The *Ins & Outs* of Chinese Monetary Policy Transmission

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Abstract

We estimate a policy rule for the People's Bank of China that accounts for the dual nature of its price stability mandate—encompassing domestic inflation and the exchange rate—and for the evolution of its operational framework. A single novel policy indicator summarises the shift from quantity-based policy to one acting increasingly on market interest-rates. The *Ins*: The domestic transmission of Chinese monetary policy follows textbook patterns, with exceptions due to the active management of the renminbi and of the capital account. The *Outs:* Internationally, fluctuations in Chinese output affects primarily commodity markets, and with them global production and trade. The pass-through of the commodity repricing to foreign (US) producer and consumer prices is substantial. Financial spillovers are second-order, and mostly derivative from trade spillovers.

Keywords: Monetary Policy; International spillovers; China

JEL Classification: E44, E52, F33, F42

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1 Introduction

One of the most consequential phenomena of the past few decades has been the remarkable ascent of China as a global economic powerhouse, if not as the largest global economy altogether.[1] Much has been written to analyse the features of this unprecedented economic miracle (see e.g. Prasad and Rajan, 2006; Song, Storesletten and Zilibotti, 2011; Zhu, 2012). Yet, we still know surprisingly little about the mechanics of shocks transmission in China, and of their potential international spillovers.

Monetary policy is no exception. The gradual yet fundamental institutional changes initiated with the country's "opening-up" reforms have led to a dramatic evolution of the Chinese economic paradigm. With the progressive liberalisation of Chinese financial markets being a prime example. In turn, this has led to a continuous adaptation and transformation of the operating framework of the People's Bank of China (PBOC), which over the years has transitioned across multiple policy targets, and an ever-changing arsenal of instruments and intermediate targets. The complexity of this institutional setup and of its evolution over the past few decades have made the study of monetary policy in China a particularly challenging endeavour.

Our paper is a first attempt at providing a comprehensive analysis of the monetary policy of the PBOC, and at characterising and quantifying its transmission both domestically and internationally.

Two main developments are key to our effort. First, we use a novel composite monetary policy indicator to gauge the PBOC monetary policy stance against the backdrop of a continuously evolving operating framework that went from being essentially quantity-based, to one increasingly centred on market interest rates. Second, we estimate an endogenously switching monetary policy rule for the PBOC that is consistent with its mandate of facilitating the Chinese government achieving its growth objectives, while maintaining price stability. Importantly, the rule explicitly accounts for the dual nature of the price stability mandate, therefore encompassing both domestic inflation and stability of the value of the renminbi.

[1] China is second only to the US when using nominal GDP at market exchange rates. A ranking based on the purchasing power parity (PPP) of its currency would place it in first place. See https://www.imf.org/external/datamapper/PPPSH@WEO/OEMDC/ADVEC/WEOWORLD.

The composite monetary policy indicator (CMPI) builds on the intuition developed in Xu and Jia (2019), and summarises information from a variety of monetary and credit aggregates as well as interest rates, with time-varying weights, to reflect the transformation that the PBOC operating framework underwent over the past few decades. The CMPI combines information from the growth rate of M2 and of total credit—also known as total social financing—as well as of lending rates and reserve requirement ratios, that served as the preferred intermediate targets and policy instruments in the earlier part of our sample. In the latter part of the sample, it gives more weight to market interest rates, such as the 7-day repo and reverse repo rates, the 3-month Shibor, and the 1-year loan prime rate (LPR).

Our specification of the policy rule for the PBOC builds on the seminal work of Chen, Ren and Zha (2018)—CRZ henceforth. CRZ propose a policy rule with the following two key characteristics. First, it is specified against the official Chinese government's targets for growth and inflation that are announced at the beginning of every year during the plenary assembly of the National People's Congress. Second, it features an endogenously switching response of monetary policy to growth depending on whether output overshoots or undershoots the government's annual target. Relative to CRZ, we introduce two main innovations. First, we add an explicit term that targets fluctuations in the value of the renminbi, to reflect the dual nature of the PBOC's price stability objective and the importance that currency management has beyond its effects on domestic inflation (Gang, 2018). To do so, we reconstruct a monthly effective exchange rate for the Chinese yuan using the official China Foreign Exchange Trade System (CFETS) trade weighs and central parity exchange rates, that are used as a gauge to keep the "exchange rate basically stable at an adaptive and equilibrium level" (Gang, 2018). Second, we use the CMPI as a policy indicator, in place of the growth rate of M2 used by CRZ. This allows us to specify a single policy rule that encompasses all the alternative policy instruments and targets that the PBOC has used to achieve its policy objectives over the course of the last few decades.

We use the policy rule's residuals to identify Chinese monetary policy shocks and to study their domestic (the *Ins*) and international (the *Outs*) transmission.

The *Ins* The identified monetary policy shock leads to an increase in Chinese interest rates, with those at shortest maturity reacting the most. This qualifies the identified shock as a short-term monetary policy contraction, or in other words, as a conventional monetary policy tightening. The 7-day repo rate, the official policy rate operated by the PBOC since the introduction of the interest rate corridor, contracts significantly on impact. The pass-through to short-term lending rates is almost full, while the short-term interbank Shibor contracts even more. The shock affects interest rates up to a 2-year maturity, while the longer end of the Chinese yield curve is largely unresponsive.

Higher borrowing costs are paired up with a persistent contraction in aggregate lending, and lead to an equally protracted contraction in economic activity, which drags down Chinese imports as well. The contraction in imports is twice as large as that in domestic output. Chinese exports eventually contract to a similar extent but, importantly, do not respond for the full year after the shock hits, suggesting that additional measures to incentivise exports may be in place. The inflation response is initially pushed upwards by increased housing costs, which make up a significant component of consumer prices in China.

Collectively, these responses point to a domestic transmission mechanism for Chinese monetary policy that is very much in line with what documented for other advanced economies. Important differences however arise when considering the response of the exchange rate and the capital account.

The strict capital controls that are in place in China are effective at curbing private capital flights by domestic residents to a very large extent, which results in them being mostly unresponsive to the shock. Conversely, foreign investment into China are progressively reduced. Both FDIs and banking flows, that virtually capture the full extent of private inflows into China, contract very significantly in the medium term.

The reduction in private foreign investments is counteracted by a progressive reduction of official foreign exchange reserves, which points to mechanisms highlighted in e.g. Avdjiev, Hardy, Kalemli-Özcan and Servén (2022). At the same time, we find some evidence of a short-lived increase in FX reserves and in the reserve ratios imposed on domestic banks, which points to activity in place to shield the yuan from excessive volatility. Indeed, one of the main difference relative to the transmission of monetary policy in other

advanced economies is the delayed appreciation of the yuan.

As noted in e.g. Das (2019), the current exchange rate regime in China is best understood as a de facto crawling peg against the US dollar, combined with a more flexible management against the remaining CFETS currencies. Our results highlight this duality very clearly. The non-dollar CFETS exchange rate appreciates significantly at medium horizons, and accounts for virtually all of the movements in the CFETS index. Conversely, the bilateral CNY/USD rate is kept mostly stable after the shock hits, and if anything, is slowly depreciates over time.

The *Outs* The international transmission of Chinese monetary policy shocks seems to operate primarily through fundamentally standard trade channels. With an important amplification mechanisms being played out by commodity markets and potentially also by integrated production networks. Conversely, our results point to a relatively minor role for financial channels.

The domestic contraction in Chinese production, and particularly of Chinese imports, sets out a potent chain reaction that leads to a strong contraction in both global output and trade. Hence, to an overall deterioration in the global growth outlook. The large role that China plays not only in the context of global trade of final goods, but also as a key actor in production networks worldwide puts these results into perspective.

Consistent with the heightened global macroeconomic risk and with flight-to-safety motives that lead to a stronger dollar in risk-off scenarios, the US dollar appreciates with delay (see e.g. Gourinchas and Rey, 2022; Obstfeld and Zhou, 2023). At the same time, the contraction in Chinese production kicks off a material fall in the demand for raw materials, which results in a significant albeit delayed fall in commodity prices, despite the US dollar appreciation. This is particularly true for industrial metals, heavily utilised in manufacturing processes (see also Gazzani and Ferriani, 2024). Global financial conditions are largely unaffected, but some mild deterioration is noted in conjunction with the stronger dollar and with weaker commodity prices at medium horizons. The delayed response of global asset prices to a Chinese policy shock suggests that real effects rather than financial ones are the primary channels responsible for their contraction (see also Miranda-Pinto, Pescatori, Prifti and Verduzco-Bustos, 2023). This puts these results in

stark contrast with those documented in e.g. Rey (2013) and Miranda-Agrippino and Rey (2020, 2022) on the amplification of the global transmission of US monetary policy through the Global Financial Cycle.

The absence of an international risk-taking channel for the transmission of Chinese monetary policy does not prevent some countries from suffering adverse consequences also in this respect. In particular, we show that emerging market economies that rely heavily on Chinese demand for raw materials also experience a liquidity shock as a result of the Chinese contraction, due to a fall in inflows of foreign capital.

Lastly, we show that as China's largest trading partner, the US economy too is vulnerable to Chinese spillovers. The US trade balance deteriorates in response to the Chinese shock, dragged down by a substantial fall in US exports. US output falls by roughly the same amount as Chinese output, albeit with more delay. The price spillovers are also significant. Despite the dollar appreciation, the fall in commodity prices leads to a fall in US import price inflation, with significant pass-through to US producer and consumer price inflation alike.

The paper is organised as follows. We discuss the related literature in the reminder of this section. Section 2 describes the evolution of the PBOC monetary policy framework and of the related exchange rate regime. Section 3 introduces our novel monetary policy indicator, and we estimate the non-linear policy rule for the PBOC in Section 4. Sections 5 and 6 contain our main results. Section 5 focuses on the domestic transmission of Chinese monetary policy, while international spillovers are presented in Section 6. Section 7 concludes. Additional results are reported in the Appendix.

Related Literature Our paper contributes to a growing literature that studies the features and transmission of Chinese monetary policy. Chen, Chen and Gerlach (2013); Jones and Bowman (2019) and Kim and Chen (2022) analyse and discuss the implementation of Chinese monetary policy, and the evolution of the operating framework in detail. Fernald, Spiegel and Swanson (2014) is an early empirical study of the domestic Chinese monetary policy transmission that shows that increases in reserve requirements and interest rates reduce activity and inflation, suggesting that the transmission of monetary

policy in China may be akin to that in Western market economies. Similarly, McMahon, Schipke and Li (2018) show that while not used as an active policy tool as done in other major central banks, the PBOC communication has become increasingly important in steering financial markets expectations. Still within the domestic context, Chen, Ren and Zha (2018) analyse the role that shadow banking credit plays in the transmission of monetary policy, and its interaction with more traditional bank lending.

An important feature of the Chinese policy landscape is the active management of the renminbi. A useful description of the evolution of the Chinese exchange rate regime is found in Das (2019). The more recent reforms concerning the renminbi stabilisation goal are studied in detail in Jermann, Wei and Yue (2022), while Bahaj and Reis (2024) study the interaction between the onshore and offshore yuan, and the role played by the latter in the implementation of capital controls, another prevalent feature of Chinese policy.

The progressive move from a quantity-based to a price-based monetary policy framework for the conduct of Chinese monetary policy has motivated a number of studies to explore alternative ways to both measure the policy stance, and identify policy shocks. Chen, Ren and Zha (2018) emphasise quantity-based instruments, and single out the growth rate of M2 as the intermediate policy target for the PBOC between 2000 and mid-2016. Similarly, Barcelona, Cascaldi-Garcia, Hoek and Van Leemput (2022) elect the changes in the flow of total social financing as an encompassing indicator to summarise monetary, fiscal, and credit policies. Funke and Tsang (2021) focus instead on interest rates only, and measure the Chinese monetary policy stance as the factor common to the 7-day reverse repo rate, the reserve requirement ratio, the PBOC's open market operations, and the interest rates on the Medium-Term Lending Facility (MLF) and the Pledged Supplementary Lending (PSL) Facility. While relevant over particular sample periods, neither of the quantity-based variables is sufficient to capture the complex evolution into the interest-based framework that is in place currently. Equally, focusing exclusively on interest rates is likely to downplay earlier years when policy was conducted by setting lending quotas and targets for aggregate lending. The composite monetary policy indicator that encompasses both price and quantity measures is novel, and builds on the intuition in Xu and Jia (2019).

