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Keywords: Capital control policy, Growth-at-risk, Quantile regressions, Narrative approach.

JEL classification: F38, G01, G28

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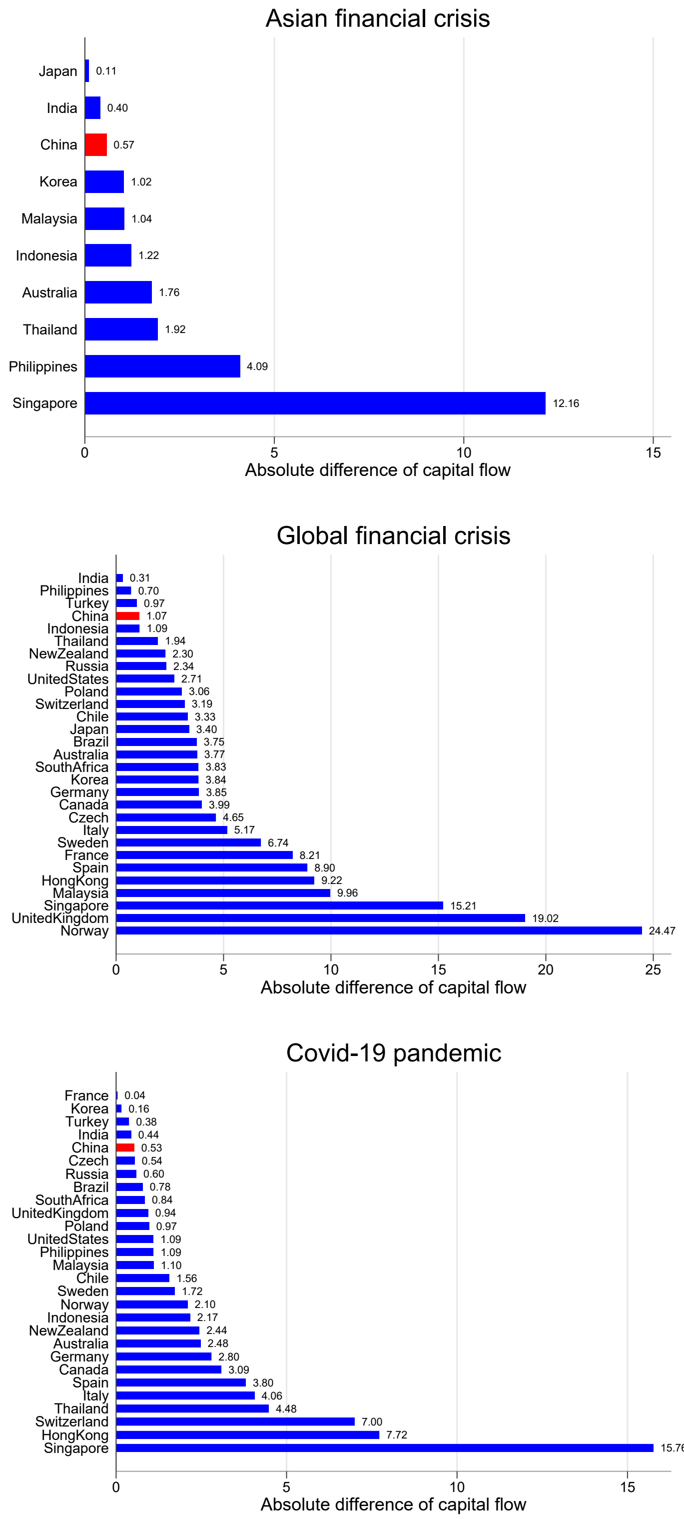
1 Introduction

The capital control liberalization has been generally believed to be beneficial to developing and emerging countries by realizing more efficient allocation of resources, achieving assets diversification, promoting financial development and enhancing welfare of whole society (Edison et al., 2004; Prasad et al., 2007). Several previous empirical studies also support the positive effects of liberalization on economic growth (Chortareas et al., 2015; Klein and Olivei, 2008; Kose et al., 2011; Quinn and Toyoda, 2008). In other words, capital control would stem growth and lead to higher implementation cost. However, if there is a downside risk in one country, with an underdeveloped domestic financial market and banking system as well as a fully liberalized capital account, such country would suffer from capital flight which would depreciate the domestic currency and trigger further outflows, leading to a totally recession.

Since worrying about such phenomenon happens in China, policymakers are cautious about fully liberalizing their capital account and they intend to use capital control policies prevent capital flight and dampen the volatile capital flows. As pointed out by Cheung et al. (2016), Habermeier et al. (2017), Miao et al. (2020), and Yu (2009), a largely closed capital account prevents China from exposing to capital flight, and protects it from external financial volatility. Figure 1.1 plots the the absolute difference of capital flows to GDP ratio between crisis years and the year before crisis. The top figure is the average absolute difference of capital flows to GDP ratio between Asian financial crisis (AFC) in 1997 and 1998 and the year before crisis in 1996 and 1997. The mid figure is the average absolute difference of capital flows to GDP ratio between Global financial crisis (GFC) in 2008 and 2009 and the year before crisis in 2007 and 2008. The bottom figure is the absolute difference of capital flows to GDP ratio between COVID-19 pandemic in 2020 and the year before in 2019. Compared to the year before crisis, China's absolute difference of capital flows to GDP ratio does not show any severe fluctuations, only 0.57 %, 1.07%, and 0.53% for AFC, GFC, and COVID-19 pandemic respectively. Besides, China's absolute difference of capital flows to GDP ratio is also small relative to other major economies ranked 3 of 10 in AFC, 4 of 29 in GFC, and 5 of 28 in COVID-19 pandemic.[1] Although these results

[1]For Asian financial crisis, we only plot the economies in Asia and pacific areas.



