-2020, and again after 2022, we see that the interest expense responded immediately. In contrast, the Fed funds rate only had a small and delayed effect on the interest income. This leads to the combined effect that raising interest rates decreases the Fed's profit after 2008.

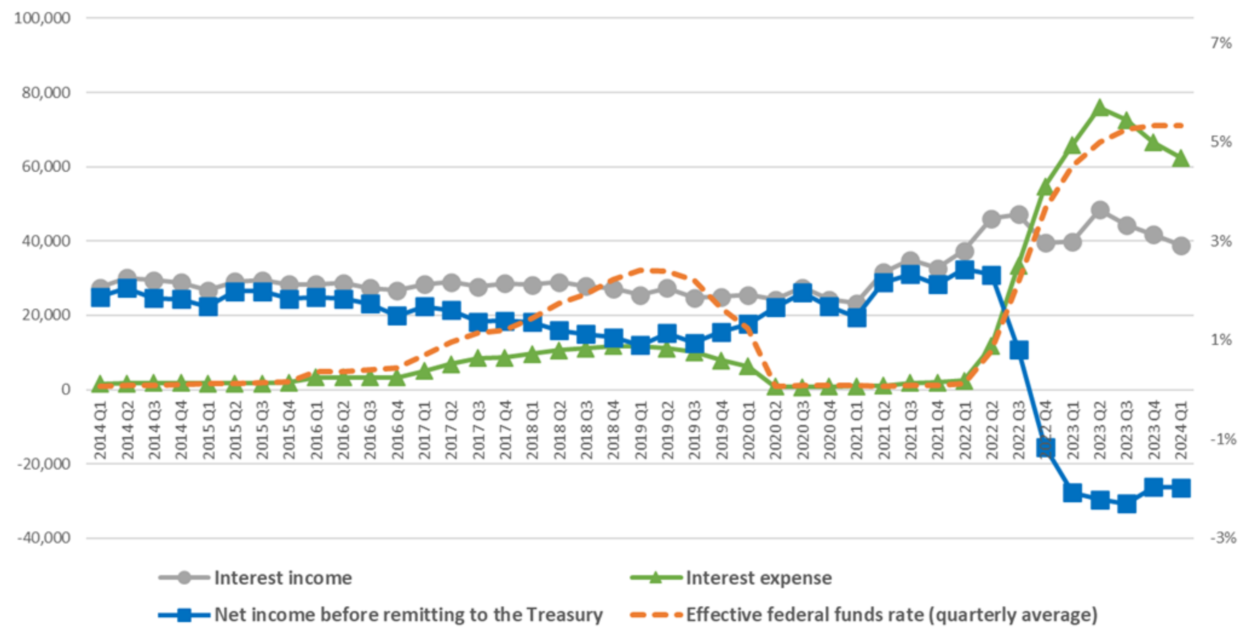
The US case study highlights the importance of the domestic short-term interest rate on the central bank's profit. Moreover, its relationship with the profit depends on the asset maturity and the quantity of interest-bearing liability. To conclude, prior to 2008, the Fed profited from high interest rates. In contrast, after 2008, hiking interest rate decrease their profit as shown in Figure 5.

Figure 4. Fed Return on Asset and the Federal Funds Rate



This figure shows the return on assets for the Fed (dotted line, left scale) and the annual average of the effective federal funds rate (solid line, right scale) from 1928 to 2023. *Data Sources:* Annual Reports of the Board of Governors of the Federal Reserve System.

Figure 5. Fed Income Components and the effective Fed funds rate



This figure shows the Fed's total interest income, total interest expense, and net income before remitting to the Treasury (millions USD, left scale). It also displays the quarterly average of the effective federal funds rate (right scale). The data range from 2014 Q1 to 2024 Q1. *Data Sources:* Federal Reserve Banks Combined Quarterly Financial Reports (Unaudited)

4.2.3 Reserve Bank of Australia's Profits and the Policy Rate

Our final case study, the Reserve Bank of Australia (RBA), can be viewed as a convex combination of the Fed and SNB. From 2003-2008, less than 30% of RBA's assets were domestic. The other 70% were gold and foreign reserves. The RBA was, therefore, similar to SNB in terms of asset structure, and exchange rate movement was the main driving force of its profit. After the 2008 financial crisis and the Covid crisis in 2020, RBA aggressively bought long-term domestic assets to stimulate the economy, resulting in around 90% of its assets being domestic as of 2022. This asset structure resembles the Fed's case, and like the Fed, the domestic policy rate is now the main driving force for the RBA. There is, however, one key distinction between the RBA and the Fed regarding how the capital gains and losses are realized. If the central bank realizes losses only until securities are sold, then the policy rates would have minimal effect on the central bank's asset value, provided it holds assets to maturity. This is the case for the Fed. At the same time, if the central bank uses fair value accounting, that is, if it uses mark-to-market valuation on its assets, then capital losses are generated as soon as interest rates increase. This is the case with RBA.

From July 2021 to May 2022, the RBA's policy rate was at 0.1%. Starting in May 2022, RBA started hiking interest rates, and by the end of June 2022, the policy rate was at 0.85%. As a result, during the fiscal year 2022 (which spans from July 2021 to June 2022), RBA reported a capital loss of 46 billion Australian dollars on its domestic securities. This loss is equivalent to 7.5% of its total assets or 2% of its GDP. This episode of capital loss due to the hike in interest rates highlights another important channel on which policy rates can impact central banks' profit. The case for RBA shows that beyond interest income and expenses, interest rates can also impact profit by changing the value of the portfolio a central bank holds. In the next section, we will generalize our observations in the case studies to a rich panel of cross-country data.

4.3 Central Bank Panel

We examine the key factors driving central bank profits using annual panel data for 116 central banks between 1996 and 2024. We focus on the relationship between profits, policy rates, and changes in foreign exchange rates (against USD). We first estimate the following equation:

$$RoA_{i,t} = \beta_1 r_{i,t} + \beta_2 \tilde{e}_{i,t} + \nu_t + \alpha_i + \epsilon_{i,t}, \tag{1}$$

where $RoA_{i,t} = Profit_{i,t}/Asset_{i,t-1}$ denotes RoA for country i in year t, and $Profit_{i,t}$ and $Asset_{i,t}$ denote the net profit on the income statement and the total asset value on the balance sheet at the end of year t, respectively. $r_{i,t}$ denotes the policy rate at the end of year t. $\tilde{e}_{i,t} = (e_{i,t} - e_{i,t-1})/e_{i,t-1}$ denotes the rate of local currency depreciation, where $e_{i,t}$ denotes the local currency spot price of one USD at the end of year t. α_i is the country fix effects and ν_t is year fixed effects. We exclude 1% of observations for each variable at each tail of the distribution to eliminate outliers. All of the standard errors reported

Table 2. Foreign Exchange Rate, Policy Rate, and Profits: Baseline

Dependent Variable: RoA	Total RoA (1)	Non-Int. (2)	Int. (3)	Int. Exp. (4)	Int. Inc. (5)
r	-0.146***	-0.112**	0.014	0.137***	0.123***
$\tilde{e}$	0.068***	0.050**	0.017	-0.019*	-0.002
Observations	1162	1070	1103	1085	1108
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.322	0.181	0.6477	0.736	0.552

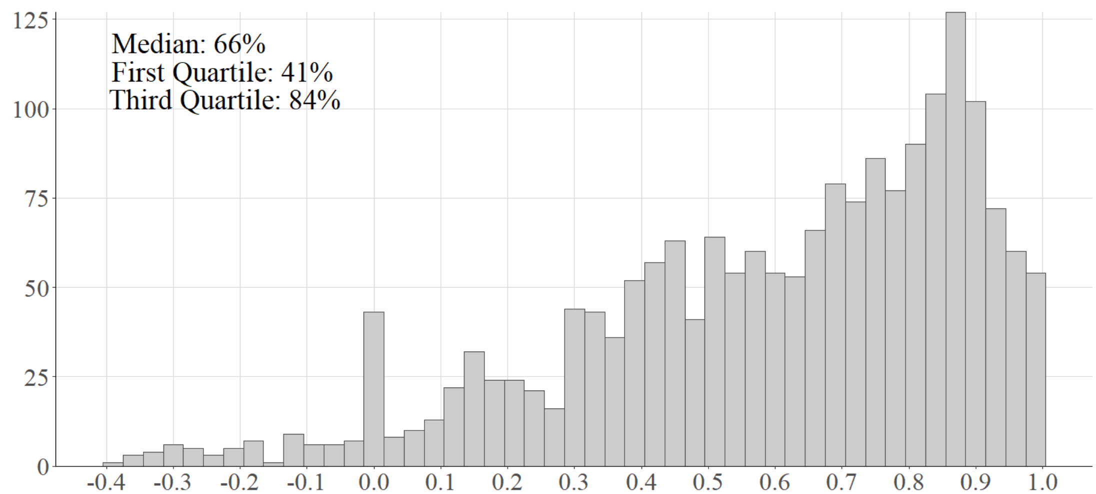
This table shows the estimation result of equation (1): $RoA_{i,t} = \beta_1 r_{i,t} + \beta_2 \tilde{e}_{i,t} + \nu_t + \alpha_i + \epsilon_{i,t}$ for country i in year t, where RoA denotes return on assets based on total net income (column (1)), non-interest income (column (2)), net interest income (column (3)), total interest expense (column (4)), and total interest income (column (5)), r denotes the policy rate at the end of each year, and $\tilde{e}$ denotes the rate of local currency depreciation against the USD. The sample is annual data for 116 central banks from 1996-2024. Standard errors are clustered by country. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. *Data Sources:* S&P IQ Pro and Macrobond data (for policy rates).

in this section are clustered by country. Table 2 column (1) gives us the baseline results. In addition, using the information provided in each central bank's income statement, we can further decompose $Profit_{i,t}$ into interest-related and non-interest-related components. Interest-related components include interest income and interest expenses, while Non-interest components include capital gains and losses. column (2) in Table 2 reports the estimation for equation (1) by substituting $Profit_{i,t}$ to its non-interest component. column (3) - (5) uses the net interest income (interest income plus interest expenses), interest expense, and interest income, respectively[2]

From Table 2 column (1), we see that the depreciation of local currency (against USD) is positively correlated with central bank profit, while high interest rates are negatively correlated with profits. Columns (2) and (3) indicate that exchange rates and interest rates affect central bank profit mainly through non-interest-related components (capital gains and losses). Columns (4) and (5) further indicate that the impact of interest and exchange rates

[2]For robustness, we follow Goncharov et al. (2023) and estimate the model using an alternative definition of return on assets: $RoA_{i,t} = 2Profit_{i,t}/(Asset_{i,t} + Asset_{i,t-1})$. We also re-define $e_{i,t}$ as the exchange rate against special drawing rights (SDR). All the results (magnitude and significance) we report in this section remain unchanged.

Figure 6. Net Foreign Asset To Total Asset Ratio



This figure shows the histogram of the net foreign asset (foreign asset minus foreign debt) to total asset ratio for 93 central banks during the covered periods of 1996-2024. There are 1,906 bank-year observations, with the first quartile, median, and third quartile being 41%, 66%, and 84%, respectively. The ratio is upper bound by 1, and a negative value means net foreign debt. *Data Sources:* IMF's International Financial Statistics.

on interest income is similar to their impact on interest expenses, and they cancel out each other. To sum up, using a rich panel of income statement data, Table 2 indicates that local currency depreciation is positively correlated with higher profit through capital gains. This is consistent with the case study of SNB. At the same time, high policy rates are negatively correlated with profit through capital losses. This is, again, consistent with the RBA case study.

In this section, we look closer at the relationship between exchange rates and profits. As shown in Table 2, depreciation of local currency increases profits through capital gain. Intuitively, the increase in profits should depend on how many foreign assets a central bank holds. The more foreign assets a central holds, the more profitable depreciation becomes. To capture this effect, for each country i at time t, we compute the net foreign asset to total asset ratio. Figure 6 displays the results for all countries across all time periods (with a total of 1672 country/year observations). Note that by construction, the ratio is bounded above by 1. A negative ratio indicates the central bank has a net foreign debt. The median for

Table 3. Foreign Exchange Rate and Profits: Variation by Net Foreign Asset Dummy Variable

Dependent Variable: *RoA*	Total RoA (1)	Non-Int. (2)	Int. (3)
r	−0.103**	−0.090	0.000
$\tilde{e}$	0.048**	0.019	0.029
$\tilde{e} \times FAR$	0.059*	0.084*	−0.035*
FAR	−0.426	−0.277	−0.122
Observations	985	919	952
Country fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Adjusted R^2	0.351	0.190	0.670

This table shows the estimation result of equation (2): $RoA_{i,t} = RoA_{i,t} = \beta_1 r_{i,t} + \beta_2 \tilde{e}_{i,t} + \beta_3 \tilde{e}_{i,t} \times FAR_{i,t} + \beta_4 FAR_{i,t} + \nu_t + \alpha_i + \epsilon_{i,t}$ for country i in year t, where RoA denotes return on assets based on total net income (column (1)), non-interest income (column (2)), and net interest income (column (3)), r denotes the policy rate at the end of each year, $\tilde{e}$ denotes the rate of local currency depreciation against the USD, and $FAR_{i,t}$ is an indicator function that equals to one if the central bank i at time t has a net foreign asset to total asset ratio greater than 66.23%, and equals to zero otherwise. Standard errors are clustered by country. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. *Data Sources:* S&P IQ Pro, Macrobond data (for policy rates), and International Monetary Fund's International Financial Statistics (For FAR).

the ratio is 66.23%, with the first and third quartiles being 40.88% and 83.75%, respectively. Consider the following augmented regression:

$$RoA_{i,t} = \beta_1 r_{i,t} + \beta_2 \tilde{e}_{i,t} + \beta_3 \tilde{e}_{i,t} \times FAR_{i,t} + \beta_4 FAR_{i,t} + \nu_t + \alpha_i + \epsilon_{i,t}, \tag{2}$$

where we define $FAR_{i,t} = 1$ if country i at time t has a net foreign asset to total asset ratio greater than the median (66.23%), and $FAR_{i,t} = 0$ otherwise. Table 3 demonstrates that depreciation is positively correlated with profits, and the correlation is stronger for central banks that hold more foreign reserves.