Our rule-based identification builds on the work of Chen et al. (2018). Alternative

methods have been devised in e.g. Sun (2018), that constructs a narrative measure based on the author's reading of PBOC communication about the monetary policy stance, and in Sun (2020), that exploits reactions to particular announcements in standard event-study fashion. Kamber and Mohanty (2018); Shieh (2024); Das and Song (2022) use high-frequency changes in interbank rates around PBOC announcements to identify shocks to Chinese monetary policy in a manner consistent with a line of work using such high-frequency surprises to study monetary policy transmission in advanced economies (e.g. Gürkaynak, Sack and Swanson, 2005). This approach is only applicable to the very recent period to allow for sufficiently liquidity in interest rate swap markets, and market interest rates becoming a more dominant tool of Chinese monetary policy. Even then, focussing on a single interest rate relies on a strong assumption that there is a stable relationship between interest rates in different segments of Chinese financial markets, which requires passing judgement on how effective the interest rate liberalisation reform has been in reducing market fragmentation (Chow and Perkins, 2014).

Studies of the international spillovers of Chinese policy are still limited. Barcelona et al. (2022) find some tentative evidence of spillovers to both real activity and financial conditions from what they dub a Chinese "credit impulse" that may be due to a combination of monetary, fiscal and industrial policies. Shieh and Sanyal (2024) study how spillovers of Chinese monetary policy shocks identified using high-frequency surprises to 7-day repo rates vary across international stock markets depending on the production network links with China. Similar to us, and using the M2-based policy shocks of Chen et al. (2018), Gazzani and Ferriani (2024) documents powerful spillovers of Chinese monetary policy to global commodity markets.

2 The Chinese Monetary Policy Framework

The People's Bank of China (PBOC) has operated as the Chinese central bank since 1983. Its official mandate, enshrined in the 1995 Law of the People's Republic of China on the People's Bank of China, defines the objective of the prudent monetary policy as *"to maintain the stability of the value of the currency, and thereby promote economic*

growth".[2] Differently from inflation targeting central banks, this formulation of the mandate effectively encompasses two distinct policy targets. Specifically, as described by former governor Yi Gang, "to maintain currency stability has two tiers of meanings: internally it means to maintain prices stable and externally it means to keep [the renminbi] exchange rate basically stable at an adaptive and equilibrium level" (Gang, 2018).

The framework for the implementation of this broad mandate has undergone profound changes since the 1990s (see e.g. Chow and Perkins, 2014). Largely driven by the gradual liberalisation of Chinese financial markets, the policy framework has progressively transitioned away from quantity-based monetary policy instruments and intermediate targets, and towards a system predominantly centred on market interest rates (see e.g. Fernald, Spiegel and Swanson, 2014; Kim and Chen, 2022). In parallel, the Chinese authorities have also undertaken a progressive liberalisation of the exchange rate regime, which has evolved from a strict US dollar peg into a more flexible management with respect to a broader basket of currencies.

We briefly review these developments in what follows. This serves as a background to motivate the novel measure for the PBOC monetary policy stance that we introduce in the next section.

Domestic Monetary Policy Framework. At the turn of the century, the PBOC had just transitioned away from directing lending via credit quotas—a practice prevalent during the 1990s—to utilising a monetary aggregate (M2) as an intermediate target for monetary policy (Gang, 2018). Credit provision however remained central in the conduct of the PBOC's policy. The benchmark lending and deposit rates, set by the PBOC, provided an anchor for interest rates across the country. And, in the same spirit, starting from the mid-2000s the PBOC began using changes in the reserve requirement ratios (RRR) for Chinese banks as an additional quantity-based instrument to regulate the amount of available liquidity (Jones and Bowman, 2019).

This system remained largely in place until the financial crisis of 2008. Between 2009 and 2015, the non-bank financial sector started playing an ever greater role in Chinese credit allocation. Over that period, and while the PBOC was intent to unwind the stim-

[2]See http://www.pbc.gov.cn/en/3688229/3688299/3688302/index.html.

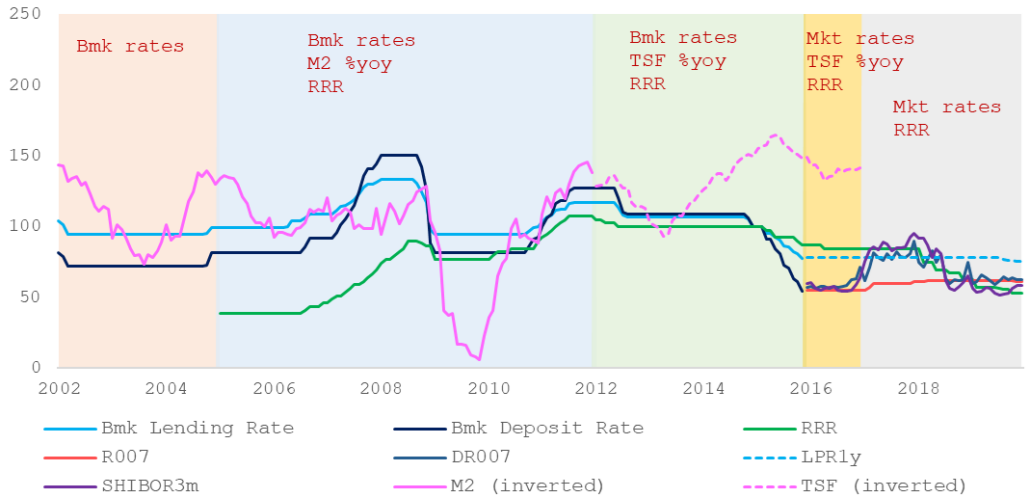
ulus injected in response to the financial crisis by restricting the money supply, shadow bank lending soared (Chen, Ren and Zha, 2018). The resulting divergence between total credit and M2 induced the PBOC to place a greater emphasis on aggregate financing to the real economy (AFRE)—also known as total social financing (TSF)—as the primary quantity target starting from 2012 (Gang, 2018).

At the same time, the Chinese authorities were also managing a progressive liberalisation of interest rates, which eventually culminated with the benchmark lending and deposit rates being officially phased out in 2013 and 2015, respectively. In their place, the PBOC resolved to affect market-based interest rates by establishing a series of new monetary operations and lending facilities (Gang, 2021). In the current interest rate based framework, two policy rates have emerged as key—the 7-day reverse repo rate (R007), and the Medium-Term Lending Facility (MLF) rate.

The PBOC 7-day reverse repo rate sits at the centre of the interest rate corridor system that was established in 2015. In conjunction with the interest rate on excess reserves (the floor) and the Standing Lending Facility (SLF) rate (ceiling), it aims to control the interbank 7-day repo rate (DR007), and short-term interbank funding conditions more broadly. The 7-day repo rate has become a key policy target rate since the introduction of the corridor system, and in the aftermath of the liberalisation of the lending and deposit rates. In addition, in oder to better align actual lending rates with the policy rate, in August of 2019 the PBOC instructed Chinese banks to quote their Prime Lending Rates (LPR)—i.e. the lending rates offered to their highest-quality customers—as a spread over the official MLF rate (Gang, 2021). As a result, the LPR now tracks the policy rate on the medium-term lending facility more closely, and it has replaced the phased-out benchmark rates as the reference rate for new bank loans (Jones and Bowman, 2019).

To summarise, over the past two decades monetary policy implementation in China has progressively placed less weight on quantity-based instruments (quotas, RRR) and targets (M2, TSF growth) in favour of price-based instruments (corridor system, R007, MLF rate) and targets (interbank lending rates, LPR). Furthermore, it has moved away from directly steering commercial financial institutions, e.g. through the benchmark deposit and lending rates, to indirectly affecting market-based interest rates via a broad set of lending facilities and monetary operations.

FIGURE 1: EVOLUTION OF THE CHINESE MONETARY POLICY FRAMEWORK



Note: The chart plots the key policy instruments and targets used by the PBOC to conduct monetary policy between 2002 and 2019. All series expressed as an index, December 2015=100.

Figure 1 provides a visual illustration of the evolution of the Chinese monetary policy framework between 2002 and 2019. Following the narrative of events discussed above, the chart highlights five main phases, each characterised by the different combination of instruments and intermediate targets that were relevant over that period. To make the series comparable, we express them in index points, with December 2015 set to 100.[3]

The early 2000s (pale-red block) were characterised by a focus on the 1-year benchmark lending and deposit rates, with the annual growth rate of M2 as the intermediate target. Starting from 2005, the PBOC started making more systematic use of the required reserve ratios (RRR), which are added to the mix as a further quantity-based monetary policy instrument (blue block). From 2012 (green block), the PBOC responds to the growth in shadow banking by targeting broader credit supply as measured by total social financing (TSF), which from that point onwards replaces M2 as the intermediate target. The 1-year benchmark loan rates were changed for the last time in November 2015, and replaced thereafter by the market-based interest rates influenced by the PBOC's open market operations and liquidity facilities. The orange block delineates this phase by introducing the 7-day interbank repo and PBOC reverse repo rates (DR007, R007), the 1-year

[3]This chart is intended for illustrative purposes only. As we discuss in the next section, for our analysis we construct a composite measure of the Chinese monetary policy stance that takes into account a broad range of policy variables without imposing arbitrary cut-off dates for each variable's relevance.

loan prime rate (LPR1y), and the interbank unsecured lending rate (3-month Shibor) in place of the benchmark rates. During this phase, changes in banks' reserve requirements remain an active tool in the PBOC arsenal, and growth in credit quantities (TSF) continues to play a role as a policy target along with the aforementioned market rates. Finally, the last phase of Chinese monetary policy reform (in grey) removes total social financing to emphasise the greater weight placed on interbank repo rates relative to total credit or money growth since 2017. This final shift reflected the prescriptions of China's 13th Five-Year Plan (2016-2021), which identified a more market-based operational framework as a policy priority (Jones and Bowman, 2019).

Before moving on to a more formal measurement of the Chinese monetary policy stance, we note that the conduct of monetary policy in China cannot be considered in isolation from the exchange rate management policy that we review in greater detail below. Crucially, to retain monetary policy independence while also managing its exchange rate, China implements strict capital controls. Like the monetary policy framework, the capital flow management framework has also undergone a series of important reforms (see Bahaj and Reis, 2024).

Exchange Rate Regime. China's exchange rate regime and its implementation have also changed considerably over the past two decades.

Until the first half of 2005, the Chinese yuan (CNY) was pegged to the US dollar, at 8.2765 yuan per USD. On the 21st of July of the same year, the Chinese authorities announced a transition to a managed floating exchange rate regime, based on market supply and demand, and with reference to a broader basket of currencies. On that date, the yuan was revalued against the US dollar by 2.1%. [4] This transition was implemented by allowing the CNY to trade within a narrow range around a central parity rate calibrated based on the previous day's closing rate against the US dollar. Over the following decade, the trading bands have been progressively loosened, and the yuan has been allowed to gradually appreciate against the US dollar in a manner consistent with a *de facto* 'crawling peg' (Das, 2019).[5] Managing this gradual yuan appreciation

[4] See http://www.pbc.gov.cn/english/130721/2831438/index.html.