Notes: The top figure is the averaged one year absolute differences of capital flows to GDP ratio between Asian financial crisis (AFC) in 1997 and 1998 and the year before crisis in 1996 and 1997. The mid figure is the averaged one year abosolute differences of capital flows to GDP ratio between Global financial crisis (GFC) in 2008 and 2009 and the year before crisis in 2007 and 2008. The bottom figure is the one year abosolute differences of capital flows to GDP ratio between COVID-19 pandemic in 2020 and the year before in 2019.
Source: IMF Balance of Payments and International Investment Position statistics (BOP/IIP)

Figure 1.1: Absolute differences of capital flows to GDP ratio

cannot conclude that the volatile capital outflow during crisis could have been significantly reduced by the actively using of capital controls, countries with pervasive controls or use capital control episodically show lower absolute difference of capital flows to GDP ratio. In fact, there are several studies have documented the effectiveness of capital control in dampening the capital flows (Ahmed and Zlate, 2014; Dell'Erba and Reinhardt, 2015; Landi and Schiavone, 2021; Ostry et al., 2012). Besides, Eichengreen and Leblang (2003) find that capital controls have positive effects on economic growth in periods of financial instability. Thus, these positive effects have been associated with the benefits of capital control policies.

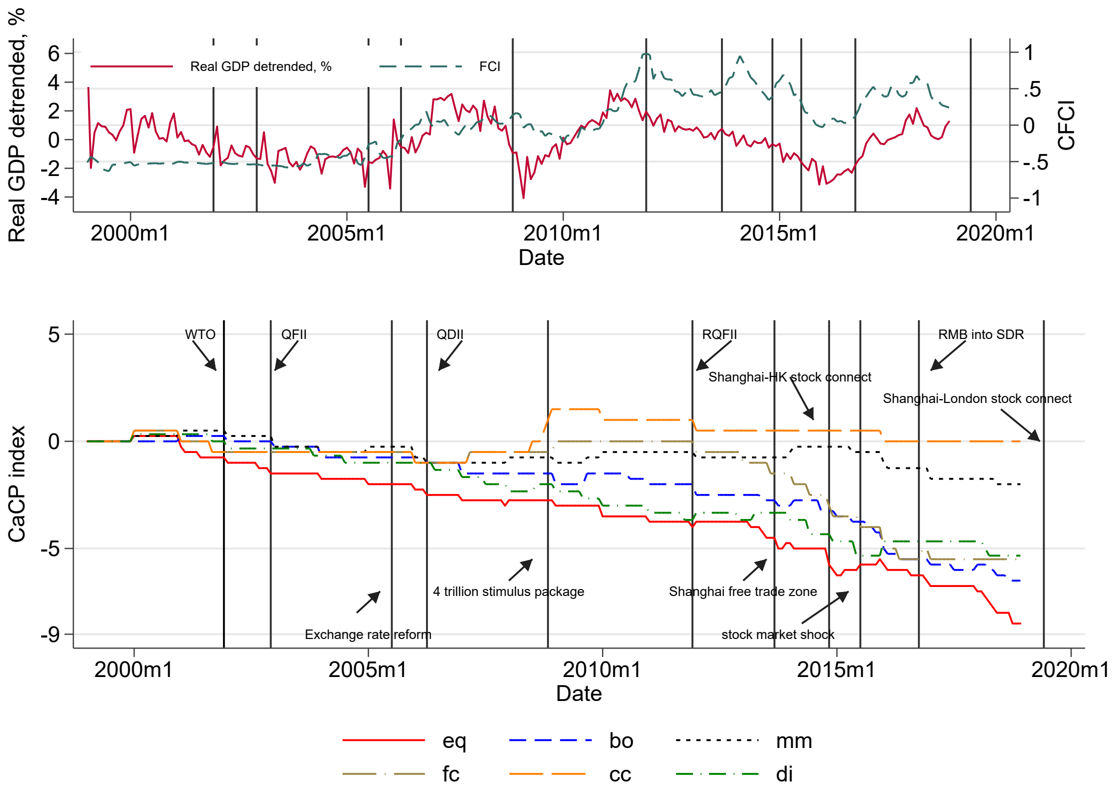
However, nearly all of the existing literature focuses on the effects of capital control policies on conditional mean level of economic growth. If capital control policies effectively decrease systemic risk, one could forecast the benefits to be observed in the downside risk of GDP growth distribution. Besides, the policymakers are more interested in what type of policy stance can mitigate the possibility of recessions and strengthen the resilience of financial system. In this regard, Bekaert et al. (2006) find that countries with more open capital accounts experience a greater reduction in the ratio of consumption growth volatility to GDP growth volatility. In other words, the capital control policies can reduce relatively the volatility of GDP growth, which means capital control policies would affect the shape of GDP growth distribution.