Suppose we redefine $FAR_{i,t}$ as a continuous variable of the net foreign asset to total asset ratio for country i at time t and rerun regression (2). Table 4 summarizes the results. The results again indicate that the more foreign reserves a central bank holds, the more profitable

Table 4. Foreign Exchange Rate and Profits: Variation by Net Foreign Asset Ratio

Dependent Variable: RoA	Total RoA (1)	Non-Int. (2)	Int. (3)
r	−0.091*	−0.075	0.003
$\tilde{e}$	0.014	−0.017	0.029
$\tilde{e} \times FAR$	0.109**	0.127**	−0.024
FAR	0.109	1.000	−0.625
Observations	985	919	952
Country fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Adjusted R^2	0.354	0.187	0.665

This table shows the estimation result of equation (2): $RoA_{i,t} = RoA_{i,t} = \beta_1 r_{i,t} + \beta_2 \tilde{e}_{i,t} + \beta_3 \tilde{e}_{i,t} \times FAR_{i,t} + \beta_4 FAR_{i,t} + \nu_t + \alpha_i + \epsilon_{i,t}$ for country i in year t, where RoA denotes return on assets based on total net income (column (1)), non-interest income (column (2)), and net interest income (column (3)), r denotes the policy rate at the end of each year, $\tilde{e}$ denotes the rate of local currency depreciation against the USD, and $FAR_{i,t}$ is the net foreign asset to total asset ratio for country i at year t. Standard errors are clustered by country. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. *Data Sources:* S&P IQ Pro, Macrobond data (for policy rates), and International Monetary Fund's International Financial Statistics (For FAR).

it is to depreciate the local currency through capital gain[3].

4.3.1 Policy Rates and Profits

In this section, we focus on policy rate's effect on central bank profit. The US and Australia case studies show that how the policy rate affects profit depends on the balance sheet structure. Since the breakout of COVID-19, central banks in advanced economies have drastically changed their balance sheet structure due to large-scale asset purchases. We construct a variable $QE_{i,t}$, where $QE_{i,t} = 1$ if country i is classified as "Advanced economies" in the IMF World Economic Outlook and year t is greater than 2019. This is a proxy that country i's asset maturity is longer due to large-scale asset purchases. The following 24 countries in our panel is classified as advanced economies: Australia, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Greece, Hong Kong, Iceland, Israel, Korea, Latvia, Lithua-

[3]The results (magnitude and significance) in Table 3 and 4 are robust to different specifications for $r_{i,t}$. Various polynomial degrees have been added, and the relationship between exchange rates and profits is very robust.

nia, Macao, Malta, New Zealand, Norway, Singapore, Slovak Republic, Slovenia, Sweden, Switzerland, and Taiwan.

We consider the following extended regression:

$$RoA_{i,t} = \beta_1 r_{i,t} + \beta_2 r_{i,t} \times QE_{i,t} + \beta_3 \tilde{e}_{i,t} + \beta_4 QE_{i,t} + \nu_t + \alpha_i + \epsilon_{i,t}.$$

Table 5 summarizes the results. Column (1) indicates that policy rates are negatively correlated with profits, and the correlation is much stronger for central banks with large-scale asset purchases (proxied by $QE_{i,t}$). This stronger correlation is due to the non-interest (capital loss) channel indicated by column (2) and the interest channel indicated in column (3). Note that the results in column (2) are consistent with the case study on the Reserve Bank of Australian. That is, central banks that have performed QE incur larger losses during policy rate hikes due to capital losses. Meanwhile, the results in column (3) are consistent with the case study on the Fed. After QE, central banks' net interest income decreases during interest rate hikes due to high interest expense and stable interest income.

To conclude, policy rates affect profit mainly through capital gain and losses and also through interest expenses, as in the case of RBA and Fed. These channels are magnified after central banks perform QE. Moreover, depreciation of local currency increases profits through capital gain (non-interest part). The more foreign reserves a central bank has, the more profitable it is to depreciate.

5 Profit Concern and Foreign Exchange Intervention

In the previous section, we see that the depreciation of local currency leads to central bank profit through capital gain. In this section, we test whether profit concerns have an impact on how central banks intervene in the foreign exchange market.

Table 5. Policy Rate and Profits: Variation by QE

Dependent Variable: RoA	Total RoA (1)	Non-Int. (2)	Int. (3)	Int. Exp. (4)	Int. Inc. (5)
r	−0.138***	−0.115**	−0.010	0.136***	0.125***
$r \times QE$	−0.719***	−0.523*	−0.257**	0.199**	−0.054
$\tilde{e}$	0.068***	0.049*	0.017	−0.019**	−0.002
QE	−0.698	−0.200	−0.487	−0.221	−0.755**
Observations	1162	1070	1103	1085	1108
Country fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.334	0.186	0.652	0.737	0.555

This table shows the estimation result of equation (3): $RoA_{i,t} = \beta_1 r_{i,t} + \beta_2 r_{i,t} \times QE_{i,t} + \beta_3 \tilde{e}_{i,t} + \beta_4 QE_{i,t} + \nu_t + \alpha_i + \epsilon_{i,t}$. for country i in year t, where RoA denotes return on assets based on total net income (column (1)), non-interest income (column (2)), net interest income (column (3)), interest expense (column (4)), interest income (column (5)), r denotes the policy rate at the end of each year, $\tilde{e}$ denotes the rate of local currency depreciation against the USD, $Covid$ is an indicator function that equals one if country i belongs to OECD and the year t is greater than 2019, and zero otherwise. Standard errors are clustered by country. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. *Data Sources:* S&P IQ Pro and Macrobond data for policy rates.

5.1 Intervention and RoA: Visual Evidence

The key variable of interest in this subsection is $Y_{i,t}$, which is a proxy of foreign exchange intervention for country i at time t. Following the literature, let

$$Y_{i,t} \equiv \frac{\text{Reserve}_{i,t} - \text{Reserve}_{i,t-1}}{|\text{Reserve}_{i,t-1}|},$$

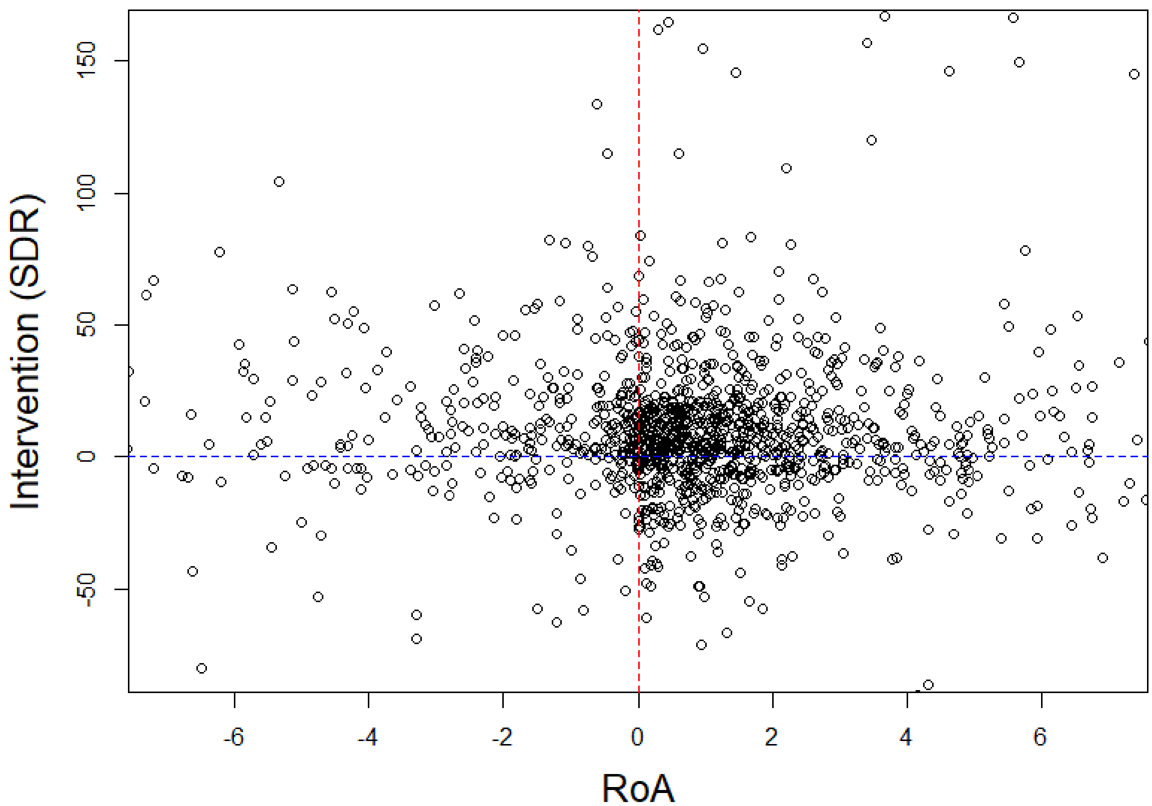
where $\text{Reserve}_{i,t}$ is the value, measured in special drawing rights (SDR) of the net foreign asset for country i at the end of time period t.[4] $Y_{i,t}$ represents the percentage change in the net foreign asset for country i during time t. By increasing (decreasing) $Y_{i,t}$, central banks can intervene in the foreign exchange market and depreciate (appreciate) their local currency. This section provides empirical evidence that central bank profit concerns indeed have a significant impact on how they intervene in the foreign exchange market. We begin with visual evidence that is supported by scatter plots, and we go to the regression-based

[4]The SDR is based on a basket of five currencies (USD, EUR, JPY, GBP, and CNY) defined by the IMF. Note that $\text{Reserve}_{i,t}$ can be negative in the case of net foreign debt.

approach in the later subsection.

5.1.1 Variation by Foreign Asset Ratios

Figure 7. Foreign Market Intervention and Profits



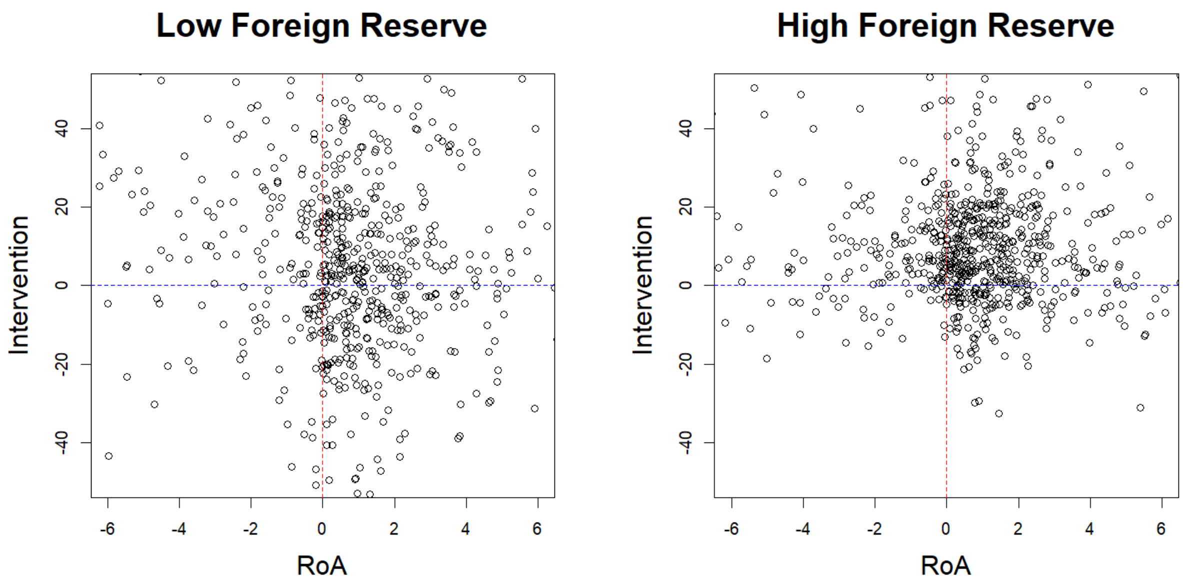
This figure shows the scatter plot of foreign exchange market intervention and central bank profit. The y-axis is the foreign exchange market intervention as measured by the annual percentage change in the central bank's net foreign asset, valued in special drawing rights (SDR). The x-axis is the central bank's profits as measured by return on asset (annual net income over the beginning-of-the-period total asset). There are 1,477 country-year observations for a panel of 116 central banks from 1996 to 2024. *Data Sources:* S&P IQ Pro and International Monetary Fund's International Financial Statistics.