[5] The initial trading band was +/-0.3% against the USD, while it was wider around non-dollar currencies at +/-1.5%. The non-USD trading band was widened to 3% in September 2005. The USD band

has required considerable FX interventions, together with sustained growth in Chinese reserves (Das, 2019; Adler, Chang, Mano and Shao, 2021).

On the 11th of August 2015, the PBOC unexpectedly announced a further change in the CNY/USD central parity quotation mechanism, which was accompanied by a 1.9% depreciation of the yuan. While turbulence ensued in the immediate aftermath of the announcement, as market participants interpreted the move as a signal of more depreciation to come, the PBOC later clarified the nature of the reform as a move towards targeting a wider trade-weighted basket of currencies. Accordingly, in December of 2015 the China Foreign Exchange Trade System (CFETS)—a PBOC subsidiary—started publishing weekly series of renminbi effective exchange rate indices. These include an index constructed using in-house currency trade-based weights, as well as alternative public exchange rate weights from the Bank for International Settlements (BIS) and the Special Drawing Rights (SDR) basket.[6]

Jermann, Wei and Yue (2022) show empirically that the reform established a central parity rate for the RMB exchange rate against the dollar that gave roughly equal weights to maintaining a stable exchange rate against the CFETS basket, and allowing the dollar bilateral rate to reflect market forces by tracking the previous day's CNY/USD closing rate.[7] Effectively, the exchange rate regime transitioned to a half-way point between a currency basket peg, and a flexible adjustment to market forces subject to a daily trading band. Notably, the 2015 reform also established a formal basis behind the monetary authority's objective of maintaining the "RMB exchange rate basically stable at an adaptive and equilibrium level." And effectively implied that the PBOC's exchange rate objective could be accurately captured by the renminbi exchange rate against the CFETS currency basket.

As noted, the implementation of the managed RMB exchange rate regime inevitably

was then also widened to +/-0.5% in 2007, 1% in 2012, and 2% in 2014.

[6]The currency basket initially consisted of 13 currencies, and was expanded to cover 24 currencies as of 2017. For details, see the initial calculation methodology at https://iftp.chinamoney.com.cn/english/bmkidxrud/20151211/1989.html; changes effective as of January 2017 at https://iftp.chinamoney.com.cn/english/bmkidxrud/20161229/2048.html; and from January 2020 at https://iftp.chinamoney.com.cn/english/svcnrl/20191231/1496901.html.

[7]The PBOC has on several occasions leaned against pressures on the yuan by adjusting the central parity quotation mechanism, e.g. via the temporary addition of a countercyclical factor in May 2017. These deviations can be thought of as a temporary reduction of the weight placed on market-based adjustments (Jermann et al., 2022).

involved considerable foreign exchange interventions, especially during the period of gradual appreciation against the dollar, from 2005 to 2014. Left unsterilised, FX purchases can and do alter the domestic supply of RMB, thus directly affecting the monetary policy stance. In order to limit the effects of FX interventions on the domestic money supply, China uses both sterilisation and capital controls. While generally very effective, sterilisation may however not have been full at all times (Wang, Li, Huang and Wang, 2021).[8] Thus, a study of monetary policy in China should explicitly incorporate the managed renminbi regime to capture the interplay between domestic liquidity and the exchange rate, as discussed in detail in the next section. In addition, since the sterilisation is achieved through different tools often used simultaneously—e.g. open-market operations, PBOC bill issuance, RRR adjustments—capturing the monetary policy stance also requires keeping track of these multiple tools (see Wang et al., 2021).

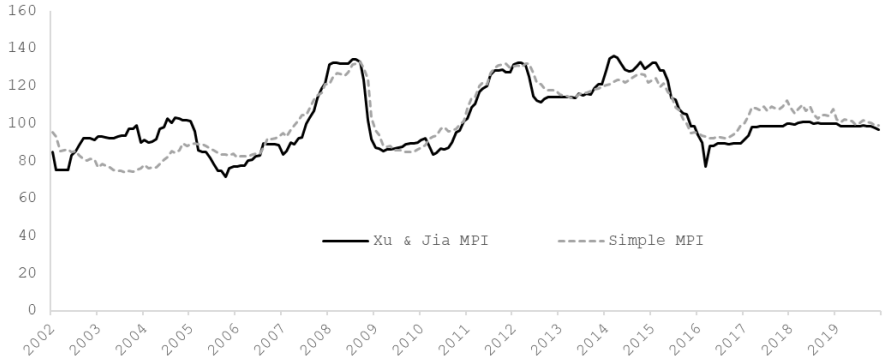
3 Measuring the Chinese Monetary Policy Stance

The gradual yet profound reforms to the Chinese monetary policy framework and exchange rate regime discussed previously make measuring the Chinese monetary policy stance in a systematic and coherent way particularly challenging. In particular, the ever changing set of policy instruments and intermediate targets implies that no single aggregate is likely to be a sufficient measure of the PBOC policy stance throughout the years.

To capture this evolving policy framework in a parsimonious way that can be tractably used for empirical analysis, we use a composite monetary policy indicator (CMPI) that encompasses all the multiple instruments and targets used by the PBOC, and constructed based on the intuition in Xu and Jia (2019). The CMPI summarises information in a variety of Chinese monetary and credit aggregates, as well as interest rates, with time-varying weights, which allows us to keep track of the changing nature of the primary policy targets and instruments over time.

[8]Sterilisation was limited until the early 2000s, whilst stringent capital controls were in place, but increased from mid-2002 primarily through the sale of PBOC bills (Glick and Hutchison, 2009). As the sheer amount of bills made them harder to place, the PBOC started to rely less on bill issuance and more on "reserve requirement increases and greater window guidance" for sterilisation purposes (Wang et al., 2021). Sterilisation has been close to full apart from a hiatus around the global financial crisis.

Figure 2: Chinese Composite Monetary Policy Indicator



Note: Chinese Compostite MPI index updated from Xu and Jia (2019). Simplified MPI based on key instruments and targets of Chinese monetary policy.

Concretely, the CMPI is constructed as a weighted average of up to 54 different policy and market interest rates, as well as a wide range of quantities reflecting either PBOC liquidity management operations (e.g. liquidity injected or drained through open market operations, lending facilities, banks' required reserves) or monetary target variables (M2, TSF growth).[9] The CMPI is normalised such that an increase corresponds to a tightening of the policy stance. The resulting broad indicator is plotted as the black solid line in Figure 2 from 2002–2019. The CMPI is a proprietary index. To give some clarity on how the reforms to the monetary policy framework shape the PBOC stance captured by the CMPI, we construct a very simple version of the indicator by averaging the key instruments and targets by period, as identified in Figure 1 (grey dashed line). More specifically, we first take the monthly percentage changes of the indicators shown in Figure 1. We then calculate the simple average over these changes, and cumulate it to obtain the Simple MPI in Figure 2. Thus constructed, the simple average of a changing set of key monetary policy tools and targets tracks the broader CMPI very closely, with a correlation of 0.87.

Both measures in Figure 2 reveal a sharp easing in Chinese monetary policy in response to the global financial crisis (GFC) at the end of 2008. This is reversed in 2010–2011, with monetary policy held relatively tight until 2015. The PBOC countered the slowdown of Chinese growth from 2015 by easing to a degree comparable with its response to the

[9]This indicator is similar in spirit to the shadow interest rate proposed in Lombardi and Zhu (2018) to summarise the US monetary policy stance at the zero lower bound.

GFC, albeit at a slightly more gradual pace. This easing episode ended in early-2016 as the economy rebounded and the PBOC needed to correct the market's perception of the 2015 exchange rate reforms as heralding further devaluation of the currency.

4 A Policy Rule for the PBOC

The composite monetary policy indicator introduced in the previous section serves as a useful metric to quantify the overall monetary policy stance of the PBOC. But, as ever, central banks operate and set their stance primarily in response to changes in the macroeconomic outlook, and in a way that facilitates achieving their objectives. The PBOC is no exception. Therefore, we must account for the systematic component of policy to isolate plausibly exogenous variation that can be used to study the transmission of Chinese monetary policy to the broader economy.

To summarise the PBOC's reaction function, we build on the seminal work of Chen, Ren and Zha (2018)—CRZ henceforth. CRZ propose a non-linear monetary policy rule for the PBOC, consistent with the policy objective of supporting the government's drive to promote economic growth. Specifically, CRZ assume that controlling the money supply is the primary policy instrument of the PBOC, and specify the following rule at quarterly frequency:

$$\Delta M_t = \phi_0 + \phi_M \Delta M_{t-1} + \phi_\pi(\pi_{t-1} - \pi_t^*) + \phi_{y,t}(y_{t-1} - y_t^*) \ , \tag{1}$$

where ΔM_t denotes the quarterly growth rate of M2, π_t the CPI inflation rate, and y_t the growth rate of output, all annualised. Notably, and differently from the case of inflation targeting central banks, the rule in Eq. (1) is specified against the official Chinese government's objectives, or goals, for output growth (y_t^*) and inflation (π_t^*) that are set and announced each year at the National People's Congress plenary meeting. The rule's coefficient associated with the growth objective is allowed to be time-varying. In particular, CRZ posit that the PBOC may wish to respond more forcefully when realised

growth falls short of the government's objective for that year. Formally,

$$\phi_{y,t} = \begin{cases} \phi_{y,H} & \text{if } y_{t-1} - y_t^* \geq \bar{y} \\ \phi_{y,L} & \text{if } y_{t-1} - y_t^* < \bar{y} \ , \end{cases} \tag{2}$$

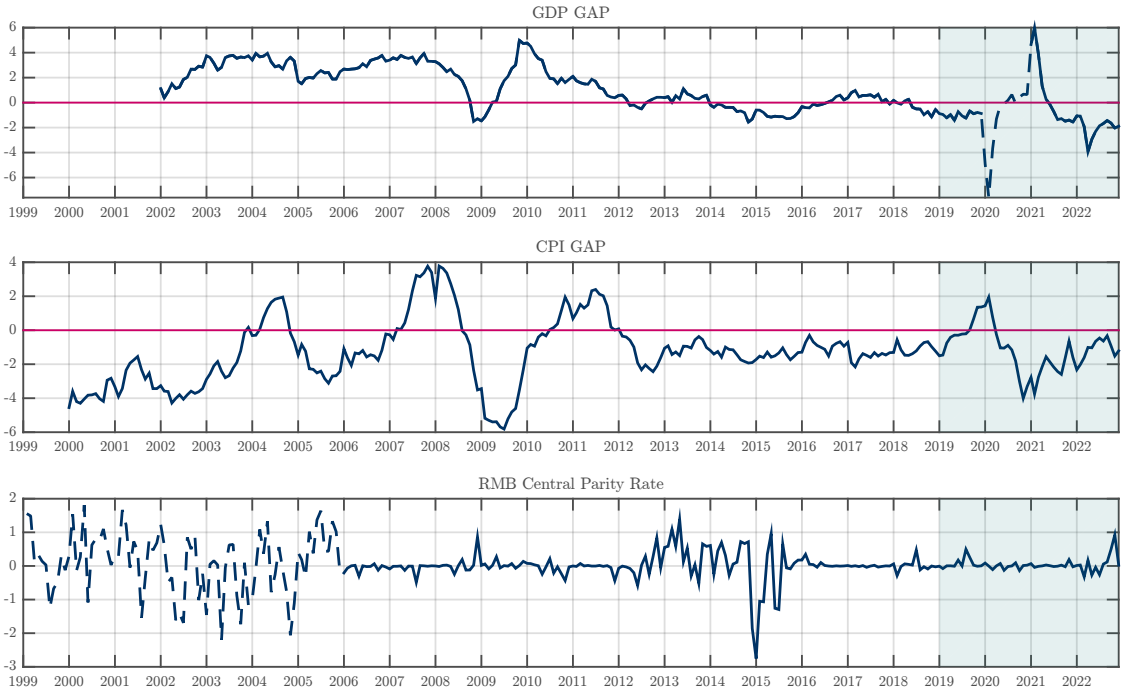
where $\bar{y}$ is set to be equal to zero. In CRZ the inflation goal (π_t^*) is assumed to be constant and equal to 3.5% throughout the sample.