Motivated by these findings, I study the marginal effects of China's capital control policies on GDP growth distribution and the term structures of such distribution. To this end, I use the framework extended by Adrian et al. (2019) calculate the quantile marginal effects of GDP growth forward to 15 months on different types of capital control indices and fit a skewed t-distribution to obtain the estimated distribution. Building on the delicately compiled China's capital control indices by Chen and Qian (2016), I use a narrative approach to identify the causal relationship between capital control policies and GDP growth. Results show that there exist heterogeneous effects of aggregated capital control indices over the real GDP growth distribution. Specifically, the aggregated capital control indices are beneficial in reducing the downside risk of real GDP growth in the medium term whereas they are costly on the upswings of real GDP growth in the near-term. After I estimate the marginal effects of capital controls policies on real GDP growth over quantiles, the results show that the heterogeneous effects are stronger in the short term than medium term. Besides, the heterogeneous effects are more evident in the short term for outflow control index and resident transaction control index. The granular indices show broadly heterogeneous effects even if several of them are insignificant. As for policymakers, in order to obtain benefits more rapidly after implementation, the capital control measures should be implemented in advance in accordance with the economic status.

The rest of the chapter is structured as follows. In next section, I introduce the capital control implementation history in China. In section 3, I present main studies related with this paper. In section 4, I describe the data and method on how to identify the causal relationship between capital control indices and economic growth. Section 5 describes the methodology I used to estimate the marginal effects. Section 6 presents the empirical results of the marginal effects of GDP growth to the capital control indices. Section 7 presents some robustness exercises. Section 8 concludes.

2 Capital control implementation in China

As pointed out by Craig et al. (2013), McCowage (2019), and Miao et al. (2020), China has liberalized its capital account in a gradual and sequenced way in order to avoid capital flow fluctuations. There are also several characteristics with respect to China's capital account liberalization. First, policymakers prefer to liberalize direct investment prior to portfolio investment. Second, policymakers prefer to liberalize capital inflows prior to capital outflows and the liberalization of outflows is usually related with the easing of appreciation pressure from "hot money" and over accumulation of reserves. Third, policymakers prefer long term flows to volatile short term flows. Fourth, policymakers prefer domestic/foreign official investors to other types investors such as individual investors. Fifth, policymakers usually implement policies in some experimental (or piloting) region and restrict the scale and degree. In Figure 2.1, I plot the control intensity of six types of granular capital control indices and the relationship between China's Financial Condition Index (CFCI, right axis) and the real GDP detrended (left axis), and I also mark the critical events related with the changing of China's capital account. In other words, all these events are consistent with the features I have mentioned above.



Sources: "China Economy Time Series" by Chang et al. (2016); China's Financial Condition Index by Author (see section 4.1); China's capital control dataset from Chen and Qian (2016).

Figure 2.1: Capital control indices, detrended GDP (%) and China's Financial Condition Index

Being afraid of the volatile inflow of foreign direct investment, China built special economic zone for piloting in 1979 and then welcomed inflow from Hong Kong and Taiwan initially. In 1992, the FDI inflows came from more developed economies such as American, Europe, and Japan. In 1994, the People's Bank of China (PBoC) abolished the dual-tracked exchange rate and changed to market based managed floating exchange rate regime. In 1996, the current account were fully convertible, but the Asian financial crisis burst in 1997, resulting the delay of fully openness of capital account. These events are not recorded in figure 2.1. After joining the World Trade Organization (WTO) in December 2001, China began to further ease the capital controls on portfolio investment. In December 2002, China started the "Qualified Foreign Institutional Investors (QFII) program" which the approved foreign institutional investors can invest in restricted quota at Chinese financial market. In July 2005, since the RMB appreciation pressure built up, the PBoC abandoned pegging RMB to dollar such that China achieved truly managed floating exchange rate. In April 2006, China introduced "Qualified Domestic Institutional Investors (QDII) program" such that domestic investors can invest in overseas financial markets. This outflow liberalization measure is used to ease the appreciation pressure from "hot money inflows" and to encourage the domestic firms to "go abroad".[2]

The 2008 GFC shocked the world economy and in order to recover from such crisis, China implemented the "4 trillion RMB stimulus package". Besides, China also eased the capital inflow controls and attracted the foreign investment. Based on QFII, China continued to raise the "RMB Qualified Foreign Institutional Investors (RQFII) program" in December 2011, which the approved institutional investors can invest in Chinese financial market using RMB without official caps on RQFII quotas. In September 2013, Shanghai Free Trade Zone was established such that (foreign) companies in this zone can achieve cross-border using of RMB except for the "negative list". Besides, in November 2014, China created a new channel for cross-border equity investment for Chinese retail investors and Hong Kong SAR investors, which called "Shanghai–Hong Kong Stock Connect".

Nevertheless, there is a crisis accompanied by the accelerated liberalization process. The domestic factors of the rising labor cost, the overvalued expectation on RMB, and the willing of unwinding carry trade inflows, plus the the global factors of "Taper Tantrum" from U.S. in 2013 generated a sudden stop and then RMB depreciation expectations encouraged capital flight, resulting a severe stock market slump (Chan, 2017; Miao et al., 2020). Thus, the policymakers tightened the capital outflows in 2015 and 2016 which lead to the skepticism of China's determination on capital account liberalization (Miao et al., 2020). In October 2016, RMB was included in IMF's Special Drawing Rights (SDR) which better facilitated trade and investment with foreign partners. Meanwhile, after recovered from the stock market crisis, China continued to relax the capital account by expanding the quotas of QFII, QDII, and RQFII, and in June 2019, the "Shanghai–London Stock Connect" was launched such that global investors can benefit from China's financial market through London, and Chinese investors can also access to London Stock Exchange directly.