Figure 7 shows the scatter plot between intervention $Y_{i,t}$ and $RoA_{i,t}$, where $RoA_{i,t}$ is the return on assets defined annual net income over the beginning-of-the-period total asset. These are annual data, and each data point represents a country-year. There are 1,477 country-year observations for a panel of 116 central banks from 1996 to 2024.

There is no apparent pattern displayed in Figure 7. The lack of correlation between intervention and RoA is also unsurprising. As we have previously discussed, how much the exchange rate impacts a central bank's profits depends on how much foreign reserve it holds. For countries with low foreign reserves (like the Fed), local currency depreciation would not impact its profits. Therefore, even if the Fed has profit concerns, we still won't see any patterns in its foreign exchange intervention. To address this issue, we split the data in half according to the net foreign asset to total asset ratio. For the 1,477 country-year observations in Figure 7, the median net foreign asset to total asset ratio is 67.43%. The left panel of Figure 8 consists of all the country-year where the ratio is less than 67.43% while the right panel consists of the rest of the data. Once we split the data, we see that although there's still a lack of pattern on the left panel, the pattern is clear on the right. For the country-year with a high net foreign asset to total asset ratio, we see that there's a lack of data in the third quadrant. That is, there's very little data where central banks negatively intervene in the foreign exchange market (which will cause the local currency to appreciate and lead to income losses) while they report losses. This is especially clear in Figure 9, a zoom-in on Figure 8. From these figures, it's clear that when the exchange rate has an important implication for profit (reflected by a high net foreign asset to total asset ratio), foreign exchange policy is clearly influenced by profit concern. When experiencing losses, the central banks will restrain from negatively intervening in the foreign exchange market, which would lead to appreciation and further losses.

The profit of a central bank with a high foreign asset to total asset ratio is very sensitive to the foreign exchange rate. For those central banks, Figures 7 through 9 display the equilibrium result that those who report losses (especially small losses) in a given year are highly unlikely to negatively intervene in the foreign exchange market in the same year. Such a pattern cannot be found among the central banks whose profits are less sensitive to the foreign exchange rate. This is clear evidence that central bank profit concerns do affect monetary policies. In this case, profit concerns constrained central banks' policy tools to influence the foreign exchange market.

Figure 8. Foreign Market Intervention and Profits: Split Data

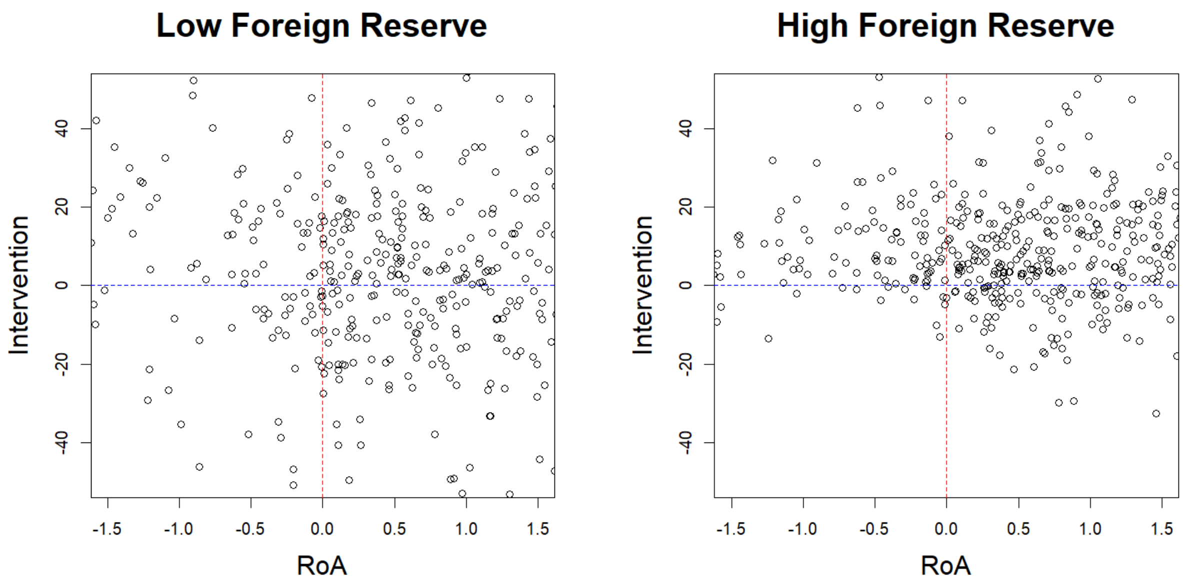


This figure shows the scatter plot of foreign exchange market intervention and central bank profits. There are a total of 1,477 data points for a panel of 116 central banks from 1996 to 2024. We split the data in half according to the net foreign asset to total asset ratio (FAR). The data point is recorded in the lift panel for the central bank at a given year with FAR lower than the median (67.43%). Otherwise, it's recorded in the right panel. The y-axis is the foreign exchange market intervention as measured by the annual percentage change in the central bank's net foreign asset, valued in special drawing rights (SDR). The x-axis is the central bank's profits as measured by return on asset (annual net income over the beginning-of-the-period total asset). *Data Sources:* S&P IQ Pro and International Monetary Fund's International Financial Statistics.

5.1.2 Variation by Accounting Rules

Central banks have substantial control over their profits, and this power comes from both the control over monetary policies and accounting rules. This section focuses on the accounting rules used by different central banks. Unlike private firms, central banks enjoy more accounting discretion and are not subject to auditing. Moreover, some central banks create their own accounting rules that allow greater flexibility. Therefore, in contrast to private firms, which treat accounting rules as exogenous, central banks can choose what kind of accounting rules they want to use when reporting profits. Within our dataset, there are 44% of the country-year observations use the International Financial Reporting Standards (IFRS), while the remaining 56% use the local or self-created accounting rules. In general, central banks using IFRS are less able to manage profits since IFRS does not allow

Figure 9. Foreign Market Intervention and Profits: Split Data Zoom-in

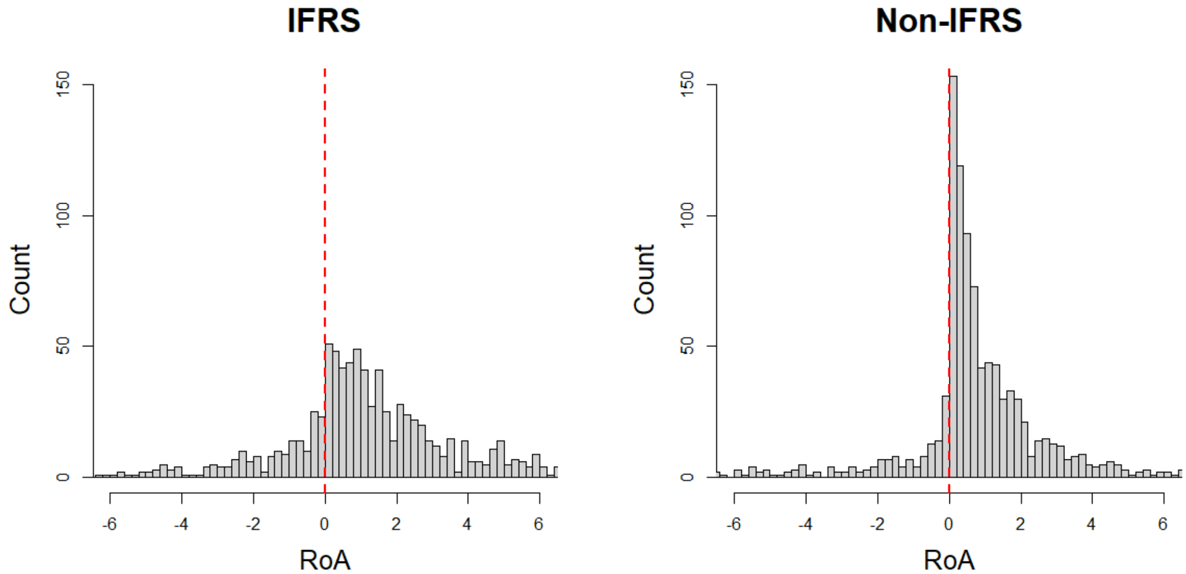


This figure shows the (zoom-in) scatter plot of foreign exchange market intervention and central bank profits and focuses on the data points that are near the zero profit threshold. We split the data in half according to the net foreign asset to total asset ratio (FAR). For the central bank at a given year with FAR lower than the median (67.43%), the data point is recorded in the lift panel. Otherwise, it's recorded in the right panel. The y-axis is the foreign exchange market intervention as measured by the annual percentage change in the central bank's net foreign asset, valued in special drawing rights (SDR). The x-axis is the central bank's profits as measured by return on asset (annual net income over the beginning-of-the-period total asset). *Data Sources:* S&P IQ Pro and International Monetary Fund's International Financial Statistics.

general-loss provisions, limits the ways to hide losses, and requires that a greater share of the balance sheet be marked-to-market. Note that, however, it is also common for central banks that use IFRS to report their non-compliance with specific IFRS rules to suit their reporting needs. However, as a general rule, central banks using the IFRS have less room for discretion than non-IFRS regimes. After all, if central banks really have strong incentives to manage profits, they could always choose to use non-IFRS accounting rules. Therefore, it is reasonable to assume that central banks that choose to use non-IFRS accounting rules might have greater profit concerns than those who use IFRS.

Figure 10 displays the RoA for the country-year data that use IFRS and those that do not. We can see that the RoA for non-IFRS data experiences a more significant jump at profit zero compared to its IFRS counterpart. Moreover, significantly fewer non-IFRS data are negative compared to IFRS data. This is consistent with our assumption that central

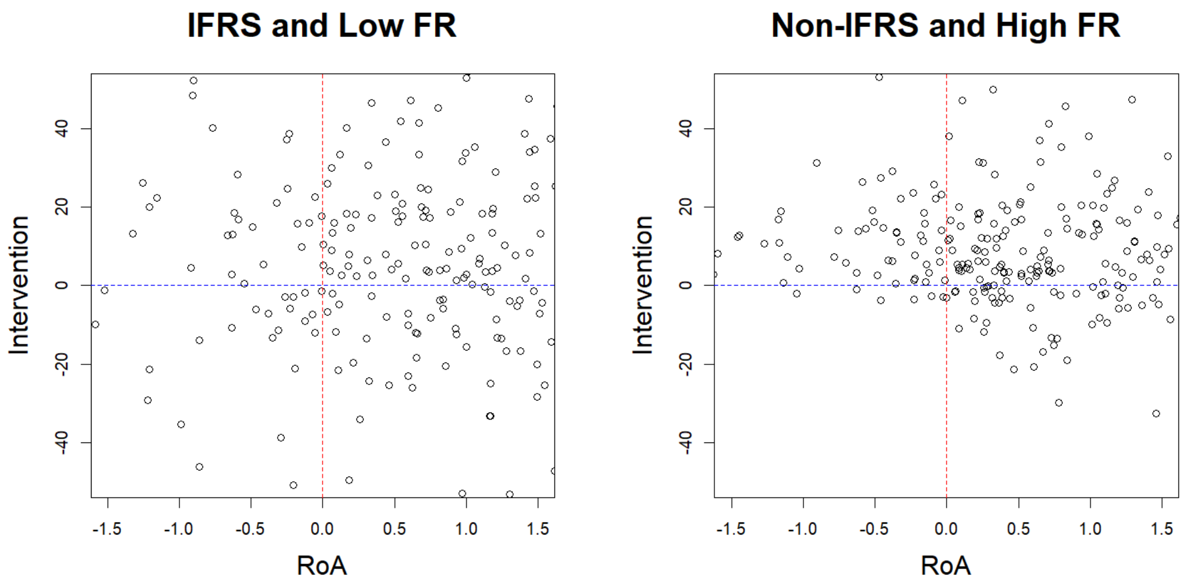
Figure 10. Return on Assets for IFRS and Non-IFRS countries



This figure shows the histogram of central bank profits as measured by the return on assets (periodic net income over the beginning-of-the-period total asset). We split the data according to the accounting rule used. The data are recorded in the left panel for the central banks that use International Financial Reporting Standards (IFRS). Otherwise, the data are recorded in the right panel. *Data Sources:* S&P Capital IQ Pro.

banks that use non-IFRS are more likely to have profit concerns. Figure 11 displays the scatter plot of intervention and RoA. The data is divided according to the accounting rule and the net foreign asset to total asset ratio (FAR). The left panel consists of data from the central banks that use International Financial Reporting Standards (IFRS) and with FAR lower than the median (67.43%). The right panel comprises central banks with non-IFRS accounting rules and higher than median FAR. Here we see a clear pattern — the asymmetric distribution of data along the zero-intervention line for the right panel but not for left panel. There's a lack of data in the third quadrant for Non-IFRS, High FAR data, meaning that central banks constrain their policy amid loss. This confirms that country that uses non-IFRS accounting rules indeed have greater profit concerns over those who use IFRS, and such concern indeed affects their monetary policies. In subsection 5.1.3, we provide a simple simulation that gives us clearer intuition behind the equilibrium results we see in Figures 7 through 11.

Figure 11. Foreign Market Intervention and Profits: IFRS and Non-IFRS countries



This figure shows the scatter plot of foreign exchange market intervention and central bank profits and focuses on the data points that are near the zero profit threshold. We split the data according to the accounting rule used and the net foreign asset to total asset ratio (FAR). For the central banks that use International Financial Reporting Standards (IFRS) and with FAR lower than median (67.43%), the data are recorded in the left panel. The right panel consists of central banks with non-IFRS accounting rules and higher than median FAR. The y-axis is the foreign exchange market intervention measured by the annual percentage change in the central bank's net foreign asset, valued in special drawing rights (SDR). The x-axis is the central bank's profits as measured by return on asset (annual net income over the beginning-of-the-period total asset). *Data Sources:* S&P IQ Pro and International Monetary Fund's International Financial Statistics.