To account for the most salient features of the Chinese monetary policy framework discussed earlier, we generalise the CRZ policy rule along several dimensions. In particular, relative to the original rule, we introduce: (i) the composite monetary policy indicator (CMPI) of Section 3, to reflect the evolving nature of the set of instruments and targets used by the PBOC since the beginning of the framework reform; (ii) an additional term that tracks the value of the renminbi against the evolving basket of currencies officially targeted by Chinese officials; (iii) a threshold value $\bar{y}$ for the GDP gap that is allowed to be different from zero; and (iv) time-varying official inflation objectives. Finally, we estimate this generalised policy rule at monthly frequency.[10]

Other than the monetary policy indicator, the most substantive departure relative to CRZ is the introduction of an explicit term that captures fluctuations in the value of the renminbi. The discussion in Section 2 makes it clear that the exchange rate enters the decision rule of the PBOC above and beyond its effects on consumer price inflation. In turn, this suggests that explicitly separating the "two tiers of meanings" (Gang, 2018) of the price stability mandate is warranted. To capture the desire of keeping the exchange rate "basically stable at an adaptive and equilibrium level", we add to the rule the monthly change in the RMB nominal effective exchange rate calculated using the official CFETS trade weights and central parity exchange rates (ΔCPR_t). As discussed earlier, the quotation rules for central parity rates were reformed in 2015 to clarify the desired balance between a stable exchange rate against a basket of currencies, and flexible market adjustments in the RMB. A further effect of the reform was that of redirecting

[10]For the estimation of the rule we make use of a monthly Chinese GDP series developed by the FRBNY and available since January 2002. The monthly GDP series is constructed to match the annual growth rate of output of the official Chinese statistics. The rule is estimated with Maximum Likelihood using the same algorithm developed in CRZ.

FIGURE 3: INPUTS TO PBOC POLICY RULE



Notes: The GDP and inflation gaps are expressed in annualised/year-on-year percentage points. Chinese officials did not release a target for growth in 2020. The dashed line in the top panel is obtained by assuming a target growth of 6% for 2020, same as in 2019 and 2021. The central parity rate is in monthly percent changes. The dashed line is used during the US dollar peg regime. The shaded areas highlight the years not included in our baseline estimation. See main text for details.

the spotlight on the gap between the spot and central parity rates, as an indicator of the Chinese authorities' inclination to lean against the market-implied appreciations or depreciations (Jermann et al., 2022). With the aim to formulate a policy rule flexible enough to capture this evolving exchange rate framework, we interact the central parity rate fluctuations with this gap for the period since the CFETS central parity rates were introduced.[11] The exchange rate pillar of the PBOC policy rule thus emphasises that a recent RMB appreciation (depreciation), coupled with a positive (negative) gap between the spot and central parity rate, may lead to further appreciation (depreciation) pressures, thus inducing a stronger PBOC reaction. The interaction between the central parity rate

[11]Central parity rates for a narrow set of currencies (USD, EUR, JPY, HKD) are available from January 2006, with more currencies added over time to reach a total of 25 central parity rates as of mid-2024. Prior to 2006 the RMB was pegged to the US dollar. During this period we set the central parity rates for all bilateral exchange rates in the RMB index at the levels required to maintain the peg to the US dollar at 8.2765. In other words, we rescale the spot dollar bilaterals by the CNY/USD pegged rate.

and the related gap introduces a further nonlinearity in the PBOC policy rule relative to the original formulation of CRZ.

Allowing for a flexible threshold that triggers the regime switch in the monetary policy rule is motivated by the observation that Chinese growth is seldom in a shortfall regime as defined by CRZ (i.e. below the government goal) over the sample at hand. As shown in the top panel of Figure 3, the shortfall regime is visited only in a handful of occurrences, which implies that very few observations are effectively used to estimate the rule coefficients over that regime.

Finally, while the Monetary Policy Committee of the PBOC meets officially only once a quarter, the stance of monetary policy is adjusted at much higher frequency, with announcements related to e.g. open market operations, reserve requirement ratios, and lending facilities at times occurring multiple times within a month. This suggests that a quarterly rule as in CRZ may potentially disregard relevant variation at higher frequency.[12]

One key characteristic of our policy rule, as well as of that of CRZ, is that the rule's inputs enter the specification with a lag, which makes the policy reaction function entirely backward looking. This is a point of departure relative to specifications for central banks in advanced economies that instead rely on expected deviations of output and inflation from targets. But it is consistent with the Chinese institutional features. The PBOC seldom conducts surveys of expectations, making it less likely that monetary policy is forward-looking in practice.[13]

In our baseline specification, we estimate the generalised policy rule over the sample 2002:01-2019:12, due to the excessive macroeconomic volatility during the Covid-19 pandemic. The estimated coefficients and associated t-statistics are[14]

[12]Additionally, due to the very short life span of most Chinese time series, switching to a higher sampling frequency is beneficial to gain power in the estimation of the rule coefficients and for the purpose of shocks identification.

[13]We thank Tao Zha for providing corroborating evidence on this point. One concern with this specification of the rule is that it may leave open the possibility that rule deviations may correlate with current economic conditions. As we show in the next section, this is not an empirically relevant concern, as estimated impact effects are statistically zero. In robustness tests we have included expected global growth as an additional control. This did not produce any appreciable difference in the estimated responses.

[14]We omit the intercept for notational brevity. We report full estimation results over different samples and across different threshold values for the GDP gap in Appendix B.

$$CMPI_t = \begin{cases} \underset{\substack{0.954\\(54.538)}}{\phi_M}\ CMPI_{t-1} + \underset{\substack{0.026\\(3.469)}}{\phi_\pi}\ \tilde{\pi}_{t-1} + \underset{\substack{-0.036\\(-1.831)}}{\phi_x}\ \tilde{x}_{t-1} + \underset{\substack{0.002\\(0.392)}}{\phi_{y,t}}\ \tilde{y}_{t-1} & \text{if } \tilde{y}_{t-1} \geq \bar{y} \\ \underset{\substack{0.954\\(54.538)}}{\phi_M}\ CMPI_{t-1} + \underset{\substack{0.026\\(3.469)}}{\phi_\pi}\ \tilde{\pi}_{t-1} + \underset{\substack{-0.036\\(-1.831)}}{\phi_x}\ \tilde{x}_{t-1} + \underset{\substack{0.069\\(2.579)}}{\phi_{y,t}}\ \tilde{y}_{t-1} & \text{if } \tilde{y}_{t-1} < \bar{y}\ , \end{cases}$$

where $\tilde{\pi}_t = (\pi_t - \pi_t^*)$ and $\tilde{y}_t = (y_t - y_t^*)$ are, respectively, the inflation and GDP gaps against the official government's objectives as in CRZ, and the exchange rate term is defined as $\tilde{x}_t \equiv \Delta CPR_t \times \mathbb{I}_{t>2006:01}(RMB_{spot,t} - CPR_t)$. The GDP gap threshold ($\bar{y}$) is estimated to be 1%.[15]

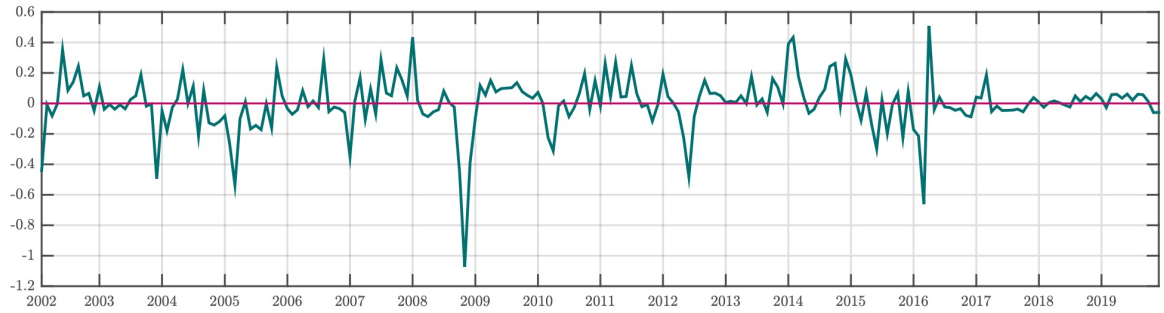
The estimated coefficients show that the Chinese authorities respond to roughly similar degrees to both inflation overshooting the annual target, and to a depreciation in the value of the domestic currency. In the context of the generalised rule, the objective of promoting economic growth translates into the PBOC effectively not counter-acting above-goal growth in any meaningful way. Conversely, periods in which the GDP gap falls below the threshold—or GDP is indeed below the government's target—warrant further additional stimulus, with the coefficient associated with the GDP gap more than twice as large as that of the inflation or exchange rate gaps. To put these numbers in context, we normalise the CMPI to have the same sample standard deviation of the primary lending rates.[16] The estimated coefficients indicate that when annual CPI inflation exceeds the target by 1ppt, this leads to a Xbps increase in the synthetic policy rate. Similarly, when the RMB depreciates by 1% *and* the spot rate is also below the central parity rate by 1%, the CMPI is tightened by Xbps. Conversely, when annual GDP is below the threshold by 1ppt, the synthetic policy indicator is lowered by Xbps. The estimated rule suggests a very strong role for policy inertia at monthly frequency, as evident from the coefficient on the lagged CMPI being close to one.[17]

[15] The threshold is estimated by minimising the sum of squared residuals of the rule over a grid of different threshold values. See Appendix B. We note that the estimated coefficients for the GDP gap are not particularly sensitive to the value of the threshold, but increasing the threshold makes the estimates more precise.

[16] While the CMPI allows to keep track of the different policy instruments and targets over time, it lacks a clearly interpretable unit. The rescaling allows to interpret the estimated coefficients in terms of changes in a hypothetical synthetic policy rate.

[17] Table B.1 in Appendix B reports the coefficients of the rule estimated over a sample that includes the

FIGURE 4: POLICY RULE RESIDUALS



Notes: Residuals of the generalised monetary policy rule for the PBOC.

Figure 4 plots the estimated rule residuals. That is, the unsystematic component of the PBOC monetary policy according to our specification of the policy rule. Given the normalisation of the CMPI, positive readings signal an exogenous (relative to the rule's inputs) tightening of the monetary policy stance. The series captures well the aggressive loosening implemented by the PBOC in the wake of the 2008 global financial crisis. The PBOC started cutting interest rates in August 2008. A large ¥4 trillion ($586 billion) stimulus package then followed in the spring of 2009, and continued to be disbursed in 2010 (Yueh, 2010). The loosening in response to the Chinese slowdown of 2015-16, on the other hand, takes the form of consecutive negative values of the policy rule residuals. A further notable episode is the easing surprise of early 2016, abruptly reversed shortly thereafter, in line with accounts of the PBOC's comprehensive actions to counter market expectations of RMB devaluations discussed in Section 2. This also coincides with the process of interest rate liberalisation culminating with the removal of the ceiling on deposit rates, and the introduction of the interest-rate corridor (see e.g. Das and Song, 2022).

In the next sections, we use the estimated rule's residuals to identify monetary policy shocks in China and study the domestic transmission of Chinese monetary policy and its global spillovers.

Covid years (2002:01-2022:12). Once accounting for the exceptional growth volatility over that subperiod (see Figure 3), we note that the coefficients remain relatively stable over time. Thus, we do not find evidence of any substantial time variation in the estimated policy rule over the most recent sample.