[2]Similar scenario also happened in 2013, when China was also tortured by "hot money" and over accumulation of reserves, China also relaxed outflow controls and more firms were encouraged to invest abroad for answering the "Belt and Road Initiative".

As depicted by figure 2.1, all these marked programs are related with the loose of capital controls and the crises are with the urgent tightening of capital outflows. For example, in 2008, before the "4-trillion RMB stimulus package" the index of trade credit ("cc" in orange dash line), bank loans ("fc" in camel dash dot line), and direct investment ("di" in green dash dot line) increase which means the tightening of such controls. This is also happened in 2015 that the policymaker tightened the security investments ("eq" in red solid line) and direct investment ("di").

3 Literature Review

A large literature has documented the effectiveness of capital control in dampening the capital flows, but the results are mixed. Ahmed and Zlate (2014), Bruno et al. (2017), and Ostry et al. (2012) find that the capital control policies are generally effective in reducing the bank, bond, and portfolio inflows. Baba and Kokenyne (2011) also admit the decreasing in inflows and lengthening of maturities after controlling the capital account, but they believe the relationship is not statistically significant. Furthermore, Binici et al. (2010) find that there are heterogeneous effects of implementing capital control policies. They show that the effects are varied for different types of capital controls, asset categories, direction of flows, and countries income levels. They conclude that the debt and equity controls are effective in reducing outflows but have little effect on inflows. Chantapacdepong and Shim (2015) investigate the effect of bond inflow management on cross-market correlations. They find that loosened policies would significantly increase the bond flow correlations, while tightened policies are not significantly decreasing bond inflows. Dell'Erba and Reinhardt (2015) find there is an opposite effect of controlling on short term debt flows: it decreases the probability of surges in banking debt flows but increases the probability of surges in financial sector FDI. Landi and Schiavone (2021) find that capital controls on other inflows and outflows are more effective for AEs, but capital controls on portfolio inflows are more effective for EMs.

Forbes and Warnock (2012), Forbes et al. (2015), Frost et al. (2020), Magud et al. (2018), and Osina (2021), however, assert that most capital flow managements (CFMs) do not significantly affect their objectives. Frost et al. (2020) and Osina (2021) believe that the macroprudential policies are more effective in managing the volume of capital (in)flows. The divergence of the results may originate from the datasets the researchers used. For most effective results, researchers usually use the dataset by Schindler (2009) which is a gradated version of AREAER narrative measures (e.g., Binici et al., 2010; Ostry et al., 2012) or Fernández et al. (2016) which is based on Schindler's dataset (e.g., Dell'Erba and Reinhardt, 2015; Landi and Schiavone, 2021). However, as for the studies with insignificant results (e.g., Forbes and Warnock, 2012; Forbes et al., 2015; Osina, 2021), they use the Chinn and Ito (2008) KAOPEN aggregated indicator of financial globalization that is also compiled using AREAER. Chinn and Ito (2008) use principal component analysis (PCA) on three categorical indicators and take the rolling average of five-years window. As discussed by Karcher and Steinberg (2013) and Quinn et al. (2011) , since it is constructed with five-years average, even if a country has fully liberalized its capital account, the intensity of index still increases. This lead to reverse causality problem that the independent variables would be positively associated with KAOPEN after the liberalization of capital account.

In early 2000s, many studies have examined the effectiveness of the capital control in China. Although some researchers believe that the capital controls are not binding or losing their effectiveness since they can be circumvented under current account convertibility (Habermeier et al., 2017), most of them have reached a consensus that capital controls are still generally effective. However, evaluating the effectiveness of China's capital controls has some difficulties due to its complexity. As argued by Habermeier et al. (2017) and Otani et al. (2011), there are many layers and types of controls, and even if for quantitative measures, it is not clear how to give weights to this actions such that the impact can be qualified properly. Thus, the early literature usually measures the effectiveness of market arbitrage in exchange rates or interest rates (Habermeier et al., 2017). This mechanism means that if the capital control policies are effective, there are significant and persistent spreads between the onshore and offshore interest rates. Chen (2013) , Cheung and Herrala (2014), Ma and McCauley (2008), and Otani et al. (2011) use covered interest differential to infer the effectiveness of China's capital controls and they find the capital control is effective. In addition, Funke et al. (2015) analyze the fundamental or global driving force of the differentials using extended GARCH framework. They find that permitting cross border outflows has an impact in reducing the volatility of differentials. Maziad and Kang

(2012) study the inter-linkages between onshore and offshore markets also using a bivariate GARCH model, and they find the evidence of volatility spillovers between two markets. Chen (2013) and Craig et al. (2013) both study the intensity of capital control using a Threshold Auto-regression (TAR) models. They find the arbitrage opportunities still exist and the capital controls explain much of the divergence of differential.

Although the covered interest differential can explain the effectiveness of capital control policies, it cannot uncover the costs or benefits of implementing specific policies. Controls on different directions of flows, different categories of flows will show different impact on their policy objectives. As pointed out by Chen (2013), covered interest differential is a *de facto* level of capital control. This measure usually not perfectly reflects the policymaker's policy stance (in fact it reflects the impact of many political and economic factors), with the direction of causality going both ways (Quinn et al., 2011). Therefore, it is necessary to use *de jure* measures to quantify the actions of capital control policies. Craig et al. (2013) summarize the capital account liberalization measures, but they do not quantify these measures. Kimball and Xiao (2006) construct annual basis China's capital control indices but they do not adopt an econometric analysis. Although there are also several cross-section level datasets on capital control policies, most of them have either no granular level data (e.g., Chinn and Ito, 2008), or too short time horizon in yearly basis (e.g., Fernández et al., 2016).