5.1.3 Simulation

In this section, we construct a simple simulation to provide intuition. We start by making a simplified assumption that a central bank either has or doesn't have profit concerns. It then goes through the following processes:

1. The central bank draws an optimal foreign exchange market intervention $Y_1 \sim \mathbb{N}(\mu_{Y_1}, \sigma^2_{Y_1})$.

2. The central bank draws a "latent" return on assets $RoA_1 \sim \mathbb{N}(\mu_{RoA_1}, \sigma^2_{RoA_1})$.

3. After the central bank observes (Y_1, RoA_1), it updates intervention and obtain Y_2:

   - If the central bank does not have profit concerns, $Y_2 = Y_1$. That is, the central bank will always maintain the optimal intervention when there are no profit concerns.

- If $RoA_1 \geq 0$, $Y_2 = Y_1$. That is, the central bank will always maintain the optimal intervention when the latent profit is non-negative, regardless of the existence of profit concerns.
- If $RoA_1 < 0$ and the central bank has profit concerns, then the central bank will choose Y_2 according to the following minimization problem:

$$\min_{Y_2}(Y_2 - Y_1)^2 + \delta\mathbb{E}[\mathbb{I}(RoA_2 < 0)],$$

where $\mathbb{I}(\cdot)$ is an indicator function and RoA_2 is the "realized" return on assets and will be defined in the next step. Note that the minimization problem states that the central want to update the intervention so that it's not too far away from the optimal intervention Y_1, at the same time decreasing the probability that the realized profit is negative.

4. After obtaining an updated intervention Y_2

- If $Y_2 = Y_1$, then $RoA_2 = RoA_1$. That is, if the updated intervention is identical to the optimal intervention, then the realized and latent profit will also be identical.
- If $Y_2 \neq Y_1$, then the realized profit is determined through the following intervention function:

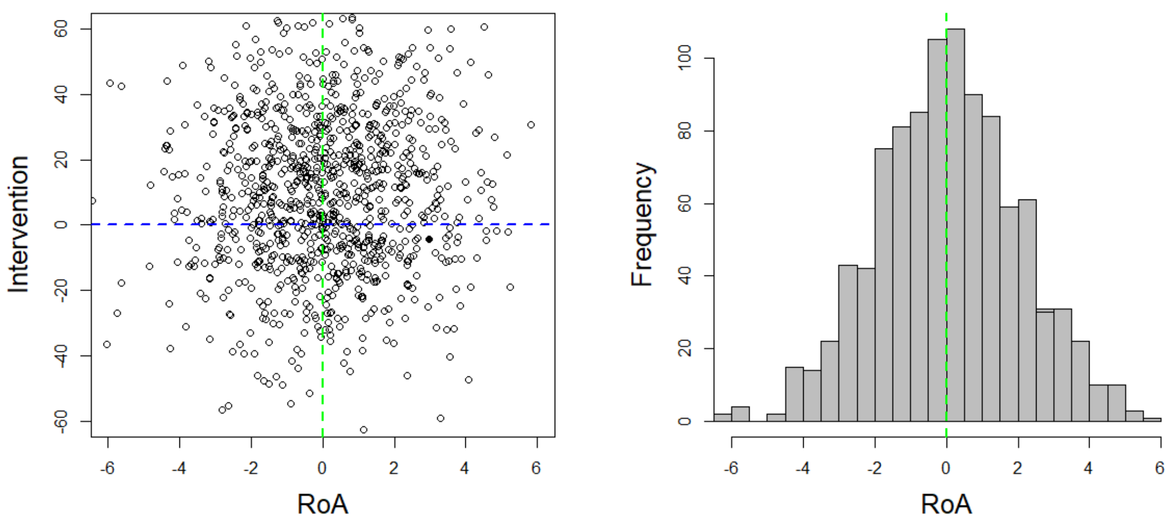
$$RoA_2 = RoA_1 + a(Y_2 - Y_1) + \epsilon,$$

where $a \in \mathbb{R}^+$ is a constant and $\epsilon \sim \mathbb{N}(0, \sigma_\epsilon^2)$. Note that σ_ϵ^2 captures the uncertainty for the central bank to control its own profit.

5. The central bank obtain (Y_2, RoA_2).

We start by simulating 1000 central banks with no profit concerns. The results are summarized in Figure 12. On the left panel, we plot the realized intervention (Y_2) on the vertical axis and the realized profit (RoA_2) on the horizontal axis. We can see that there is no correlation. On the right panel is the distribution of the realized profit (RoA_2), which is normally distributed without any discontinuous jumps.

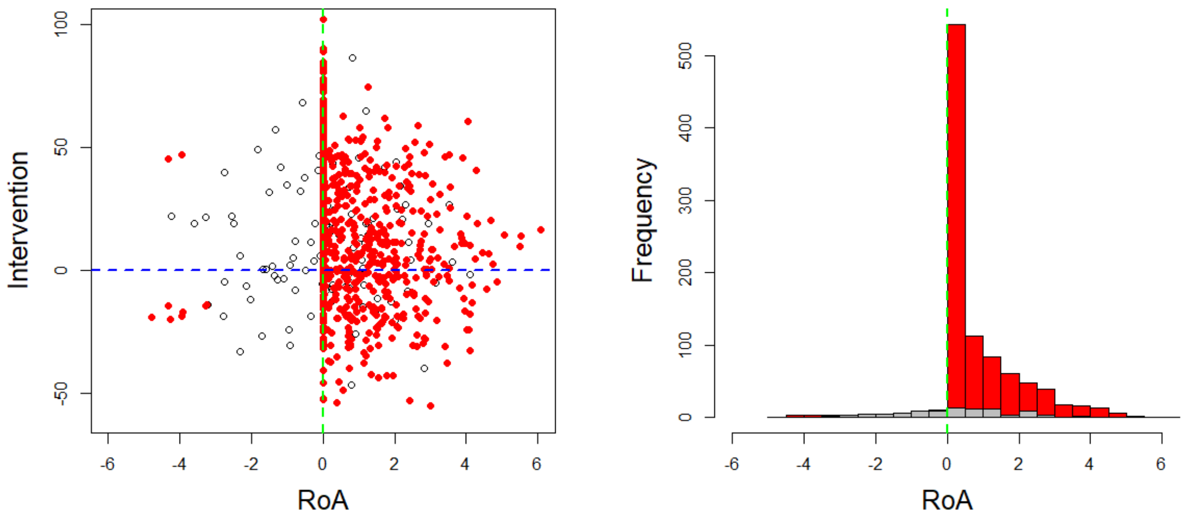
Figure 12. Distribution When No Central Bank Have Profit Concerns



This figure shows the simulation results where all central banks have no profit concerns. There are a total of 1000 simulated data points. The left panel displays the scatter plot of foreign exchange intervention and return on assets and the left panel plots the return on assets.

To illustrate the effect of profit concerns on monetary policy, we assume that the central banks have perfect control over their profits: i.e., $\sigma_\epsilon^2 = 0$. Moreover, we assume that 90% of the central banks in our simulation have profit concerns, while the other 10% do not. The results are summarized in Figure 13. Note that the red dots on the left panel and the red bins on the right represent data coming from the central banks with profit concerns, while the gray represents central banks without profit concerns. Since central banks are assumed to have perfect control over their profits, if latent profit (RoA_1) is a small negative number, the central bank will intervene in the foreign exchange market such that its realized profit (RoA_2) is exactly zero (hence the penalty term in the loss function disappear). Note that if the latent profit is a large negative number, the central bank might decide not to intervene since reaching a zero RoA_2 will cause Y_2 to be too far away from Y_1. Finally, if the latent

Figure 13. Perfect Profit Control, 90% Central Banks Have Profit Concerns

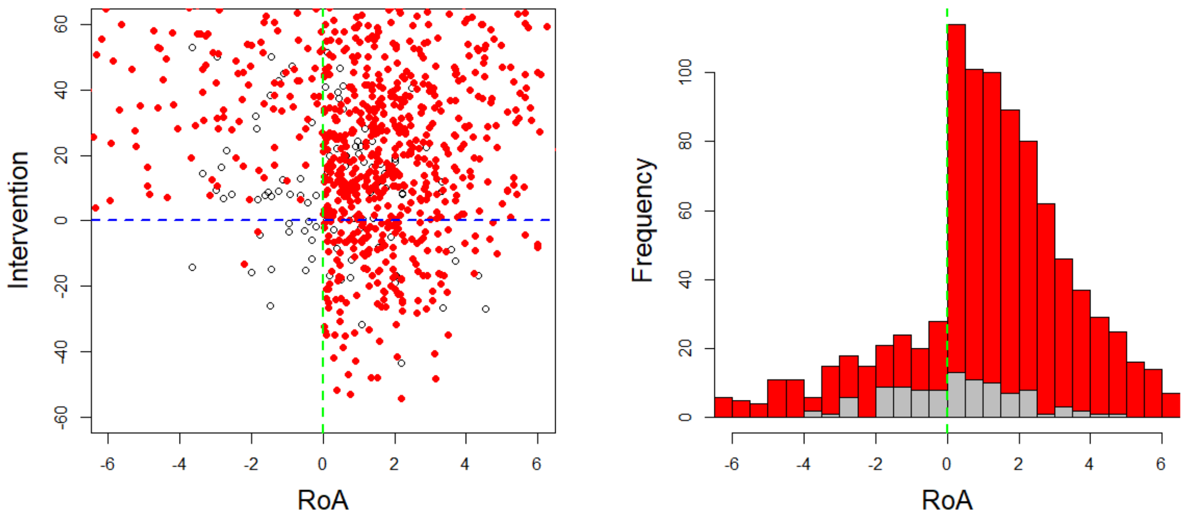


This figure shows the simulation results where 90% of the central banks have profit concerns and can perfectly control their profits. The remaining 10% are assumed to not have profit concerns. There are a total of 1000 simulated data points. The left panel displays the scatter plot of foreign exchange intervention and return on assets and the left panel plots the return on assets. The red dots and bins represent the simulated data from central banks with profit concerns, while the gray dots and bins are from central banks without profit concerns.

profit is non-negative to begin with, the central bank will not update the intervention. The most important feature here is the data bunching at zero-profit.

For our last case, we assume 90% of the central banks have profit concerns, but they do not have perfect control over their profits: i.e., $\sigma_\epsilon^2 > 0$. Figure 14 summarizes the results. Observe that in the left panel, the red dots in the second quadrant represent central banks that try to intervene but fail to reach a positive profit due to the imperfect control of RoA_2. Moreover, the fact that the data are not all bunched at profit zero is also due to the imperfect control of RoA_2. There are two important features in this simulation outcome that closely resemble the data we actually observe. First, we observe a lack of red dots in the third quadrant, which matches the data. This is due to the fact that central banks with $RoA_1 < 0$ will try to positively intervene in the foreign exchange market to achieve a positive RoA_2. As a result, very few central banks with profit concerns will end up performing negative intervention and achieving $RoA_2 < 0$ simultaneously. The second important feature we

Figure 14. Imperfect Profit Control, 90% Central Banks Have Profit Concerns



This figure shows the simulation results where 90% of the central banks have profit concerns and can *not* perfectly control their profits. The remaining 10% are assumed not to have profit concerns. There are a total of 1000 simulated data points. The left panel displays the scatter plot of foreign exchange intervention and return on assets and the left panel plots the return on assets. The red dots and bins represent the simulated data from central banks with profit concerns, while the gray dots and bins are from central banks without profit concerns.

observed from this simulation is displayed in the right panel. We see a smooth distribution on both sides of the $RoA_2 = 0$, and a discontinuous jump at profit zero. This result matches the data and is due to the imperfect control of profit. Some central banks that have a negative latent profit $RoA_1 < 0$ may end up "over-achieving" and obtain a large positive RoA_2.

For both the simulation results and the real data, we see that there's a lack of negative intervention when profits are negative. The negative interventions suddenly show up at the right side of the zero profit threshold.

5.2 Intervention and RoA: Last Fiscal Month

In this section we show that foreign exchange interventions (FXIs) that increase profits are particularly likely right before central banks are about to release their financial statements, pointing to a causal effect of profit concerns on intervention. Furthermore, these interventions mainly occurred when central banks had strong incentives to avoid losses, strengthening the conclusion that these interventions are motivated by profit concerns.