5 Domestic Monetary Policy Transmission: The *Ins*

In this section we study the features and the effects of the transmission of Chinese monetary policy to domestic aggregates. Our intent is to provide a comprehensive assessment of how the Chinese economy responds to monetary policy, as well as of how the Chinese authorities jointly adjust their numerous policy levers to ensure that the main policy objectives remain on sight.

We estimate the effects of monetary policy using monthly Vector Autoregressive (VAR) models identified using the rule residuals estimated in Section 4 as an instrumental variable. Formally, we use the rule residuals as an internal instrument, included in the VAR and ordered first.[18] In this respect, our approach follows very closely that of Romer and Romer (2004), with the exception that we do not impose additional constraints on the impact responses of the remaining variables of the VAR.[19]

The baseline sample for our estimates goes from February 2002 to December 2019, and corresponds to the sample over which we estimate the PBOC policy rule. For the specifications that make use of interest rates and capital flows, we use a restricted sample that starts in 2006 due to data availability, and for consistency with the chronology of the liberalisation of financial and capital markets in China. To measure Chinese output at monthly frequency we use the index of industrial production released by the National Bureau of Statistics in China. This variable is released in year-over-year growth rates to account for the strong and variable seasonal patterns induced by the Chinese New Year falling in either January or February of every year.[20] For consistency, we transform all the variables in the VAR in year-over-year growth rates, with the exception of those already expressed in percentage points such as interest rates.[21]

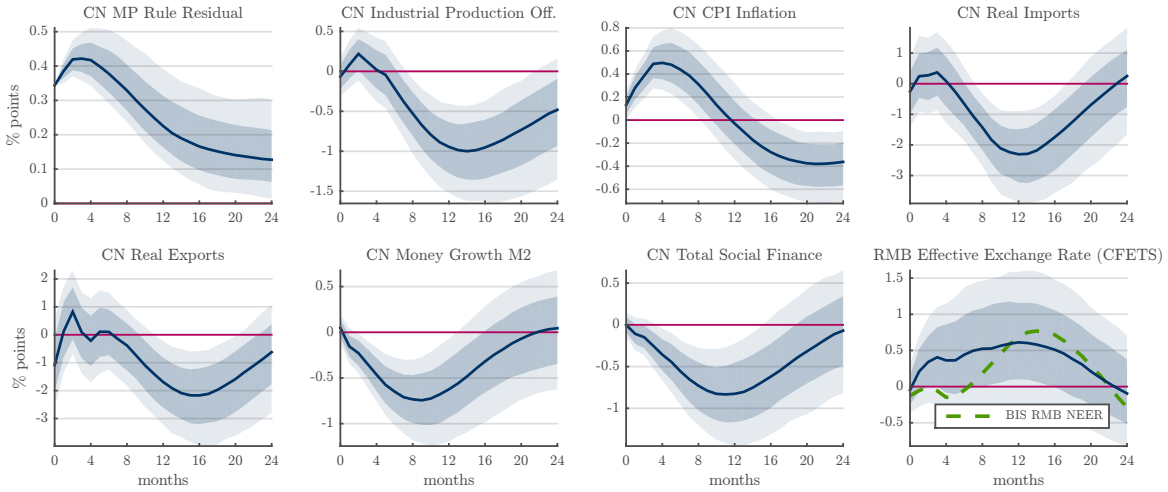
[18] Using the residuals as an internal instrument gives us more conservative estimates, and accounts for potential correlation with the lags of other variables not included in the generalised policy rule of Section 4. An alternative is to use the rule residuals as an external instrument instead, and to identify the impact effects using a two-step IV estimator (see e.g. Miranda-Agrippino and Ricco, 2023, among many others). Results are largely equivalent and reported in the Appendix.

[19] We verify that controlling for the contemporaneous comovement with global trade, global GDP and expectations of global GDP growth does not alter our results.

[20] In practice, the National Bureau of Statistics partially accounts for this seasonality by effectively releasing a single number that accounts for industrial production growth over the months of January and February combined. We retrieve this series from Haver Analytics and adopt their convention whereby the same number is used in the first two months of each year.

[21] We verify that this transformation does not meaningfully affect our results by estimating our baseline VAR with variables in log levels and using the alternative level index for Chinese output estimated by

FIGURE 5: DOMESTIC RESPONSES TO CHINESE MONETARY POLICY



Notes: Median IRFs to a contractionary monetary policy shock normalised to yield a contraction of Chinese industrial production of 1% at peak. Shaded areas correspond to 68% and 90% posterior credible sets. Monthly BVAR(6). 2002:02-2019:12.

Due to the relatively short sample available, we estimate the VARs using six lags and standard macroeconomic priors (Giannone et al., 2015). The results are reported in terms of impulse responses (IRFs) to a contractionary monetary policy shock. Due to the CMPI and its residuals not having a straightforwardly interpretable unit, we normalise all the IRFs such that the peak response of domestic output is equal to -1ppt. Our baseline VAR includes industrial production, consumer prices, real imports and exports, the money supply and total credit, and the exchange rate. To be able to study the effects of Chinese monetary policy on a large number of variables, we estimate a battery of VARs where we keep a core of seven variables fixed and rotate in the other variables of interest in place of the exchange rate. We use different colours in the figures to highlight when the estimates are obtained from different VARs.

The responses of the baseline VAR are reported in Figure 5. The monetary tightening induces a delayed but protracted contraction of economic activity. Industrial production does not respond in the immediate aftermath, but declines steadily to reach its peak response shortly after a year. A similar dynamic characterises the response of external trade but, importantly, the magnitude of the adjustment is in this case decisively larger,

the NYFED used in Section 4. See Appendix.

with peak contractions in the order of 2ppt for both imports and exports. The timing of the adjustment of Chinese exports is noteworthy. Relative to the contraction in output and imports, the peak fall in exports realises with some extra delay. Moreover, Chinese exports remain essentially stable for almost a year after the shock hits. This is in principle compatible with the tendency of Chinese authorities to support domestic growth by promoting exports.

The monetary contraction leads to a decline in consumer price inflation only with a lag, while the short-term reaction is positive. A plausible explanation for this short-lived price puzzle is the considerable weight of housing-related costs (both rental payments and owner-occupied equivalent) in the Chinese CPI index.[22] We provide some evidence that this channel is at play by showing that the residential CPI sub-index rises even more than the overall CPI in the short run, and remains positive for longer.[23]

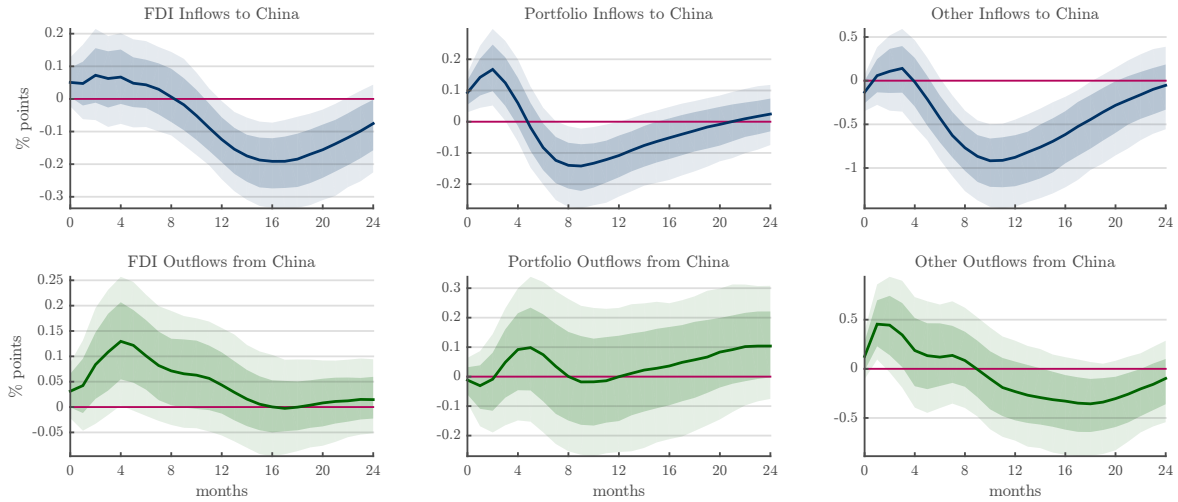
The contractionary nature of the shock is corroborated by the gradual but persistent decline in the supply of both money and total credit, that decrease by about the same amount and following a remarkably similar dynamic. While the contraction in credit is not front-loaded, both responses point to a meaningful effect on domestic financing conditions. A notable difference relative to the monetary policy transmission observed in most advanced economies with a floating currency, is the essentially muted response of the RMB index throughout. The results in Figure 5 show that despite the presence of some pressures for the renminbi to appreciate, the response is delayed and overall not significant at conventional levels. While the dynamics are somewhat different, we obtain a similarly muted response when we substitute the central parity rate constructed using the official CFETS weights with the nominal exchange rate index calculated by the BIS (green dashed lines).

The muted response of the exchange rate is consistent with the value of the renminbi being strictly managed by the Chinese authorities, and particularly so in the earlier years of our sample, as we have discussed in Section 2. To shed more light on the underlying dynamics, we report in Figure 6 the response of Chinese capital flows, and in Figure 7 the response of the components of the CFETS central parity rate, of the foreign exchange

[22] While the National Bureau of Statistics of China does not publish the actual CPI weights, estimates put the contribution of housing at above 20% (e.g. bloomberg).

[23] See Appendix. To the best of our knowledge, a CPI index that excludes housing costs is not available.

FIGURE 6: RESPONSES OF CAPITAL FLOWS

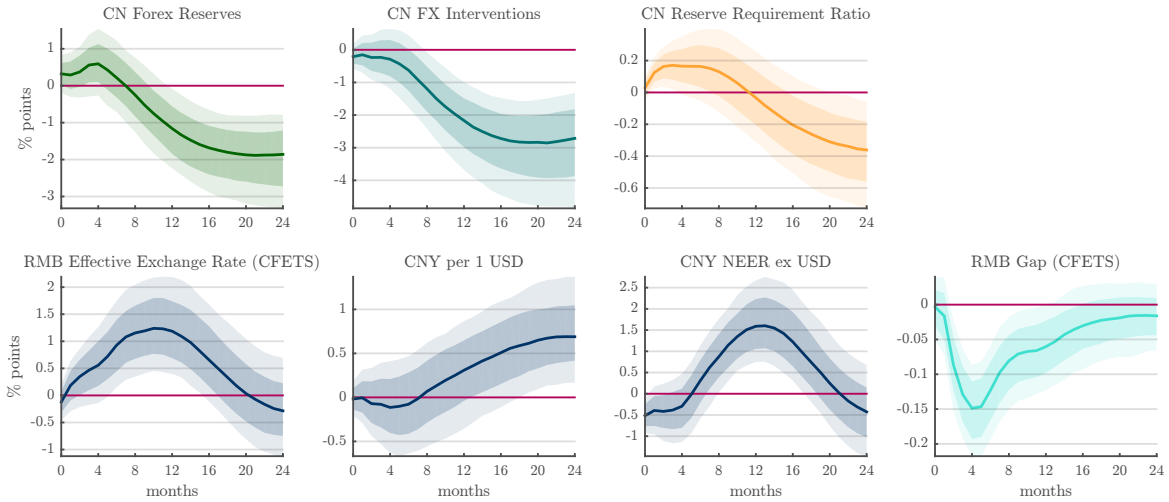


Notes: Median IRFs to a contractionary monetary policy shock normalised to yield a contraction of Chinese industrial production of 1% at peak. Each colour corresponds to a different VAR. Common variables are the indices of industrial production and consumer prices, external trade, M2 and TSF. Shaded areas correspond to 68% and 90% posterior credible sets. Monthly BVAR(6). 2006:01-2019:12.

reserves and FX interventions estimated by Adler et al. (2021), and of the required reserve ratios imposed to domestic banks. These responses are estimated from 2006 onward, which coincides with the onset of the Chinese financial liberalisation journey, as well as with the date at which capital flows data become available.