The econometric methodology used in this chapter follows Adrian et al. (2019). They use quantile regression and skewed t-distribution to fit a distribution of GDP growth, and finds that the left tail (5th percentile) of GDP growth distribution (namely, GaR) is positively correlated with slack in financial conditions. Besides, they also measure the downside risk of GDP growth using the downside entropy of the unconditional distribution of GDP growth relative to the empirical conditional distribution. This method is generally used for measuring financial instability risk. Following this framework, Adrian et al. (2018) investigate the term structure of GaR using panel quantile regressions for 11 AEs and 10 EMs, and they find that there is an inter-temporal trade off where GaR is higher in short run but lower in mid run if the financial conditions are loose. Arbatli-Saxegaard et al. (2020) study the effect of financial imbalances on macroeconomic tail risks for Norway and other advanced economies. They find that increasing in financial indicators would exacerbate GaR and lead to higher downside risks to growth. In addition, this method can also be used for studying the policy effect to GaR. Brandao-Marques et al. (2020), Duprey and Ueberfeldt (2020), Franta and Gambacorta (2020), and Galán (2020) study the effects of macroprudential measures on GaR. They find that implementing or tightening macroprudential policy reduces GDP tail risk, narrows GDP distribution, and dampens downside risk. Sánchez and Röhn (2016) agree that using macroprudential tools is related with less positive growth risk, but it lowers the average growth. Duprey and Ueberfeldt (2020) also study the effect of monetary policy and they find monetary policy can also reduce credit growth and GDP tail risk, like macroprudential policy does. Furthermore, besides macroprudential and monetary policy, Brandao-Marques et al. (2020) also consider foreign exchange interventions and CFMs, and they find that tightening monetary policy entails net losses, and the beneficial effects of foreign exchange interventions and CFMs are insignificant. Besides the effects on GaR, there are also several studies focusing on the effects on distribution of gross capital flow. Eguren Martin et al. (2021) find that macroprudential and CFMs measures are related with lower chance of large portfolio inflows and outflows. Gelos et al. (2022) find that foreign exchange interventions can help mitigate the downside risk of portfolio inflow, while capital control policies are related with larger outflows in the short term. Besides, they find little evidence for the effect of monetary and macroprudential policy on capital flows.

A large literature has documented the impact of capital account liberalization on economic growth. Many studies believe that capital controls impair growth, while capital account openness indicates a positive effect on growth (Honig, 2008; McKenzie et al., 2001). However, the literature finds mixed results on different level of development for such a country to achieve this objective. For example, Edison et al. (2004) suggest that intermediate level of development may become necessary for countries to benefit from capital account liberalization. However, Chortareas et al. (2015) and Klein and Olivei (2008) both believe that developed/advanced economies are more important to open their capital account. Quinn and Toyoda (2008) find that both developed and emerging economies are benefit from capital account liberalization. As for institutional quality, Klein (2005) believes that better (not the best) institutions have statistically and economically significant effects of capital control liberalization on economic growth. Kose et al. (2011) show that an easy satisfying lower threshold in institutional quality would improve significantly the cost-benefit trade-off for financial openness.

It must be admitted that, however, there is considerable risk if one country with an undeveloped and unregulated domestic financial market and a peg exchange rate regime quickly liberalizes its capital account transaction. On the one hand, inflow surges can lead to currency appreciation, a lose of competitiveness in trade, asset price bubbles and credit booms (Habermeier et al., 2017). On the other hand, outflow surges are more likely to be significant since the residents are longing for diversifying their portfolios. Nevertheless, there is no consensus on the size of the risk from capital control liberalization. Gou et al. (2010) find that capital inflow openness can enhance economic growth, while outflow openness may impede economic growth. Bekaert et al. (2006) and Kose et al. (2009) both believe that there is little evidence that capital account liberalization could increase vulnerability to developing countries. However, Martin and Rey (2006) find that trade globalization may not relate to financial crashes, while financial globalization may make them more likely. Furthermore, van Hulten and Webber (2009) suggest that capital account openness is not likely to heighten growth, even for the countries with appropriate institutions and policies.

Before 2011, countries that implement capital controls are usually blamed for providing convenience for trade protectionism, and receive political stigma from their trade partners. However, after 2011, IMF changed their policy stance that for developing countries, they can use capital control measures as a way to protect themselves from being tortured by financial instability (Moghadam, 2011). In 2012, IMF states that CFM is one kind of policy toolkit that can be used under certain conditions. In fact, early in 2003, Eichengreen and Leblang (2003) has stated that:

> *"[c]apital control is positive in periods of financial instability, when the insulating capacity of controls is precious, but negative when crises are absent and the direct effect on open capital account – the positive effect on resource allocation and efficiency – tends to dominate."*