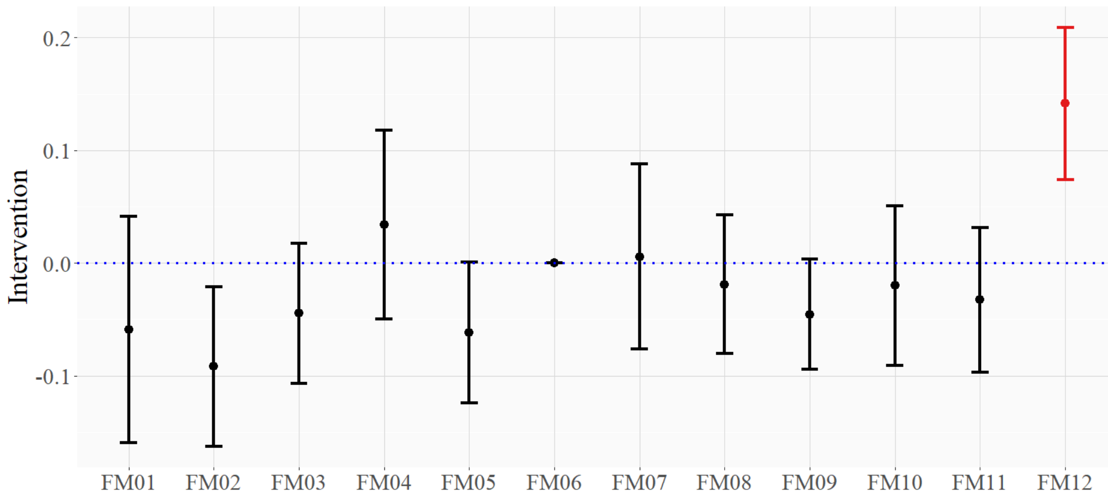
5.2.1 Foreign Exchange Intervention: The Last Fiscal Month

This section first focuses on the FXI measurement used in this paper, then on the timing of earnings reports for central banks. Finally, it demonstrates that the FXI that puts depreciation pressure on the local currency is pervasive right before central banks release their financial statements, pointing to a causal effect of profit concerns on such interventions.

The FXI is commonly estimated from the change in the stock of the central bank's foreign reserves. This measurement is widely available but has several problems. First, the movements may be due to valuation changes. Moreover, the foreign reserves that the central bank owns yield dividends periodically. These dividends should be adjusted since these are not active interventions by the central bank. Furthermore, adjustments should also be made when the central bank has foreign currency transactions with residents and non-residents. Central banks borrow from and repay loans to foreign entities like the IMF; they also accept deposits or withdrawals of foreign currencies by the government or private sectors. Adler et al. (2024) adjusts for the factors mentioned above and provides a refined FXI dataset. The FXI measurement used in this research is based on on their dataset and is of monthly frequency. There are 30,191 FXI observations from 116 countries from 2000 to 2024, and the data composition is in Table 1. The FXI is measured in percentage points of 3-year moving average nominal GDP to compare across countries.

Regarding the time of profit reporting, central banks worldwide report their profit at the end of the fiscal year, which may *not* be December 31. The information on the fiscal year-end is hand-collected from central bank income statements and websites. In the dataset, 21 of the 116 central banks' fiscal years do not coincide with the calendar year (with the fiscal year ending in June being the most common alternative).

Figure 15. Foreign Exchange Market Intervention In Each Fiscal Month Compared to the Middle of the Fiscal Year



This figure shows the estimation results for equation (3). 95% confidence intervals are displayed, and standard errors are clustered for central banks. The key parameter of interest β_{12} is significant with the point estimate of 0.14. *Data Sources:* S&P IQ Pro and Adler et al. (2024)

Having the measurement of FXI and the information about the time of report, we can see how central banks' FXI differ across each *fiscal* month by running the following regression:

$$\begin{aligned} Y_{i,t,m} = \alpha_{i,t} &+ \beta_1 \cdot \mathbb{I}(m = \text{first fiscal month for country } i) \\ &+ \beta_2 \cdot \mathbb{I}(m = \text{second fiscal month for country } i) + ... \\ &+ \beta_{12} \cdot \mathbb{I}(m = \text{last fiscal month for country } i) + \epsilon_{i,t,m}, \end{aligned} \tag{3}$$

where $Y_{i,t,m}$ is the FXI in percentage points of (3-year moving average) GDP for central bank i at the year t month m. $\alpha_{i,t}$ is the country-year fixed effect and $\mathbb{I}(\cdot)$ is the indicator function. β_6 (the intervention in the middle of the fiscal year) is left out as a baseline. Note that by increasing $Y_{i,t,m}$, central bank i actively buys foreign currencies and releases local currencies, which creates depreciation pressure on the local currency at year t, month m. $Y_{i,t,m}$ is trimmed at the 1^{st} and 99^{th} percentiles to control for outliers. β_j, for $j \neq 6$ captures the difference of central bank FXI between the fiscal month j and the middle of the fiscal year. We are particularly interested in β_{12}, the behavior in the last fiscal month when central

Table 6. Foreign Exchange Market Intervention In Each Fiscal Month Compared to the Middle of the Fiscal Year

	β_1	β_2	β_3	β_4	β_5	β_6
Estimate	−0.058	−0.091**	−0.044	0.034	−0.061*	(baseline)
Cluster standard Error	0.051	0.036	0.031	0.042	0.031	(baseline)
	β_7	β_8	β_9	β_{10}	β_{11}	β_{12}
Estimate	0.005	−0.018	−0.045*	−0.020	−0.032	**0.141*****
Cluster standard Error	0.041	0.031	0.024	0.036	0.032	**0.034**
Observations			30,191			
Country × year fixed effects			Yes			
Adjusted R^2			0.104			

This table shows the estimation results for equation (3). Standard errors are clustered by central banks. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. *Data Sources: Data Sources:* S&P IQ Pro and Adler et al. (2024).

banks were just about to release financial statements. Note that without profit concerns, the last fiscal month should *not* be different from any other month. Figure 15 display the estimations of equation (3). The intervals represent a 95% confidence ban, and the standard errors are clustered for central banks. Point estimates and standard errors are reported in Table 6. The point estimate for β_{12} is 0.141 and statistically significant[5]. This shows that central banks intervened aggressively in the last fiscal month, captured by the positive and significant β_{12}. This positive intervention would cause depreciation pressure on the local currency and help the central bank to report a higher profit.

An important critique of this finding would be a positive and significant β_{12} may be due to seasonality or other profit-unrelated reasons. The following sections address this critique by showing that the significance and magnitude of β_{12} varies predictably with central banks' *incentives* to avoid losses.

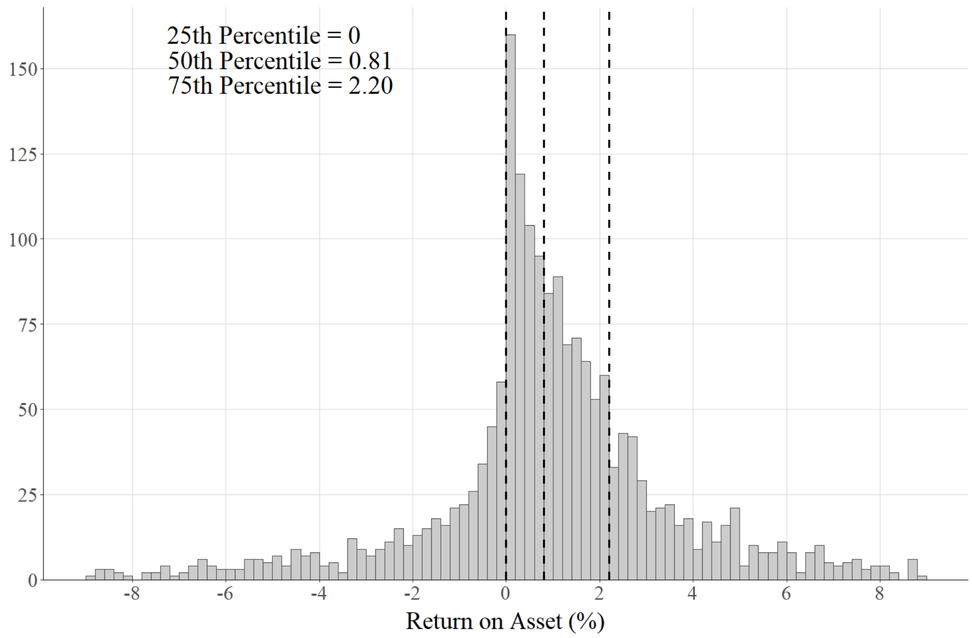
[5]The unconditional standard deviation for $Y_{i,t,m}$ is 0.745. Therefore, 0.14 is about 19% of the unconditional standard deviations.

5.2.2 Previous Year Profits

In the last section, we see that interventions that increase profits are particularly likely right before central banks release their financial statements, pointing to a causal effect of profit concerns on intervention. Here, we show that this intervention pattern is most prevalent for central banks under financial pressure. It is reasonable to assume that central banks reporting a loss (or a lower profit) in the previous year are under more financial and political pressure than the ones reporting large profits. Since we can observe each central bank's previous year's profits, we can see how the intervention pattern differs for central banks reporting different profits. To start, I divide the data into four equal quartiles according to the profit reported at the end of the last fiscal year: previous year losses (RoA < 0), previous year small profits (RoA $\in [0, 0.81\%)$), previous year medium profits (RoA $\in [0.81\%, 2.20\%)$), and previous year large profits (RoA $> 2.20\%$). Figure 16 displays the RoA distribution for the central banks and the corresponding four quartiles.

We then test equation (3) using different subsamples; the results are given in Figure 17. The top-left panel is the regression results (estimation of equation (3)) using the subsample for central banks reporting a loss in the last fiscal year. The point estimate of β_{12}, our key variable of interest, is 0.25 and significant at the 1% level. The magnitude nearly doubled compared to the estimate using the entire sample (0.14). In comparison, the top-right and lower-left panel are the regression results using the subsample for central banks that report small profits (RoA $\in [0, 0.81\%)$) and medium profits (RoA $\in [0.81\%, 2.20\%)$) in the previous year. The point estimates of β_{12} are 0.21 (significant at the 1% level) and 0.16 (significant at the 5% level), respectively. Finally, the lower-right panel shows the results for central banks that reported a large profit (RoA $> 2.20\%$) in the last fiscal year. The point estimate is 0.07 and is not statistically significant. Here, we see that the central bank that reported a loss in the previous year will intervene aggressively in the last fiscal month of the following year. The same pattern is still present, although it decreases in magnitude, for central banks that report a small to medium profit. Critically, the intervention pattern in the last fiscal

Figure 16. The Distribution of Central Banks' Return on Assets: Four Quartiles



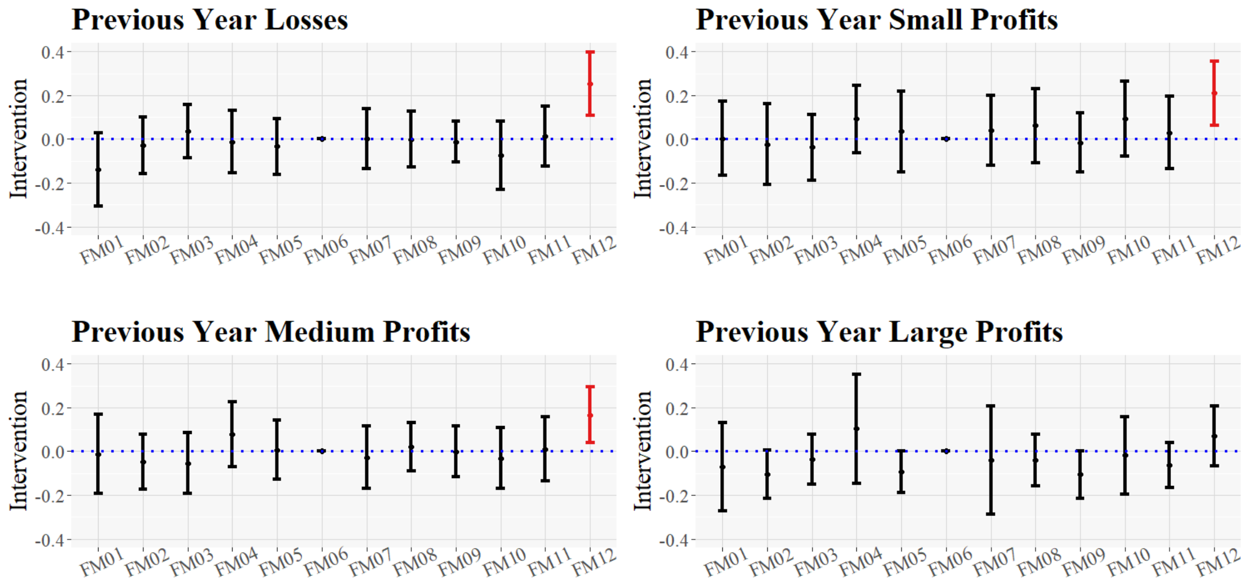
This figure displays the RoA distribution for central banks in the dataset. The data is divided into four equal quartiles according to the profit reported at the end of the last fiscal year: previous year losses (RoA < 0), previous year small profits (RoA $\in [0, 0.81\%)$), previous year medium profits (RoA $\in [0.81\%, 2.20\%)$), and previous year large profits (RoA $> 2.20\%$). *Data Sources:* S&P Capital IQ Pro.

month is not present for central banks that reported a large profit last year. Note that if the distortion pattern is not due to profit concerns, we should observe this behavior no matter what profit central banks report. Instead, we observe this behavior for all the central banks *except* for the ones that reported large profits last year. This result is also intuitive; for central banks already in a financially comfortable situation, there's less incentive to intervene in the foreign exchange market to increase profits. The results in Figure 17 show that central banks with more incentives intervene more aggressively and provide further evidence that the intervention is due to profit concerns.