The Chinese monetary policy tightening is associated with capital flight pressures by resident (outflows) and non-resident (inflows) investors alike (Figure 6). The behaviour of these two variables is however dramatically different. Consistent with China operating strict capital controls, the pressure from Chinese residents to buy non-Chinese assets is curbed to a very large extent, which results in outflows displaying an essentially non significant response throughout, with the exception of a very brief episode in the short run for banking flows (other flows in the figure). Conversely, capital inflows, that capture foreign investment into China, tend to remain stable over the short-run before contracting very significantly thereafter. There exists some heterogeneity across types of foreign investments. FDIs, which constitute the lion's share of private foreign inflows into China, contract with a significant delay. Banking flows are the most volatile, and their contraction is very significant and protracted, with a peak decline almost 5 times as large as that of FDIs. Finally, portfolio inflows, which account for a very small share of foreign

FIGURE 7: RESPONSES OF FX, FX RESERVES, AND RRR



Notes: Median IRFs to a contractionary monetary policy shock normalised to yield a contraction of Chinese industrial production of 1% at peak. Each colour corresponds to a different VAR. Common variables are the indices of industrial production and consumer prices, external trade, M2 and TSF. Shaded areas correspond to 68% and 90% posterior credible sets. Monthly BVAR(6). 2006:01-2019:12.

investment, seem to increase in the short-run to contract thereafter. The fall of foreign investment, including its timing, is consistent with the deteriorating domestic outlook and tightening of domestic financial conditions documented in Figure 5.

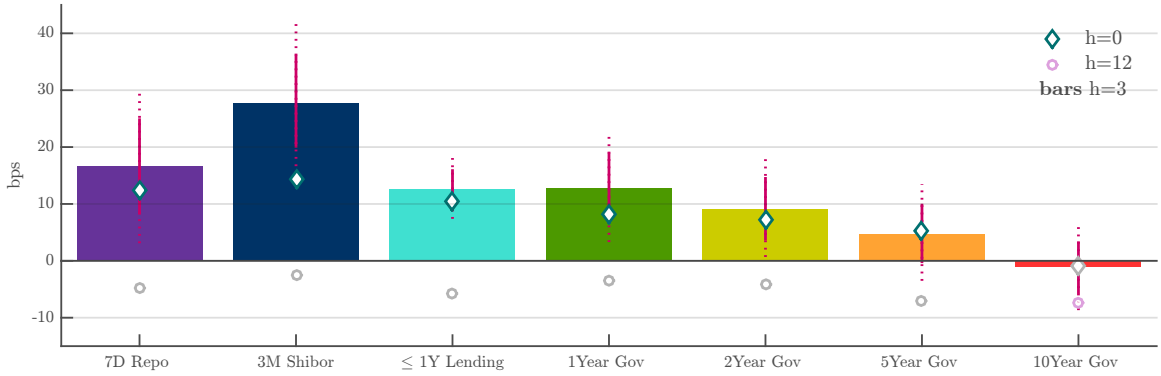
The panels in the first row of Figure 7 focus on the official flows within the Chinese balance of payments, by examining the response of two alternative measures of currency reserve accumulation, as well as of the RRR imposed on Chinese banks. Our measure of foreign exchange reserves combines the official FX reserves reported by the State Administration of Foreign Exchange (SAFE), as well as the net foreign asset positions of the state-owned banks.[24] For foreign exchange interventions we instead rely on the measure of Adler et al. (2021) that removes both estimated income and valuation effects from the stock of FX reserves. While with some delay, both measures point to a an eventual significant decline in official Chinese outflows and, consequently, to a contraction in foreign exchange reserves. At the same time, there is some evidence that official FX reserves are increased in the short-run, before they start falling, although the estimated initial response is not strongly significant. This behaviour is consistent with Chinese authorities

[24]There exists some speculative evidence that state banks may be playing a significant and ever grater role in the accumulation of foreign exchange reserves in China. This is particularly true since 2015, when official reserves seem to stabilise around a plateau. That said, results are unchanged when using only official reserves.

managing their FX reserves to counter the pressures on the renminbi induced by the monetary policy tightening in the short run (upward) and the decline in private inflows at medium horizons (downward). This countercyclical use of public capital flows to offset flighty private flows is a broadly recognised pattern in international finance (see e.g. Avdjiev et al., 2022). As noted in Section 2, reserve requirement ratios have often been used by Chinese authorities as a tool to sterilise interventions in foreign exchange markets. Consistently, RRR are tightened in the short-run to be more significantly relaxed thereafter, in line with the response of official FX reserves.

These observations on the external adjustment help us to interpret the response of the Chinese currency to the monetary tightening. The panels in the bottom row of Figure 7 report the response of the central-parity-based exchange rate against the official CFETS basket estimated since 2006, and of the three main components of the Chinese exchange rate regime: the bilateral exchange rate against the US dollar, the non-dollar renminbi index, also computed using the official CFETS weights, and the gap between the spot RMB and central parity rate. Compared to the response estimated over the full sample, we note that the delayed appreciation of the renminbi becomes more precisely estimated when starting in 2006, consistently with the strong US dollar peg regime falling out of the estimation sample. The monetary policy tightening opens up a negative gap between the spot exchange rate and the CFETS basket, that is mirrored in the initial response of the non-dollar RMB index. One way to think of this gap is as an indication that Chinese authorities do not fully incorporate the spot market volatility into their central parity rate—in other words, they oppose to some degree the depreciation pressure either through FX interventions or capital controls. The decrease in FX reserves pointed to earlier lends support to interventions playing an important role in the official response. Finally, we note that the delayed appreciation of the official RMB index is accounted for by the appreciation of the non-dollar index for the most part. Conversely, the bilateral rate agains the US dollar remains stable for the most part and, if anything, the renminbi gradually but persistently depreciates against the dollar over the two-year horizon. This is not surprising. As discussed in Section 2, China's exchange rate regime over the estimation sample consists of a *de facto* crawling peg against the US dollar, combined with a more flexible management against the remaining CFETS currencies. The responses

FIGURE 8: RESPONSES OF INTEREST RATES



Notes: Median IRFs to a contractionary monetary policy shock normalised to yield a contraction of Chinese industrial production of 1% at peak. Selected horizons. Bars denote responses at $h = 3$ months. Diamonds and circles denote responses at $h = 0$ and $h = 12$ respectively. Grey markers are for non-significant responses at 90% level. Each bar colour corresponds to a different VAR. Common variables are the indices of industrial production and consumer prices, external trade, M2 and TSF. Error bands correspond to 68% (solid) and 90% (dotted) posterior credible sets. Monthly BVAR(6). 2006:01-2019:12.

in Figure 7 highlight this duality very clearly.

Finally, we turn to the response of domestic interest rates in Figure 8. The figure cuts across the term structure, and highlights the responses at the 3-month horizon (bars), which coincides with the peak response of the market interest rates, as well as the responses on impact (diamonds) and a year after the shock (circles). The response of Chinese interest rates mirrors that found in most advanced economies. Interest rates respond strongly and on impact, and particularly so at short maturities. This clarifies the nature of the identified monetary policy shock as a tightening of the short-term policy stance. Or what we would label a "conventional" monetary policy shock in advanced economies. Figure 8 shows that the monetary policy tightening leads to roughly a 10bps increase in the policy rate (7-day Repo) introduced in Section 2. The pass-through to the short-term lending rate is almost one-to-one, while the 3-month interbank rate (Shibor) is closer to 15bps. Market rates continue to climb over the subsequent months, with the interbank rate in particular doubling its initial rise. Higher borrowing costs pair well with the deteriorating credit conditions documented in Figure 5, and confirm that lending is a powerful channel for the domestic transmission of Chinese monetary policy. The shock affects interest rates up to a 2-year maturity, while the long end of the curve is typically unresponsive.

6 International Spillovers of Chinese Policy: The *Outs*

The increasingly large footprint of the Chinese economy on the global scene makes it likely that the reverberation of Chinese shocks may be felt well beyond the national border. In this section we explore the extent to which this is the case, and the transmission channels through which the global spillovers of Chinese policy are likely to be enabled.

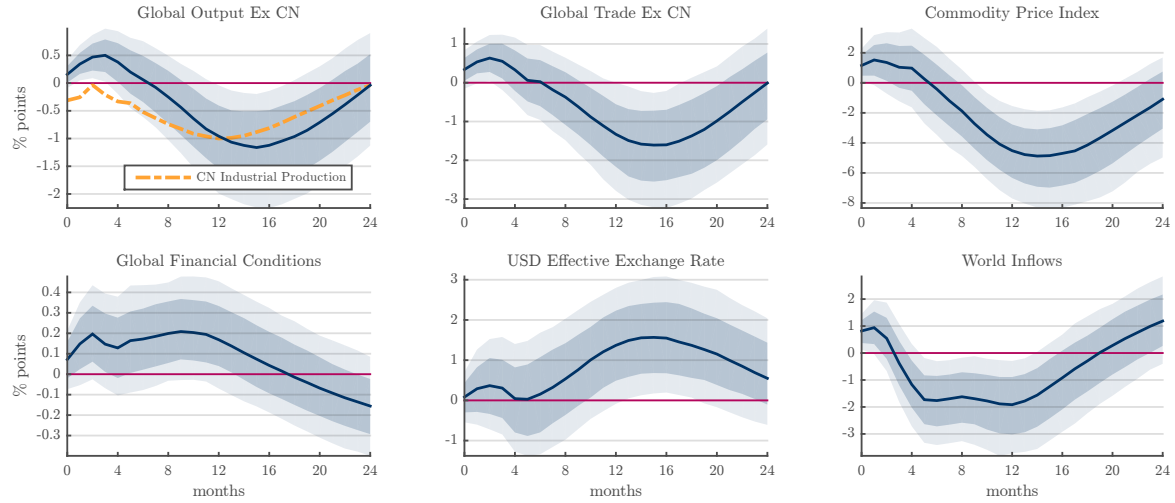
The setup in this section mimics that of Section 5. To facilitate the comparison between the domestic and global effects, we continue to normalise the identified Chinese monetary policy shock such that the peak contraction in domestic industrial production equals 1ppt. As before, all variables not already expressed in percentage points enter the VARs in year-over-year growth rates. The estimation sample goes from February 2002 to December 2019.

The global spillovers of Chinese monetary policy are depicted in Figure 9. The VAR includes the Chinese index of industrial production, global output and trade excluding China, a global index of financial conditions, the commodity price index, the US dollar exchange rate index, and a measure of global inflows expressed as a share of world GDP. Global output is measured in terms of industrial production, while global trade encompasses both imports and exports growth.[25] The response of the Chinese industrial production index is superimposed to that of global production to facilitate the comparison between the two effects.

The responses in Figure 9 show that Chinese spillovers can be sizeable, and that global trade, commodity prices as well as production networks are the main channels through which they are most likely to materialise. The domestic contraction in Chinese production, and particularly of Chinese imports, sets out a potent chain reaction that leads to a strong contraction in both global output and trade. The magnitudes of the effects are important. Global output contracts by about the same amount as domestic output, but the peak adjustment occurs somewhat later. Similarly, global trade slows down significantly reaching a trough of about 2ppt, that is again equivalent to the trough in domestic trade. The size and importance of China in the global commodity market is such that a slowing Chinese production has a detrimental effect on commodity prices,

[25]Both variables are calculated based on original data from the World Trade Monitor of the CPB Netherlands Bureau for Economic Policy Analysis. See Appendix for details on the data.