This paper is related to that of Eichengreen and Leblang (2003). They study the relationship between capital account liberalization and economic growth for 21 advanced economies over the period of 1880 to 1997. Different from other literature, they consider the impact of crises on growth and the capacity of controls to stem those effects. I also consider the effect of capital flow management measures on economic growth but distinguish from them in several aspects. First, as noted above, the literature with respect to the effectiveness of China's capital control still use covered interest differential method such that it cannot uncover the cost or benefit of implementing specific policies. In contrast, I use the rigorous constructed China's capital control *de jure* indices by Chen and Qian (2016). This dataset not only quantifies the intensity of actions but also contains different asset categories, gross flow directions and resident and nonresident transaction with long time series. This dataset helps me calculate precisely the marginal effects of different indices and measure the benefits and costs of implementing capital control policies. Second, although Eichengreen and Leblang (2003) use the crisis indicators from Bordo et al. (2014), I define the downside risk using the whole conditional distribution of GDP such that I can avoid the subjectivity of constructing the crisis indicators.[3] Besides, the quantile regression and skewed t-distribution fitting not only offer the conditional mean effects, but also allow the potential benefits of capital controls in terms of GDP growth which can be only observed on the left tail of the distribution. Third, to address the endogenous problem, I use the narrative approach based on scrutinizing the document of China's capital control at AREAER and other rules and regulation from Chen and Qian (2016) and official institutions to identify the causal effects of capital control actions on real GDP growth. Fourth, as a minor contribution, I follow the method and data used in Arregui et al. (2018) and attempt to replicate and extend China's Financial condition index to 2018M12.

4 Data and endogeneity

This section provides details of data used in estimation and then examines the endogeneity of the capital control indices for causal inference.

[3] Bordo et al. (2014) show that this indicator records currency crisis, a forced change in parity, abandonment of a pegged exchange rate, or an international rescue.

4.1 Data description

The analysis is based on a monthly time series dataset for China over the period 1999M1 to 2018M12. Table 4.1 provides descriptive statistics for all sample. The data used here rely on various sources such as Bank for International Settlements (BIS) statistics, the database on "China Economy Time Series" by Chang et al. (2016), and the China's capital control dataset by Chen and Qian (2016). As for dependent variables, I use nominal GDP data from the updated database constructed by Chang et al. (2016).[4] The CPI data are also from this database. Then I take logarithm and calculate the real GDP. Using the real GDP, I can define the GDP-at-risk (GaR) in this way:

$$\mathbf{P}\left(\Delta_h y_{t+h} \leq GaR_h\left(\alpha|\Omega_t\right)\right) = \alpha \tag{1}$$

where $\Delta_h y_{t+h} = \left(y_{t+h} - y_t\right) / \left(h/12\right)$ is the cumulative annualized growth rate of real GDP between month t and month $t+h$, and y_t denotes the real GDP. $GaR_h\left(\alpha|\Omega_t\right)$ is the GDP-at-risk in h months in future at a probability α. In other words, there is α percent probability that the real GDP growth is lower than GaR. In general, GaR is defined to be 5th percentile of the real GDP growth distribution.

As for control variables, I use real GDP, CPI obtained from Chang et al. (2016), real central bank policy rate and real effective exchange rate obtained from BIS statistics. I also consider China's Financial Condition Index (CFCI) as one of control variables since it measures China's financial conditions in money, debt, equity and housing markets. As proposed by Adrian et al. (2019), FCI is found to be relevant to explain the real GDP growth distribution. If CFCI is positive, China's financial conditions are tighter than average. This index has been compiled by Arregui et al. (2018) and used for 2017 Global Financial Stability Report (GSFR), which they estimate FCI from 1990 to 2016 for 43 advanced and emerging markets using 10 financial indicators, but this index is available only until the end of 2016 and it will not be updated regularly. In order to expand the time horizon to 2018M12 as other dependent and explanatory variables, I follow the method and data used in Arregui et al. (2018) and attempt to replicate and extend China's FCI.

[4] In Chang et al. (2016), they calculate the monthly nominal GDP by interpolating seasonally adjusted quarterly nominal GDP value added with seasonally adjusted monthly nominal retail sales of consumer goods, nominal exports, imports, and value added of industry.

The method that I follow to estimate FCI is based on the time-varying factor augmented vector auto-regressive model (TVP-FAVAR) developed by Koop and Korobilis (2014).[5] The TVP-FAVAR model takes such form:

$$x_t = \lambda_t^y y_t + \lambda_t^f f_t + v_t, \tag{2}$$

$$\begin{bmatrix} y_t \\ f_t \end{bmatrix} = c_t + B_{t,1} \begin{bmatrix} y_{t-1} \\ f_{t-1} \end{bmatrix} + \cdots + B_{t,p} \begin{bmatrix} y_{t-p} \\ f_{t-p} \end{bmatrix} + \varepsilon_t, \tag{3}$$