5.2.3 Foreign Asset Ratio

In previous sections, we have discussed how the exchange rate impacts the central bank's profit. Recall that from an accounting point of view, local currency depreciation would result in a capital gain on the foreign reserves held by central banks. Moreover, the larger

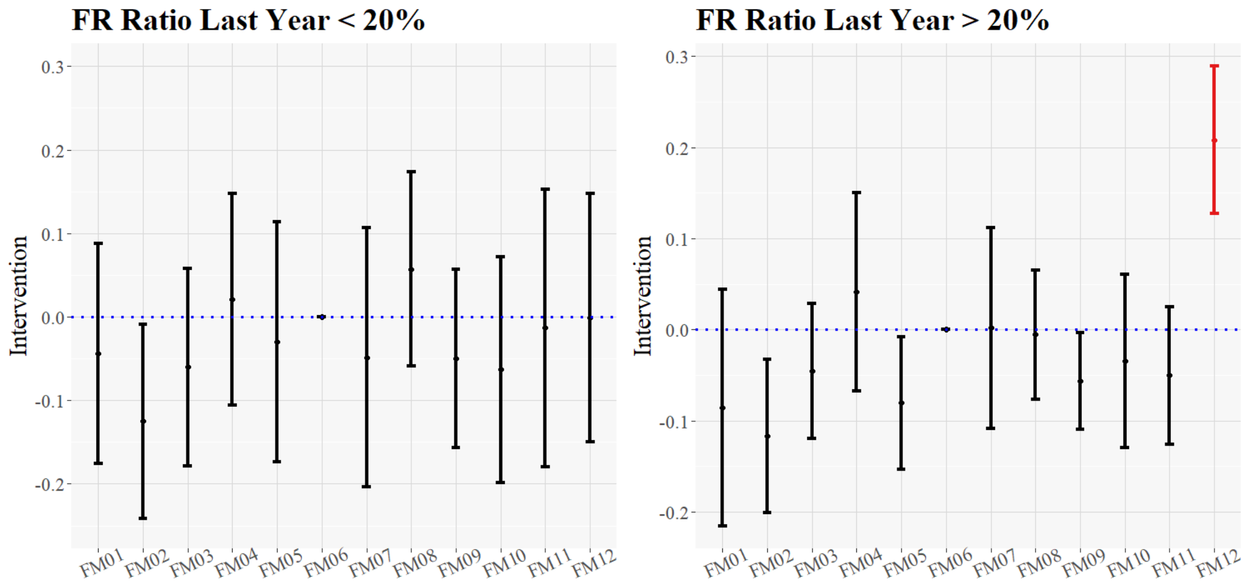
Figure 17. Foreign Exchange Market Intervention In Each Fiscal Month Compared to the Middle of the Fiscal Year (Four subsamples according to the previous year profits)



This figure shows the estimation results for equation (3) for four sub-samples. The data is divided into four groups according to the profit reported at the end of the fiscal year: previous year losses (RoA < 0), previous year small profits (RoA $\in [0, 0.81)$), previous year medium profits (RoA $\in [0.81, 2.20\%)$), and previous year large profits (RoA > 2.20). The bar represents a 95% confidence interval. Standard errors are clustered for central banks. *Data Sources:* S&P Capital IQ Pro and Adler et al. (2024).

the foreign reserves, the greater the gain from depreciation. Figure 6 plots the net foreign asset to total asset ratio for the 93 central banks in our dataset that have balance sheet data. The first quartile, median, and third quartile are 41%, 66%, and 84%, respectively. Given the large amount of foreign reserves central banks generally hold, a small fluctuation in the exchange rate could hugely impact the profit a central bank reports. However, there are some central banks in certain periods that hold a small amount of foreign reserves. For those central banks, the foreign exchange rate would have little impact on their profits. As a result, even with profit concerns, central banks with small foreign reserves would have little incentive to intervene in the foreign exchange market for profit motives. This is exactly what we observed in the data. Figure 18 displays the results. The data are grouped into two sub-samples based on the net foreign asset to total asset ratio at the beginning of the fiscal year. A central bank in a given year with a ratio less than 20% is separated from those greater than 20%. The former group accounts for 12.4% of the total available data on

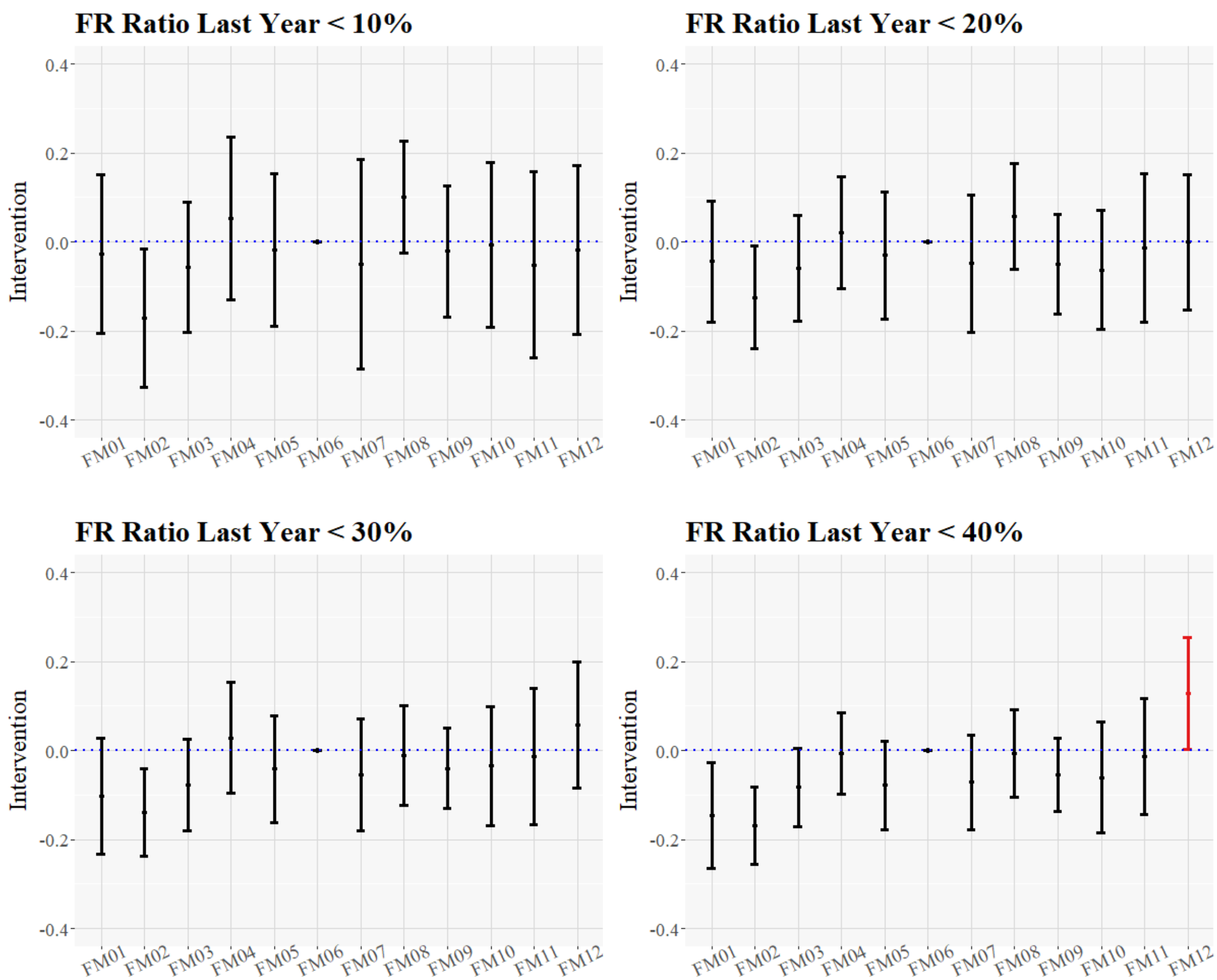
Figure 18. Foreign Exchange Market Intervention In Each Fiscal Month Compared to the Middle of the Fiscal Year (Two subsamples according to the net foreign asset to total asset ratio)



This figure shows the estimation results for equation (3) for two sub-samples. The data is divided into two groups according to the net foreign asset (foreign asset minus foreign debt) to total asset ratio: the central bank-year with a ratio less than 20% (left panel) and more than 20% (right panel). These two groups account for 12.4% and 87.6% of the available data on FXI (2,685 and 18,954 observations), respectively. The bar represents a 95% confidence interval. Standard errors are clustered for central banks. *Data Sources:* IMF's International Financial Statistics and Adler et al. (2024).

FXI (2,685 observations), while the latter group accounts for the remaining 87.6% (18,954 observations). The left panel of Figure 18 displays the regression result from equation (3) using the sub-sample with a low ratio. It shows how the central bank intervenes each fiscal month, given that it has a small foreign reserve at the beginning of the fiscal year. The point estimate of the key variable of interest, β_{12}, is 0. On the other hand, the right panel shows the same estimation using the sub-sample with a high net foreign asset to total asset ratio. The point estimation for β_{12} is 0.208 and statistically significant at a 1% confidence level with standard error clustered for central banks. The results demonstrate that central banks with large reserves tend to intervene aggressively at the fiscal year-end. On the other hand, the same pattern cannot be observed for central banks that start the fiscal year with a small foreign reserve on their balance sheet. The results are intuitive as the latter group of central

Figure 19. Foreign Exchange Market Intervention In Each Fiscal Month Compared to the Middle of the Fiscal Year (Four subsamples according to the net foreign asset to total asset ratio)



This figure shows the estimation results for equation (3) for four sub-samples according to the net foreign asset to total asset ratio. The bar represents a 95% confidence interval. Standard errors are clustered for central banks. *Data Sources:* IMF's International Financial Statistics and Adler et al. (2024).

banks has fewer incentives to intervene for profit motives than the former group.

To demonstrate that the result is robust to the 20% cutoff point, Figure 19 illustrate the same regression using data from central banks with previous year net foreign asset to total asset ratio less than 10%, 20%, 30%, and 40% respectively. As we can see, the less foreign reserve a central bank has, the pattern of intervention in the last fiscal month are more invisible.

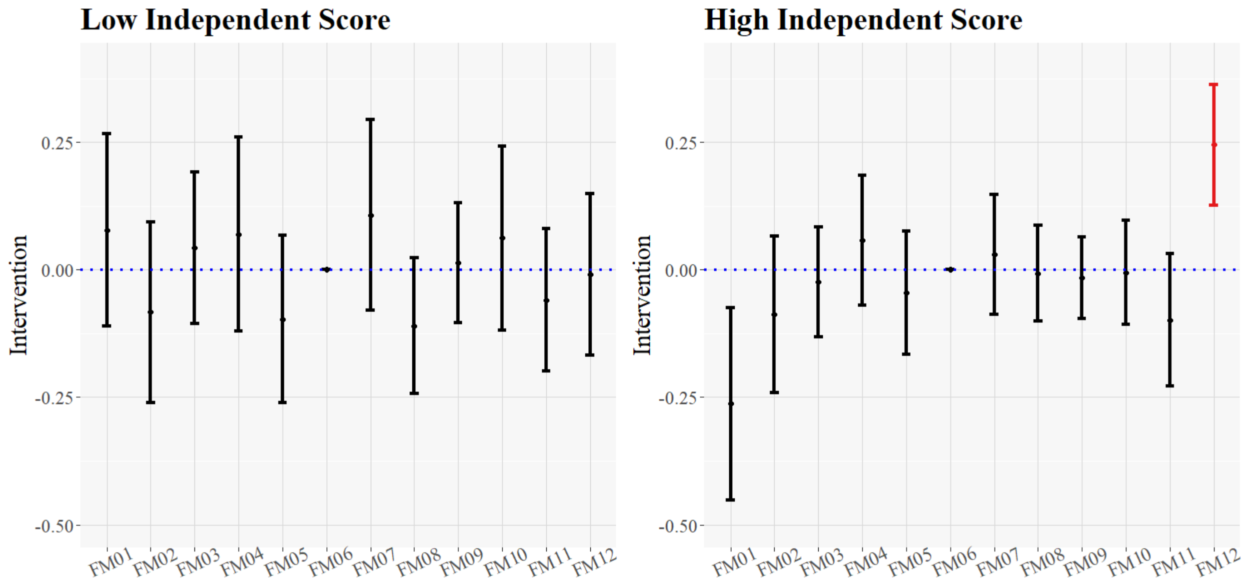
5.2.4 Central Bank de jure Independence

One key reason central banks care about the profits they report is to protect their independence. The quotes at the beginning of this paper from the Federal Reserve and the Riksbank are anecdotal evidence. Central bank losses may be viewed by the government or the public as a sign of incompetence and politicized at the expense of the independence of the central bank. Goncharov et al. (2023) provide empirical evidence on this matter. They show that central banks are discontinuously more likely to report slightly positive profits than slightly negative profits in general, but legally independent central banks exhibit a larger discontinuity. This result is consistent with the assumption that independent central banks may have stronger incentives to avoid losses.

This research shows that legally independent central banks tend to intervene in the foreign exchange market for profit concerns. At the same time, such a pattern is *not observed in less independent central banks*. This finding confirms the hypothesis that independent central banks may have stronger incentives to avoid losses. The measurement of central bank independence is based on Dincer and Eichengreen (2014). The authors pose 24 questions covering different aspects of central bank legal independence, including policy choice, objectives, and governance structures. They assign scores to central banks from 1994 to 2014, which range from zero to one, with higher values indicating more independent central banks. Among the 116 central banks covered by this study, 70 have data on the independence index from 2000 to 2014.