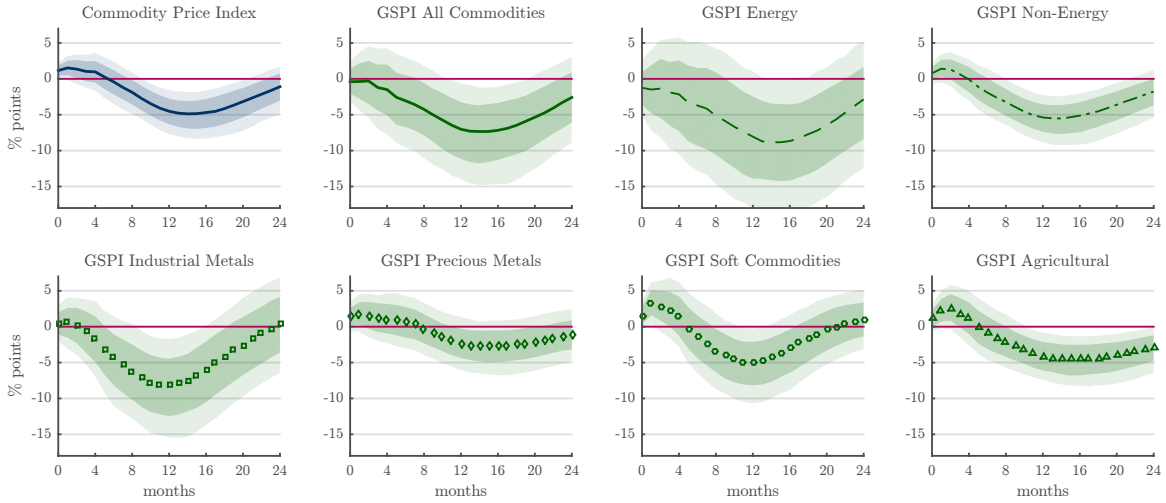
FIGURE 9: GLOBAL SPILLOVERS OF CHINESE MONETARY POLICY



Notes: Median IRFs to a contractionary monetary policy shock normalised to yield a contraction of Chinese industrial production of 1% at peak. Orange dash-dotted line denote responses of additional variables included in the same VAR. Different colours for IRFs in the main subplots correspond to different VARs. Common variables are global output and trade excluding China, global financial conditions, the commodity price index and the US dollar index. Shaded areas correspond to 68% and 90% posterior credible sets. Monthly BVAR(6). 2002:02-2019:12.

which contract by about 4ppt in annual terms. One way to rationalise these responses is to think of the role that China plays not only in the context of global trade of final goods, but also as a key actor in production networks worldwide. Against this backdrop, it is easy to see how a fall in Chinese output would naturally lead to a contraction in the global demand of raw materials, which lowers their prices, and to disruptions in global production which, together with the contraction in global trade, leads to a fall in global output. It is important to bear in mind that commodities are typically priced in US dollars. Therefore, the contraction in Chinese output leads to commodity prices to fall substantially despite the appreciation of the US dollar. The delayed response of commodity prices to the Chinese contraction is consistent with real effects rather than financial ones being the primary channels responsible for their contraction (see also Miranda-Pinto, Pescatori, Prifti and Verduzco-Bustos, 2023; Gazzani and Ferriani, 2024). Indeed, US monetary policy shocks whose international transmission is deeply rooted in its effects on the Global Financial Cycle lead to an immediate contraction in asset prices worldwide, including commodity prices (Miranda-Agrippino and Rey, 2020, 2022).

FIGURE 10: COMMODITY PRICE SPILLOVERS OF CHINESE MONETARY POLICY

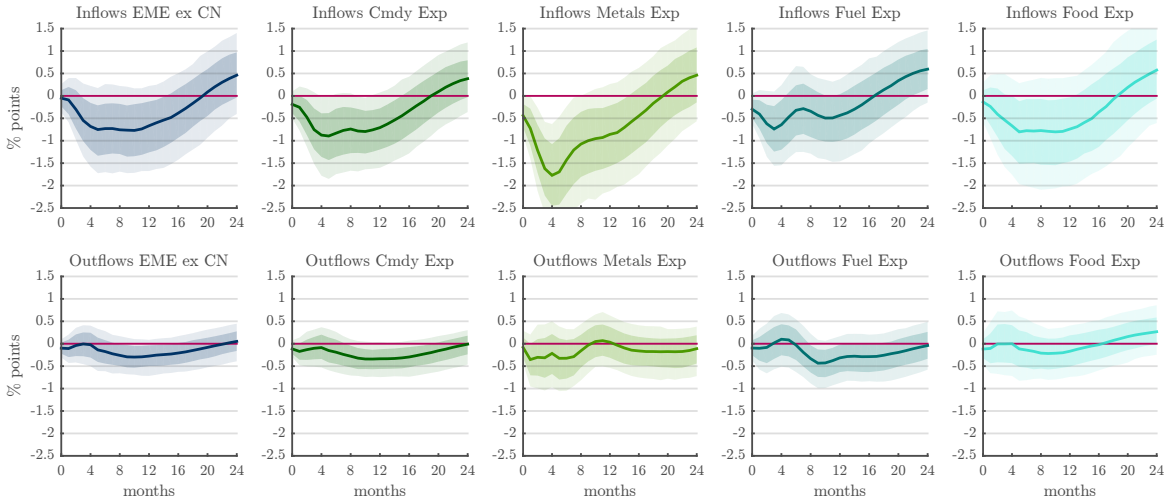


Notes: Median IRFs to a contractionary monetary policy shock normalised to yield a contraction of Chinese industrial production of 1% at peak. Different line styles for the median IRFs correspond to VARs with different commodity price indices. Common variables are global output and trade excluding China, global financial conditions, the commodity price, the US dollar index and global inflows. Shaded areas correspond to 68% and 90% posterior credible sets. Monthly BVAR(6). 2002:02-2019:12.

Further evidence of the prevalence of real effects in the international transmission of Chinese monetary policy can be found in the differential response of different categories of commodities, which we report in Figure 10. The first subplot is the reaction of the CRBPI index from our baseline specification with global variables. The second subplot shows the comparable albeit somewhat less precisely estimated response of the S&P GSCI commodity index, for which we have subindices by commodity group. An energy vs non-energy split of commodity prices in the third and fourth subplots emphasises the more material response of non-energy commodities. Of the latter, industrial metals have the most pronounced response as seen in the second row of plots. This is consistent with the contraction in Chinese manufacturing affecting disproportionately raw material prices, and aligns with findings in Gazzani and Ferriani (2024).

The response of the US dollar (Figure 9) is best understood as a response to the deteriorating global outlook. Indeed, the appreciation is not sudden, and its timing coincides with the trough of the global slowdown. The US dollar appreciation is consistent with the heightened global macroeconomic risk and flight-to-safety motives that lead to a stronger dollar in risk-off scenarios, and with the retrenchment in global trade and

FIGURE 11: SPILLOVERS TO CAPITAL FLOWS FOR COMMODITY PRODUCERS



Notes: Median IRFs to a contractionary monetary policy shock normalised to yield a contraction of Chinese industrial production of 1% at peak. Different line styles for the median IRFs correspond to VARs with different commodity price indices. Common variables are global output and trade excluding China, global financial conditions, the commodity price, and the US dollar index. Shaded areas correspond to 68% and 90% posterior credible sets. Monthly BVAR(6). 2002:02-2019:12.

commodity prices (see e.g. Gourinchas and Rey, 2022; Obstfeld and Zhou, 2023). The US dollar appreciation also puts the bilateral depreciation of the RMB documented in Section 5 into context. Finally, the appreciation of the dollar is also likely to be responsible for the modest, delayed and ultimately not economically significant tightening of global financial conditions.[26]

The finding that Chinese monetary policy does not have a meaningful impact on global financial conditions puts these results in stark contrast with those documented in e.g. Rey (2013) and Miranda-Agrippino and Rey (2020, 2022) on the global transmission of US monetary policy. However, the absence of an international risk-taking channel for the transmission of Chinese monetary policy does not imply that financial markets would be insensitive to the worsening of the global outlook initiated by the Chinese shock. Indeed, the delayed responses of both the US dollar and of commodity prices are a case in point. Figure 11 reports the response of capital flows in and out of emerging markets that rely heavily on commodities.[27] We fix the y-axis in all the subplots to highlight

[26]The global FCI enters the VAR in standardised levels such that the peak response in Figure 9 can be read as a fifth of a standard deviation.

[27]These are obtained by substituting in the alternative measures of capital flows in place of world

the difference in the magnitude of the responses. Outflows from these countries are barely affected. Conversely, capital inflows, i.e. foreign investment in these commodity producing countries, contract in a manner proportional to the commodities that are mostly affected by the Chinese shock. The fall in demand for hard commodities such as industrial metals, heavily used in manufacturing, leads to a contraction in private foreign funding for the countries that are rich in these materials. Therefore, while global financial conditions are not significantly affected, countries that rely heavily on Chinese demand for raw materials also experience a liquidity shock as a result of the Chinese contraction.

Overall, and despite the progressive liberalisation of Chinese financial markets and the gradual opening of China's capital account, the international transmission of Chinese monetary policy shocks seems to operate primarily through fundamentally standard trade channels. With an important amplification mechanisms being played out by commodity markets and potentially also by integrated production networks. Conversely, our results point to a relatively minor role for financial channels—such as e.g. financial intermediaries' risk taking behaviour (see e.g. Borio and Zhu, 2012; Bruno and Shin, 2015; Bauer, Bernanke and Milstein, 2023)—over the sample considered.

The pattern of responses in Figure 9 suggests that, as China's largest trading partner, the US economy may be particularly exposed to Chinese spillovers. Particularly so given the effects that we have documented on both commodity prices and the US dollar.

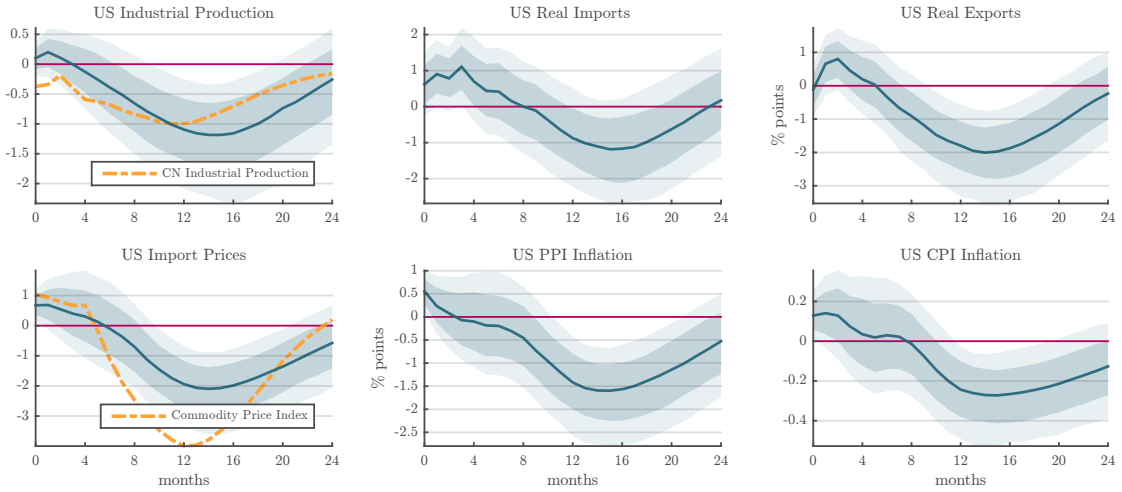
To further explore the bilateral spillovers, Figure 12 reports the direct response of US output, trade balance, and price indices to the Chinese monetary policy contraction. To facilitate the comparison of the magnitudes and speed of adjustments, we superimpose the effects that the same shock has on Chinese production and on the commodity price index (orange dash-dotted lines).[28]

While US imports appear to be relatively insensitive throughout, US exports decline substantially in response to the Chinese shock, implying that the net effect is a deterioration of the US trade balance. The US dollar appreciation and the large fall in Chinese imports are both likely to play an important role in explaining the adjustment dynamics

inflows in the VAR. See Appendix ADD for details on the countries classification.