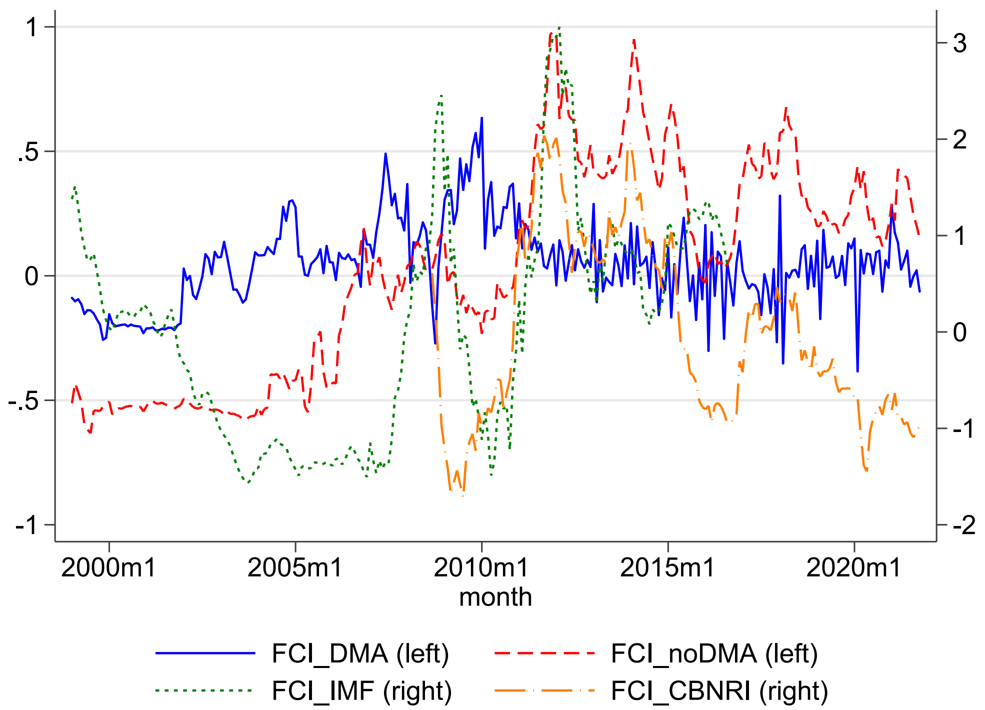
where x_t is a vector of financial variables, y_t is a vector of macroeconomic variables, f_t is the latent factor, namely the FCI we are interested in. λ_t^y and λ_t^f are regression coefficients and factor loadings respectively. $B_{t,1} \cdots B_{t,p}$ are VAR coefficients.

In order to replicate and extend the CFCI computed by Arregui et al. (2018), I also follow the macroeconomic and financial variables used in their paper.[6] The details of financial and macroeconomic variables I used are presented in Table A.2. The second column of data description is copied from Arregui et al. (2018), but since they do not specify the data type and definition they used for each country, I can only use the data roughly corresponding to their definitions. The data I use are listed in column 3 and I also offer the source and the available period of them. Following Koop and Korobilis (2014), all of the variables (including financial and macroeconomic variables) are checked by Augmented Dickey-Fuller (ADF) unit-root test and have been transformed to stationary.[7]

[5]As pointed out by Koop and Korobilis (2014) and Arregui et al. (2018), there are several advantages of this method: (1) the method can purge the FCI of the effects of macroeconomic conditions. (2) this method can account for the dynamic relationships between macroeconomic and financial variables over time. (3) the time-varying parameters can account for changes in policy regimes.

[6]According to Arregui et al. (2018), the choice of financial variables should reflect many sectors of financial system: equity, housing, bond, and interbank markets.

[7]The spread variables all show stationary and thus they remain unchanged in levels. The other financial variables have processed by percent change and they are also stationary variables. As for inflation, the ADF test shows that CPI is a trend stationary process. Thus, we eliminate the trend by HP filter and obtain the detrended CPI that is stationary.



Notes: The blue solid line (left-axis) represents my calculation of FCI using TVP-FAVAR with DMA. The red dashed line (left-axis) denotes my calculation of FCI using TVP-FAVAR. The green dotted line (right-axis) is the FCI computed by Arregui et al. (2018) using TVP-FAVAR. The orange dash-dotted line (right-axis) is the FCI computed by a China's think tank "CBNRI" using PCA.

Figure 4.1: China's FCIs: Comparison

The estimated China's FCIs are plotted in Figure 4.1. For comparison and showing the validity of my FCI, I also provide the FCI computed by Arregui et al. (2018) and other China's think tank "CBNRI". The blue solid line "FCI_DMA" represents the computation of FCI using TVP-FAVAR with dynamic model averaging (DMA). DMA method calculates FCI by averaging over many individual FCIs calculated using different financial variables, thus reducing the expected risk of the final forecast (Koop and Korobilis, 2014). The red dashed line "FCI_noDMA" is the FCI of interest using only TVP-FAVAR. The green dotted line "FCI_IMF" is the FCI constructed by Arregui et al. (2018) (time horizon until 2016M9) and I use it in robustness check in section 7.3. The orange dash-dotted line denotes the FCI constructed by a China's think tank "CBNRI" and this index starts from 2008M9.[8] Figure 4.1 shows that "FCI_noDMA" can replicate effectively the

[8]In fact, does not like U.S. Chicago Fed National FCI, China's official institutions do not compile (or publish) China's official FCI index. Besides, although several researchers have constructed China's FCI using various methods, most of them do not make it available or update it regularly. Thus, I choose the "CBNRI" index since it is regularly updated and can be obtained from WIND database. It is constructed

tightening financial conditions in GFC, and the peak in 2011M11, 2014M2, and 2018M3 corresponding to “FCI_IMF” and “FCI_CBNRI” . Besides, “FCI_noDMA“ also has a similar trend pattern with “FCI_IMF” and “FCI_CBNRI”, and the correlation coefficients between “FCI_noDMA“ and “FCI_IMF” as well as “FCI_noDMA“ and “FCI_CBNRI” are 0.6044 and 0.7806 respectively. In other words, the calculation of “FCI_noDMA“ is a desirable alternative to Arregui et al. (2018)’s FCI.