Figure 20 displays the results. The data are grouped into two equal groups according to the independence index provided by Dincer and Eichengreen (2014). Each group contains approximately 5,900 FXI observations. The left panel of Figure 20 displays the regression result from equation (3) using the sub-sample with central banks that received low independent scores. These are the central banks that are more integrated with the government. The point estimate of the key variable of interest, β_{12}, is -0.009 and is not statistically significant. On the other hand, the right panel shows the same estimation using the sub-sample with high

Figure 20. Foreign Exchange Market Intervention In Each Fiscal Month Compared to the Middle of the Fiscal Year (Two subsamples according to the independence index)



This figure shows the estimation results for equation (3) for two sub-samples. The data is divided into two equal groups according to the independence index provided by Dincer and Eichengreen (2014). Each group contains approximately 5,900 observations. The bar represents a 95% confidence interval. Standard errors are clustered for central banks. *Data Sources:* Dincer and Eichengreen (2014) and Adler et al. (2024).

independent scores. The point estimation for β_{12} is 0.245 and statistically significant at a 1% confidence level with standard error clustered for central banks. The results demonstrate that independent central banks are more likely to intervene for profit reasons than their less independent counterparts. This is consistent with the assumption that independent central banks avoid losses to protect their independence.

In the empirical section of this research, I analyze data from 116 central banks between 1996 and 2024. The findings reveal that central banks are disproportionately more likely to report a small positive profit than a small negative one, indicating a strong concern for profit. I also show that local currency depreciation boosts profits due to the revaluation gains on foreign reserves held by central banks. The main takeaway is that central banks frequently intervene in the foreign exchange market in the last fiscal month before releasing financial statements, causing depreciation and increasing profits. These interventions are driven by profit motives, especially in central banks that reported losses in the previous year, has large reserves, and those with higher independence. The distinct distortion pattern observed supports the idea that profit concerns motivate these interventions rather than other factors, such as seasonality. In the next section, I explore how these profit concerns can act as a commitment device, potentially helping economies escape liquidity traps.

6 Profit Concern and Policy Rate

In Section 4.3 we see that central bank profits positively correlate with local currency depreciation and low interest rates. Section 5 provides evidence that central banks worldwide put depreciation pressure on local currency for profit reasons. This section provides suggestive evidence that central banks intentionally under-shoot interest rate targets for profit reasons.

Our objective is to see whether central banks set policy rates "too low" for profit reasons. We employ similar methods as section 5.2. Namely, we see how CBs set policy rates towards the end of the fiscal year. To determine whether the rate set by a given CB is too low, we compare it with the standard Taylor rule, which is given by the following:

$$R_{i,t,m} = r^*_{i,t} + \pi_{i,t,m} + 0.5(\pi_{i,t,m} - \pi^*_{i,t}) - (u_{i,t,m} - u^*_{i,t}).$$

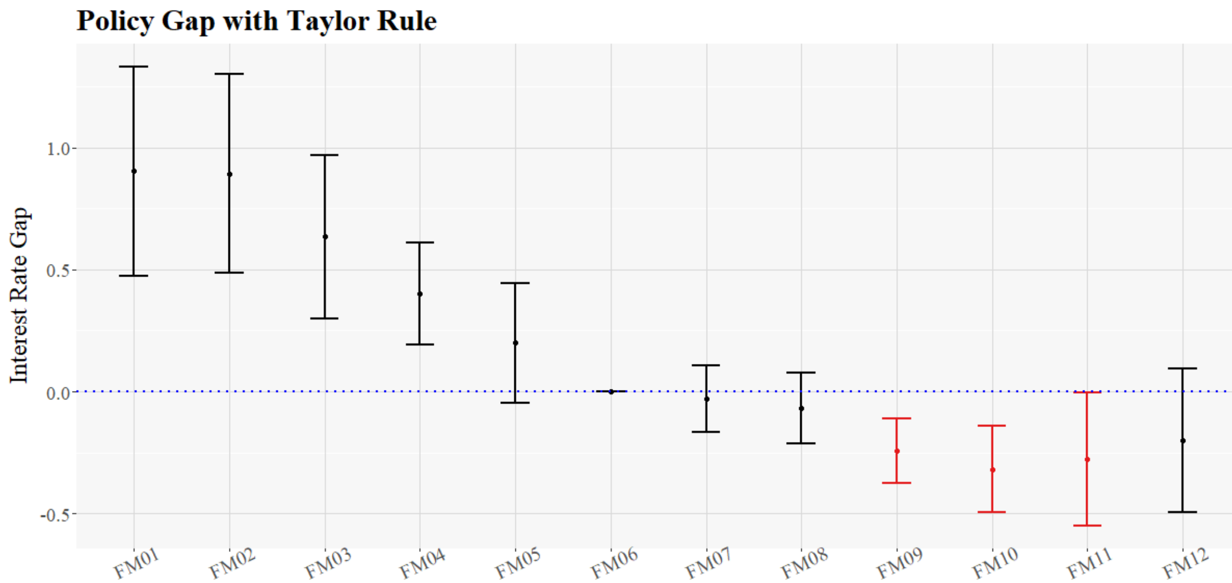
Where $R_{i,t,m}$ is the suggested policy rate for country i at time t in month m. $\pi_{i,t,m}$ and $u_{i,t,m}$ are the CPI inflation and unemployment rates, respectively. $r^*_{i,t}$, $\pi^*_{i,t}$, and $u^*_{i,t}$ are the natural real interest rate, natural inflation rate, and natural unemployment rate, respectively.

Now we can construct the "policy gap" $Y_{i,t,m}$ that captures the distance between the suggested and the actual interest rates:

$$Y_{i,t,m} \equiv r_{i,t,m} - R_{i,t,m},$$

where $r_{i,t,m}$ is the actual policy rate for country i at time t in month m.

Figure 21. Interest Rate Gap In Each Fiscal Month Compared to the Middle of the Fiscal Year



This figure shows the estimation results for equation (4) using the Taylor rule as the benchmark interest rate. 95% confidence intervals are displayed, and standard errors are clustered by country. *Data Sources:* S&P IQ Pro and IMF's International Financial Statistics.

The following regression test whether the interest rate gap has "widened" towards the end of the fiscal year:

$$\begin{aligned} Y_{i,t,m} = \alpha_{i,t} &+ \beta_1 \cdot \mathbb{I}(m = \text{first fiscal month for country } i) \\ &+ \beta_2 \cdot \mathbb{I}(m = \text{second fiscal month for country } i) + ... \\ &+ \beta_{12} \cdot \mathbb{I}(m = \text{last fiscal month for country } i) + \epsilon_{i,t,m}, \end{aligned} \tag{4}$$

where β_6 is left out as baseline.

As a technical note, in general, $r^*_{i,t}$, $\pi^*_{i,t}$, and $u^*_{i,t}$ are hard to obtain and hence $R_{i,t,m}$ is difficult to construct. But due to the county-time fixed effect $\alpha_{i,t}$, we actually do not need

$r^*_{i,t}$, $\pi^*_{i,t}$, and $u^*_{i,t}$ to estimate equation (4). Our variable of interest is:

$$
\begin{aligned}
Y_{i,t,m} &\equiv r_{i,t,m} - R_{i,t,m} \\
&= r_{i,t,m} - [r^*_{i,t} + \pi_{i,t,m} + 0.5(\pi_{i,t,m} - \pi^*_{i,t}) - (u_{i,t,m} - u^*_{i,t})] \\
&= r_{i,t,m} - [r^*_{i,t} - 0.5\pi^*_{i,t} + u^*_{i,t}] - 1.5\pi_{i,t,m} + u_{i,t,m} \\
&\equiv r_{i,t,m} - \delta^*_{i,t} - 1.5\pi_{i,t,m} + u_{i,t,m}.
\end{aligned}
$$

Therefore we can define $\tilde{Y}_{i,t,m}$ as the following

$$\tilde{Y}_{i,t,m} \equiv Y_{i,t,m} + \delta^*_{i,t} = R_{i,t,m} - 1.5\pi_{i,t,m} + u_{i,t,m}.$$

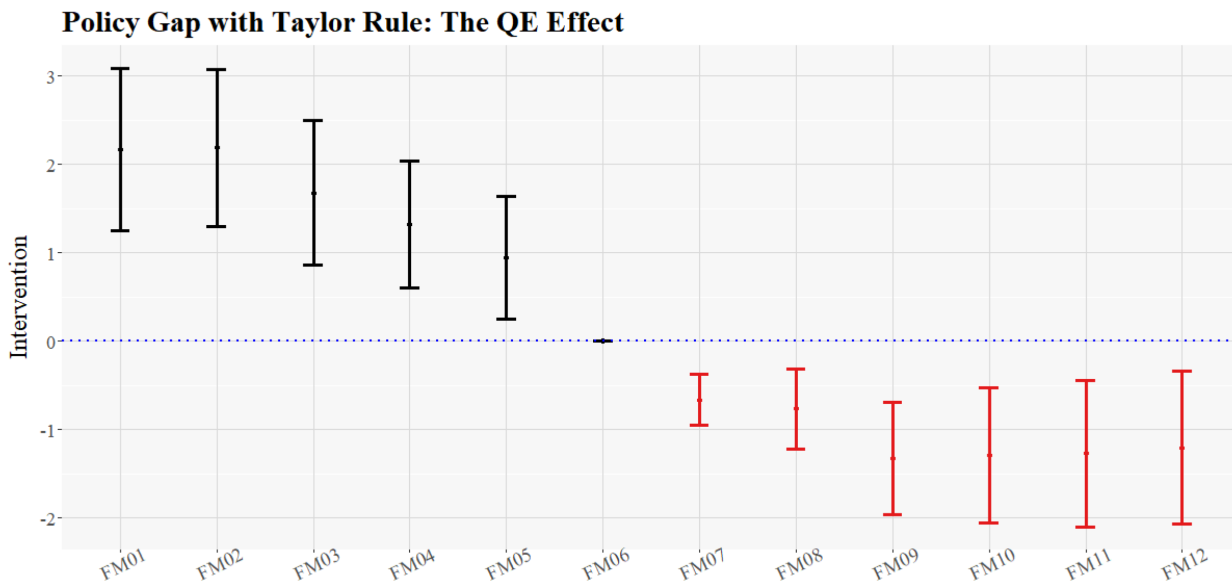
Note that $\tilde{Y}_{i,t,m}$ can be easily obtained. We then run the regression (4) using $\tilde{Y}_{i,t,m}$ instead of $Y_{i,t,m}$. The regression we actually run is given by:

$$
\begin{aligned}
\tilde{Y}_{i,t,m} \equiv Y_{i,t,m} + \delta_{i,t} = \alpha_{i,t} + \beta_1 \mathbb{I}(m = \text{first fiscal month}) + ... \\
+ \beta_{12} \mathbb{I}(m = \text{last fiscal month}) + \epsilon_{i,t,m},
\end{aligned}
$$

where β_6 is left out as baseline. Note that the two regressions should yield identical results for $\beta_1, ..., \beta_{12}$.Therefore, we only need to obtain data for $\tilde{Y}_{i,t,m} \equiv R_{i,t,m} - 1.5\pi_{i,t,m} + u_{i,t,m}$, which is readily available.

Figure 21 shows the estimation results for equation (4) by choosing the Taylor rule as the benchmark interest rates. We can see that the interest rate gap becomes negative and significant towards the fiscal year-end — the central bank under-shoots its interest rate target towards the end of the fiscal year. The plot shows that the prevailing policy rates are around 25-30 bases points lower than the suggested amount by Taylor Rule towards the fiscal year end. Also note that there's no sudden jump at the last fiscal month, instead a slow and gradual under-shoot toward the fiscal end. This make sense from a profit concern perspective. Unlike exchange rates, which affect the profit only through the last fiscal month,

Figure 22. Interest Rate Gap In Each Fiscal Month Compared to the Middle of the Fiscal Year: Advanced Economies During 2019-2024



This figure shows the estimation results for equation (4), focusing on the the advanced economies defined by the IMF during time period 2019-2024. Taylor is used as the benchmark interest rate. 95% confidence intervals are displayed, and standard errors are clustered by country. *Data Sources:* S&P IQ Pro and IMF's International Financial Statistics.

interest rates affect profit through interest income and expenses. These income and expenses occurs every month of the year. Therefore a central bank with profit concern would have incentive to under-shoot its policy rate target towards fiscal year end to be able to report a better profit that year. Figure 21 provides us with suggestive evidence that central banks worldwide set interest rates too low due to profit concerns.

6.1 Profit Concerns and Policy Rate: QE Effect

Recall that from the US and Australia case studies, we see how the policy rate affects profit depends on the balance sheet structure. Since the breakout of COVID-19, central banks in advanced economies have drastically changed their balance sheet structure due to large-scale asset purchases. In Section 4.3.1 we focused on a subset of countries from 2020 to 2024 that is classified as “Advanced economies" in the IMF World Economic Outlook. All countries in this classification have performed some degree of large-scale asset purchases. The following 24 countries in our panel is classified as advanced economies: Australia, Canada, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Greece, Hong Kong, Iceland, Israel, Korea, Latvia, Lithuania, Macao, Malta, New Zealand, Norway, Singapore, Slovak Republic, Slovenia, Sweden, Switzerland, and Taiwan.