[28]The VAR also includes global output and trade excluding both the US and China, whose peak negative response is equivalent to that reported in Figure 9 for global output and trade excluding China alone. See Appendix add.

FIGURE 12: SPILLOVERS OF CHINESE MONETARY POLICY TO THE US



Notes: Median IRFs to a contractionary monetary policy shock normalised to yield a contraction of Chinese industrial production of 1% at peak. Orange dash-dotted line denote responses of additional variables included in the same VAR. Shaded areas correspond to 68% and 90% posterior credible sets. Monthly BVAR(6). 2002:02-2019:12.

of US exports, which decline by about 2ppt at peak. In addition, the global contraction in demand that results from the Chinese slowdown may further contribute to the diminished demand for US goods. Production in the US also slows down considerably, and by roughly the same amount as Chinese production. Similar to the dynamics of global production, also in this case the peak is reached with some delay.

The price spillovers to the US are even more striking, and as such especially relevant for monetary policymakers in the US. Despite the dollar appreciation, the fall in commodity prices leads to a fall also in US import price inflation, that reaches a peak contraction of about 2ppt after a year. Around half of the commodity price fall reaches US producer price inflation (PPI), which falls by about 1.5% in annual terms. The nearly full pass-through from import to producer prices is remarkable, and puts the fall in domestic US production under new light. All else equal, US output declines despite sensibly cheaper production costs, suggesting that the softening of global demand may be the prevalent driver. Finally, the fall in commodity prices trickles all the way to affect US consumer inflation as well, which is 30bps lower after a year.

7 Conclusions

This paper develops a simple yet rich approach to characterise the stance of China's monetary policy and estimate its transmission inside and outside China. This is a challenging endeavour given the multiple policy targets and instruments as well as the continuous evolution of the policy regime over the past three decades. We implement a composite monetary policy indicator to capture the broad scope of Chinese monetary policy actions. Innovations to the endogenous policy stance are extracted by means of an estimated policy rule tailored to the multiple targets that Chinese monetary policy seeks to meet.

Domestically, the monetary policy transmission works following textbook patterns. And leads to a rise in borrowing costs, a contraction in credit, and a severe contraction in production and external trade. But—unlike for advanced economies—the effects on China's exchange rate take time to materialise, and are consistent with the duality of the Chinese exchange rate regime whereby a de facto crawling peg with the US dollar is associated with a more flexible management of the yuan against the reminder of the CFETS currency basket.

Internationally, China's policy tightening leads to a strong contraction in international trade and output. Reduced demand for raw materials plunges their price following the shock. The US dollar appreciates with delay as a result of heightened global macroeconomic risk, and fligh-to-safety motives. The delayed reaction of global asset prices points to real effects being significantly stronger than financial ones, and to global asset prices reacting to the global slowdown rather than amplifying monetary policy spillovers, as it is the case instead for US policy spillovers. As China's largest trading partner, the US economy is vulnerable to Chinese policy spillovers. With US output and inflation both significantly affected.

Despite the complexity of China's monetary policy regime with its plethora of targets and instruments, the domestic transmission is well established. International spillovers are also powerful. They operate primarily through China's key position in global value chains and inexorable demand for raw materials. The effects commodity markets, trade and inflation reverberate through advanced and emerging market economies alike. Going

forward, China's changing position in global production and financial networks is likely to determine how its monetary policy footprint may evolve.

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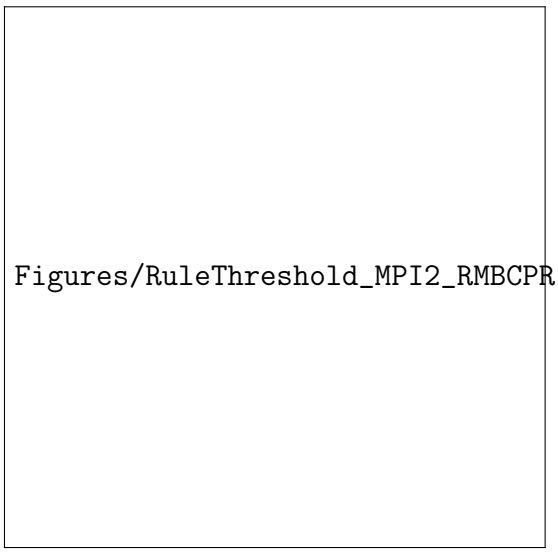
A Data Appendix

Table A.1: Data Series in Bayesian VARs

Code	Variable	Source
WORLDIP	World Production, Merges Old and New Data, Base Year 2010=100, Prod. Weights	CPB-Wolrd Trade Monitor + Own Calc.
WORLDTRADE	World Total Merchandise Trade, Volume Index, Merges Old and New Data	CPB-Wolrd Trade Monitor + Own Calc.
WORLDFCI	World Financial Conditions, Diffusion Index	CrossBorder Capital
WORLDPLIQ	World Private Liquidity, Stock, USD	CrossBorder Capital
INDPRO	US Industrial Production Index, Index 2012=100, SA	St Louis Fed FRED Database
CPIAUCSL	US Consumer Price Index for All Urban Consumers: All Items, Index 1982-1984=100, SA	St Louis Fed FRED Database
GS1	US 1-Year Treasury Constant Maturity Rate, Percent, NSA	St Louis Fed FRED Database
GERINDPRO	Production of Total Industry in Germany, Index 2015=100, Monthly, SA	St Louis Fed FRED Database
GERIMP	Imports: Value Goods for Germany, National currency Billions, Monthly Level, SA	St Louis Fed FRED Database
GEREXP	Exports: Value Goods for Germany, National currency Billions, Monthly Level, SA	St Louis Fed FRED Database
CHINDPRO	China Real Gross Value Added (Industrial Production), NSA, year-on-year % change	China National Bureau of Statistics
CHCPI	China Consumer Price Index, Not SA, year-on-year percentage change	China National Bureau of Statistics
CHMPI	Chinese Monetary Policy Index	Xu and Jia (2019)
USDEER	United States Real Effective ExhangeRate, Narrow Index	Bank for International Settlements
RMBEER	China Real Effective ExhangeRate, Broad Index	Bank for International Settlements
CRBPI	Commodity Research Bureau Price Index, Spot Prices, End of Month	Datastream
GFCFAC	Common Factor in Risky Asset Prices, 2019 Vintage, Standardized	Own Calculations
VIX	CBOE Volatility Index, Annualized Percentage Points, NSA	Datastream
CAPFGF1	First Global Factor Capital Flows, All Flows Types, Inflows and Outflows, Interp.	IFS, BOPS, WEO + Own Calculations
CAPFGF2	Second Global Factor Capital Flows, All Flows Types, Inflows and Outflows, Interp.	IFS, BOPS, WEO + Own Calculations
PSLGF1	First Global Factor Private Sector Liquidity (% of GDP)	CrossBorder Capital, WEO + Own Calculations
OUTFEME	Outflows from Emerging Markets, Percentage of GDP, All Flows Types, Interp.	IFS, BOPS, WEO + Own Calculations
INFLEME	Inflows to Emerging Markets, Percentage of GDP, All Flows Types, Interpolated	IFS, BOPS, WEO + Own Calculations
OUTFCMDY	Outflows from Major Commodity Producers, Percentage of GDP, All Flows Types, Interp.	IFS, BOPS, WEO + Own Calculations
INFLCMDY	Inflows to Major Commodity Producers, Percentage of GDP, All Flows Types, Interpolated	IFS, BOPS, WEO + Own Calculations
OUTFUS	Outflows from US, Percentage of GDP, All Flows Types, Interpolated	IFS, BOPS, WEO + Own Calculations
INFLUS	Inflows to US, Percentage of GDP, All Flows Types, Interpolated	IFS, BOPS, WEO + Own Calculations
PLIQCMDY	Private Liquidity Major Commodity Producers, Stock, USD	CrossBorder Capital

B Details on the PBOC Policy Rule

Figure B.1: Rule SSR over Threshold Grid



Notes: Sum of square residuals of the estimated policy rule over different values of the threshold $\bar{y}$.

Table B.1: Monetary Policy Rule Coefficients: MPI

	2002-2019			2002-2022		
	linear	$\bar{y}=0$	$\bar{y}=1$	linear	$\bar{y}=0$	$\bar{y}=1$
Own Lag	0.971	0.967	0.954	0.972	0.966	0.964
	[54.63]	[54.275]	[54.538]	[60.8]	[57.359]	[57.908]
CPI Gap	0.028	0.030	0.026	0.026	0.030	0.031
	[2.977]	[3.341]	[3.469]	[3.151]	[3.507]	[3.673]
ΔRMB	-0.029	-0.033	-0.036	-0.028	-0.031	-0.028
	[-2.230]	[-2.679]	[-1.831]	[-2.360]	[-2.596]	[-2.357]
GDP Gap	0.016			0.018		
	[1.716]			[2.310]		
GDP Gap (+)		0.0003	0.002		0.007	0.007
		[0.030]	[0.392]		[0.597]	[0.646]
GDP Gap (-)		0.089	0.069		0.041	0.044
		[2.064]	[2.579]		[1.955]	[2.446]

Notes: All inputs to the rule are lagged one month. Realized GDP growth is measured using a monthly GDP index.Both the GDP and inflation gaps are taken relative to the official government growth and inflation targets announced each year. The policy variable MPI is normalized to have a zero mean and the same variance as the 1-year benchmark lending rate. ΔRMB denotes log monthly changes in the RMB nominal effective exchange rate index (constructed as a geometric average using central parity rates and the corresponding trade weights published by the CFETS), interacted with the gap between the spot and central parity rates from 2006 onwards. t-stats in square brackets.

Table B.2: Monetary Policy Rule Coefficients: TSF and Loans

	$\bar{y} = 0$				$\bar{y} = 1$			
	TSF		Loans		TSF		Loans	
	2002-2019	2002-2022	2002-2019	2002-2022	2002-2019	2002-2022	2002-2019	2002-2022
Own Lag	0.975	0.997	0.958	0.980	0.981	1.005	0.966	0.996
	[74.884]	[87.541]	[67.514]	[77.256]	[74.322]	[87.789]	[64.224]	[74.311]
CPI Gap	-0.151	-0.125	-0.132	-0.104	-0.164	-0.140	-0.141	-0.110
	[-5.776]	[-5.016]	[-4.946]	[-4.258]	[-6.067]	[-5.490]	[-4.935]	[-4.178]
ΔRMB	0.025	0.014	0.043	0.036	0.025	0.014	0.044	0.036
	[2.693]	[1.761]	[4.525]	[4.307]	[2.693]	[1.737]	[4.820]	[4.491]
GDP Gap (+)	0.096	0.032	0.054	0.003	0.080	0.019	0.039	-0.008
	[2.142]	[0.836]	[1.219]	[0.077]	[1.952]	[0.534]	[0.978]	[-0.232]
GDP Gap (-)	-0.083	-0.098	-0.181	-0.046	-0.069	-0.105	-0.130	-0.061
	[-0.659]	[-2.059]	[-1.342]	[-0.889]	[-0.769]	[-2.484]	[-1.469]	[-1.478]
R^2	0.978	0.978	0.970	0.972	0.978	0.980	0.970	0.972

Notes: All inputs to the rule are lagged one month. Realized GDP growth is measured using a monthly GDP index. Both the GDP and inflation gaps are taken relative to the official government growth and inflation targets announced each year. The policy variables TSF and Loans are in yoy log growth rates. ΔRMB denotes log monthly changes in the RMB nominal effective exchange rate index (constructed as a geometric average using central parity rates and the corresponding trade weights published by the CFETS), interacted with the gap between the spot and central parity rates from 2006 onwards. t-stats in square brackets.