In this subsection, we turn our focus to these countries that have performed QE. Central banks that have performed QE have similar asset structures. In particular, the effect that high interest rates decrease central banks' profit is most pronounced among the ones that have performed QE. Using this data subset, we run equation (4) with the interest rate gap constructed using the Taylor rule. Figure 22 shows the estimation results for equation (4) by choosing the Taylor rule as the benchmark interest rates. We can see that the interest rate gap becomes negative and significant towards the fiscal year-end — the central bank undershoots its interest rate target towards the end of the fiscal year. Also note that the point estimate is very large compare to the previous estimate using the full dataset. Increasing from around 30 basis point to 130 basis point of under-shooting. This provides us with suggestive evidence that central banks worldwide set interest rates too low due to profit concerns.

7 Conclusion

This study empirically investigates the sources of profits for central banks and the link between monetary policy and central banks' profit concerns. We first present three case studies to demonstrate that the Federal Reserve and the Reserve Bank of Australia's profits depend on the policy rates, whereas the Swiss National Bank's profits depend on the foreign exchange rate. We generalize this result for other central banks using balance sheets and income statements from 116 central banks between 1996 and 2024. We find that central bank profits are positively correlated with local currency depreciation and low interest rates. This study further reveals that central banks' profits directly impact monetary policy. We provide evidence that central banks worldwide put depreciation pressure on their local currency and undershoot their interest rate targets due to profit concerns.

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Appendix A Other Approach to Test Profit Concerns: Best Response Function Approach

This section documents another way to test whether central bank profit concerns affect monetary policies. We first construct a minimal structural model, and then use empirical data to estimate the parameters in our model. The data used here are monthly exchange rates and foreign reserves data that covers 154 countries from 2001-2021. The data are gathered from IMF's International Financial Statistics.

Assume the following loss function for central bank i at time t:

$$L_{i,t} = \frac{1}{2}(Y_{i,t} - Y_i^*)^2 + \frac{\lambda}{2}\left[(\tilde{e}_{i,t} - e_i^*)^2 + \frac{\gamma}{3}(\tilde{e}_{i,t} - e_i^*)^3\right],$$

where $Y_{i,t}$ and $\tilde{e}_{i,t}$ are the same as defined before. Y_i^* and e_i^* are the central bank's target reserve growth rate and target exchange growth rate, respectively. Note that a rise in $\tilde{e}_t$ represents a local currency depreciation.

Assume further that the central bank can intervene in the exchange rate through the following intervention equation:

$$\tilde{e}_{i,t} - e_i^* = a_0 + a_1 Y_{i,t} + \epsilon_t.$$

Therefore, the central bank's (static) problem is to pick the level of foreign reserve $Y_{i,t}$ to minimize $L_{i,t}$ subject to the intervention equation. Let $e_i^* = 0$, the optimality condition is given by:

$$Y_{i,t} = Y_i^* - \lambda a_1 \tilde{e}_{i,t} - \gamma \frac{a_1 \lambda}{2} \tilde{e}_{i,t}^2.$$

Our key parameter of interest is γ, which captures the central bank's asymmetric preference toward the foreign exchange rate movement. A negative and significant γ would imply that the central bank would respond aggressively to appreciation pressure but not to depreciation pressure. That is, a negative γ indicates that the central bank prefers depreciation over appreciation. We run the following regression using our data:

$$Y_{i,t} = \alpha_i + \beta_1 \tilde{e}_{i,t} + \beta_2 \tilde{e}_{i,t}^2 + \epsilon_{i,t}. \tag{A.1}$$

Note that $\beta_1 = -\lambda a_1$, $\beta_2 = -\lambda\gamma a_1/2$, and $\gamma = 2\beta_2/\beta_1$. Therefore, we can test whether γ is negative and significant. The standard errors reported are clustered for counties.

Table A1. Asymmetric parameter estimation: γ

	β_1	β_2	γ	# of Observation
Full Sample	-70.995***	63.388	-1.785	34307
$FAR > 10\%$	-72.030***	103.646*	-2.877*	31118
$FAR > 20\%$	-70.211***	149.125***	-2.746***	29336
$FAR > 30\%$	-70.211***	149.125***	-4.247***	27554
$FAR > 40\%$	-69.066***	175.220***	-5.073***	25025
$FAR > 50\%$	-70.796***	179.351***	-5.066***	21912
$FAR > 60\%$	-68.009***	175.344***	-5.156***	18477
$FAR > 70\%$	-64.600***	174.970***	-5.417***	14923

$*p < 0.1$; $**p < 0.05$; $***p < 0.01$

Table A1 summarizes the result. Note that using the entire sample, the variable of interest γ is negative yet not significant. But as we start to drop the data (country/month) with low FAR, we see that γ becomes more negative and significant. Indicating that countries with large foreign reserves are more likely to have asymmetric preference over exchange rate fluctuation. In particular, they would respond aggressively to appreciation pressure (which will bring them losses) but not to depreciation pressure (which brings profits).

Appendix B Robustness Check of the Relation Between Foreign Exchange Rates and Profits

Table 2 shows that depreciation is associated with profits through capital gain. There is, however, one potential simultaneity issue. The central bank's profits will increase due to currency depreciation. On the other hand, the foreign exchange rate might also be affected due to profits. In particular, when central banks are facing the possibility of reporting losses at the end of their fiscal year, they might depreciate their currency to avoid the situation. To address the simultaneity issue, we redefine $\tilde{e}_{i,t}$ as follows using a narrower window: $\tilde{e}_{i,t}(1) = (e_{i,t}(1) - e_{i,t-1})/e_{i,t-1}$, where $e_{i,t}(1)$ is the local currency price of one USD at the end of first month (January) for the year t. Note that while $\tilde{e}_{i,t}$ captures the exchange rate changes within the entire year t, $\tilde{e}_{i,t}(1)$ only captures the exchange rate changes within the first month of the year t. Similarly, $e_{i,t}(3)$ represents the exchange rate changes within the first three months of the year t. Note that $\tilde{e}_{i,t}(1)$ and $e_{i,t}(3)$ might have an impact on the central bank's profits, but it's very unlikely that profits inversely impact these variables, as profits are determined only at the end of the year. Table A2 shows the results, which are consistent with the main results. We provide another robustness result in the appendix.

Table A2. Robustness Check

Panel A: First-Month Changes

Dependent Variable: *RoA*	Net Income (1)	Non-Interest Income (2)	Interest Income (3)
r	-0.088	-0.044	-0.024
Δr	0.109***	0.065*	0.039
$\tilde{e}(1)$	0.076**	0.073**	0.020*
Observations	1016	986	977
Country fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Adjusted R^2	0.333	0.232	0.784

Panel B: First-Quarter Changes

Dependent Variable: *RoA*	Net Income (1)	Non-Interest Income (2)	Interest Income (3)
r	-0.101**	-0.053	-0.027
Δr	0.102***	0.061	0.038
$\tilde{e}(3)$	0.079***	0.059**	0.018***
Observations	1016	986	977
Country fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Adjusted R^2	0.3486	0.2392	0.785

This table shows the estimation result of equation (1): $RoA_{i,t} = \beta_1 r_{i,t} + \beta_2 \Delta r_{i,t} + \beta_3 \tilde{e}_{i,t}(1) + \nu_t + \alpha_i + \epsilon_{i,t}$ for country i in year t, where RoA denotes return on assets based on total net income (column (1)), non-interest income (column (2)), and interest income (column (3)), r denotes the policy rate at the end of each year, Δr denotes the percentage-point change in the policy rate from the previous year, $\tilde{e}(1)_{i,t}$ and $\tilde{e}(3)_{i,t}$ denote the rate of local currency depreciation against the USD in the first month and first quarter of year t, respectively, and FAR is the net foreign asset to total asset ratio. The sample is annual data for 142 central banks from 1996-2022. Standard errors are clustered for countries. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. *Data Sources:* S&P IQ Pro and Macrobond data (for policy rates).

Table A3. Coefficient on Currency Depreciation Over Different Number of Months (Robustness Check of Table 2)

Dependent Variable: *RoA*	Net Income (1)	Non-Interest Income (2)	Interest Income (3)
$\tilde{e}(1)$	0.076**	0.073**	0.020*
$\tilde{e}(2)$	0.081***	0.062***	0.025***
$\tilde{e}(3)$	0.079***	0.059**	0.018***
$\tilde{e}(4)$	0.085***	0.061**	0.020***
$\tilde{e}(5)$	0.085***	0.066***	0.016***
$\tilde{e}(6)$	0.085***	0.065***	0.016***
$\tilde{e}(7)$	0.086***	0.066***	0.017***
$\tilde{e}(8)$	0.094***	0.076***	0.014***
$\tilde{e}(9)$	0.090***	0.072***	0.012***
$\tilde{e}(10)$	0.086***	0.064***	0.011***
$\tilde{e}(11)$	0.080***	0.060***	0.011***
$\tilde{e}(12)$	0.080***	0.062***	0.009***
Observations	1016	986	977
Country fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes

This table shows the estimation result of β_3 in equation (1): $RoA_{i,t} = \beta_1 r_{i,t} + \beta_2 \Delta r_{i,t} + \beta_3 \tilde{e}_{i,t}(j) + \nu_t + \alpha_i + \epsilon_{i,t}$ for country i in year t and for $j = 1, 2, ..., 12$. RoA denotes return on assets based on total net income (column (1)), non-interest income (column (2)), and interest income (column (3)), r denotes the policy rate at the end of each year, Δr denotes the percentage-point change in the policy rate from the previous year, $\tilde{e}_{i,t}(j)$ denotes the rate of local currency depreciation against the USD in the first j month(s) of year t, and FAR is the net foreign asset to total asset ratio. The sample is annual data for 142 central banks from 1996-2022. Standard errors are clustered for countries. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. *Data Sources:* S&P IQ Pro and Macrobond data (for policy rates).

Table A4. Foreign Exchange Rate, Policy Rate, and Profits: Variation by Net Foreign Asset Dummy Variable

Dependent Variable: RoA	Net Income (1)	Non-Interest Income (2)	Interest Income (3)
r	-0.127***	-0.076	-0.033
Δr	0.098**	0.072*	0.029
$\tilde{e}$	0.062***	0.044***	0.015***
$r \times FAR_{i,t}$	0.031	0.046	-0.013
$\Delta r \times FAR_{i,t}$	-0.038	-0.077	0.016
$\tilde{e}_{i,t} \times FAR_{i,t}$	0.079***	0.085***	-0.014**
FAR	-0.406	-0.469	0.051
Observations	952	917	923
Country fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Adjusted R^2	0.427	0.306	0.785

This table shows the estimation result of equation (2): $RoA_{i,t} = \beta_1 r_{i,t} + \beta_2 \Delta r_{i,t} + \beta_3 \tilde{e}_{i,t} + \beta_4 r_{i,t} \times FAR_{i,t} + \beta_5 \Delta r_{i,t} \times FAR_{i,t} + \beta_6 \tilde{e}_{i,t} \times FAR_{i,t} + \beta_7 FAR_{i,t} + \nu_t + \alpha_i + \epsilon_{i,t}$, for country i in year t, where RoA denotes return on assets based on total net income (column (1)), non-interest income (column (2)), and interest income (column (3)), r denotes the policy rate at the end of each year, Δr denotes the percentage-point change in the policy rate from the previous year, $\tilde{e}$ denotes the rate of local currency depreciation against the USD, and $FAR_{i,t}$ is an indicator function that equals to one if the central bank i at time t has a net foreign asset to total asset ratio greater than the median (67.18%), and equals to zero otherwise. The sample is annual data for 142 central banks from 2001-2022. Standard errors are clustered for countries. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. *Data Sources:* S&P IQ Pro, Macrobond data (for policy rates), and International Monetary Fund's International Financial Statistics (For FAR).

Table A5. Foreign Exchange Rate, Policy Rate, and Profits: Variation by Net Foreign Asset Ratio

Dependent Variable: RoA	Net Income (1)	Non-Interest Income (2)	Interest Income (3)
r	-0.163***	-0.141**	-0.009
Δr	0.038	0.055	-0.012
$\tilde{e}$	0.032**	0.009	0.017***
$r \times FAR_{i,t}$	0.071	0.172*	-0.094**
$\Delta r \times FAR_{i,t}$	0.100	-0.034	0.122*
$\tilde{e}_{i,t} \times FAR_{i,t}$	0.135***	0.151***	-0.018**
FAR	-0.779	-1.059	-0.114
Observations	952	917	923
Country fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Adjusted R^2	0.440	0.331	0.791

This table shows the estimation result of equation (2): $RoA_{i,t} = \beta_1 r_{i,t} + \beta_2 \Delta r_{i,t} + \beta_3 \tilde{e}_{i,t} + \beta_4 r_{i,t} \times FAR_{i,t} + \beta_5 \Delta r_{i,t} \times FAR_{i,t} + \beta_6 \tilde{e}_{i,t} \times FAR_{i,t} + \beta_7 FAR_{i,t} + \nu_t + \alpha_i + \epsilon_{i,t}$, for country i in year t, where RoA denotes return on assets based on total net income (column (1)), non-interest income (column (2)), and interest income (column (3)), r denotes the policy rate at the end of each year, Δr denotes the percentage-point change in the policy rate from the previous year, $\tilde{e}$ denotes the rate of local currency depreciation against the USD, and FAR is the net foreign asset to total asset ratio. The sample is annual data for 142 central banks from 2001-2022. Standard errors are clustered for countries. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. *Data Sources:* S&P IQ Pro, Macrobond data (for policy rates), and International Monetary Fund's International Financial Statistics (For FAR).