Table 4.1: Descriptive statistics

	p5	p25	p50	p75	p95
Real GDP growth (1 year growth, %)	-6.699	4.191	9.524	15.071	26.840
Real GDP (log level)	2.140	2.547	3.191	3.681	3.968
China’s financial condition index (CFCI)	-0.558	-0.504	-0.010	0.397	0.671
CPI (log level)	4.537	4.571	4.722	4.867	4.935
Real central bank policy rate, %	1.109	2.037	2.258	2.700	3.846
Real effective exchange rate (log level)	4.439	4.509	4.592	4.759	4.857
Gross capital account control index (CaCP)	-4.111	-2.181	-1.306	-0.694	0.222

Source: BIS statistics; “China Economy Time Series” by Chang et al. (2016); China’s Financial Condition Index by Author; China’s capital control dataset from Chen and Qian (2016).

The explanatory variables I used here are obtained from China’s capital control policy dataset constructed by Chen and Qian (2016). They extract the implementation information of capital control from the IMF’s Annual Report on Exchange Arrangement and Exchange Restrictions (AREAER) and supplement with other sources. Then they compile the *de jure* indices with a simple rule – setting the data of 1999M1 as the baseline equal to 0, if capital control tightens then add 1, if it looses then subtract 1 in the next period. They also compile a type of hybrid indices which are calculated by weighted *de jure* indices considering the share of each asset in the total value of China’s capital account. Until now, there are a number of capital control datasets originating from AREAER. Quinn and Inclan (1997) have developed an indicator of enforcement of controls on capital account and financial current account. The data cover six categories and are available for 122 countries from 1949 to 2007, and capture the intensity of those restrictions. However, Fernández et al. (2016) propose that Quinn’s index does not distinguish between capital controls on

using Principal Component Analysis (PCA) based on the monthly transaction data and statistical data from Interbank lending market (4 variables), Debt market (9 variables), Stock market (3 variables) and Credit market (4 variables).

inflows and outflows respectively. Chinn and Ito (2008) have constructed an capital account openness index called "KAOPEN", which is based on the binary dummy variables of restriction on cross-border financial transaction reported in AREAER. This index is highly aggregated even if it covers 182 countries from 1970 to 2018. As suggested by Quinn et al. (2011), the most finely gradated of the AREAER measures is Schindler (2009) "KA" index. This is a granular indices by asset category (in line with BOP terms), residency status, and direction of transactions (inflows vs. outflows), and it provides binary index at the level of individual types of transactions. Besides, it covers 91 countries during 1995 to 2005. Based on the data from Schindler (2009), Fernández et al. (2016) include more countries (100 countries), more asset categories (four new asset categories are introduced: derivatives, commercial credit, financial guarantee, and real estate), and more years (the period over 1995 to 2017). Even it is an advanced version of Schindler (2009), this dataset also inherits the disadvantage of Schindler (2009) that it cannot measure the intensity of changes in capital controls over time.

Compared with the indices aforementioned, the indices complied by Chen and Qian (2016) have several advantages: (i) both aggregated and granular, inflow and outflow, resident and nonresident transaction data; (ii) the granular data have six major asset categories; (iii) the indices can measure the intensity of changes in capital control over time; (iv) the indices are monthly-frequency and useful for studying high-frequency short-term capital flows. These advantages are capable for us to study the impact of capital control policies on different quantiles of real GDP growth. The capital control data used here are *de jure* indices.[9] The details of aggregated and granular capital control indices are presented in Table 4.2.

4.2 Identification of capital control policy shocks

I have specify the capital control indices in the last section. However, estimating the effects of capital control policy is difficult because the policy may respond automatically to economic activities or policymakers may adjust policy based the information of prospective economic growth. Friedman and Schwartz (2008) and Romer and Romer (1989) have

[9] I do not use the hybrid data compiled by Chen and Qian (2016) in my baseline model since they are not updated after 2014M12. But such data mitigate issues of lack of importance of capital flows and endogeneity problems, thus I will test these indices in robustness section 7.2.

Table 4.2: The capital control measures used in this paper

Categories	Description	Abbreviation
Aggregated indices	Gross capital account control index	"ka"
	Control index on capital account inflows	"kai"
	Control index on capital account outflows	"kao"
	Control index of capital flows by resident	"ka_r"
	Control index of capital flows by nonresident	"ka_nr"
Granular indices	Share or other securities	"eq"
	Bonds or other debt securities	"bo"
	Money market instruments	"mm"
	Commercial credits (trade credits)	"cc"
	Financial credits (bank loans)	"fc"
	Controls on direct investment	"di"

Notes: We also use deeply granular data types in the robustness section 7.1, like "dii" which is capital control index on inward direct investment and we do not present them in this table.
Source: China's capital control dataset by Chen and Qian (2016).

developed a narrative approach which I can use qualitative information from primary documents or records established by policymakers thereby compiling quantitative indices to identify the causal effects of capital control policies on economic activity.

In order to implement this method, I should specify the endogeneity of the data since it is depended on the motivation of implementing capital control policy. As I have mentioned before, if capital control policies are taken in response to factors that affect current or expected economic activities (output growth, or price stability), these can be called endogenous, while if they are taken for other reasons, we call them exogenous. The data compiled by Chen and Qian (2016) do not contain the background and the reasoning of specific policy actions, thus I need to consult the country level annual reports of AREAER for each of the policy action description. Then, I search for the key words ("output", "GDP", "growth", "CPI", and "inflation") in the description of policy actions and find that no policy action was motivated by these objectives. In addition, I double check the rules, regulations, and notices associated with capital account listed in the website of The State Administration of Foreign Exchange of China (SAFE), and list all the titles of such rules, regulations, and notices and extract their objectives in Appendix ??. I find two notices mentioning the objective of economic growth. Table 4.3 presents the details of such notices. One is the "Notice on improving the registration and management system of foreign debts

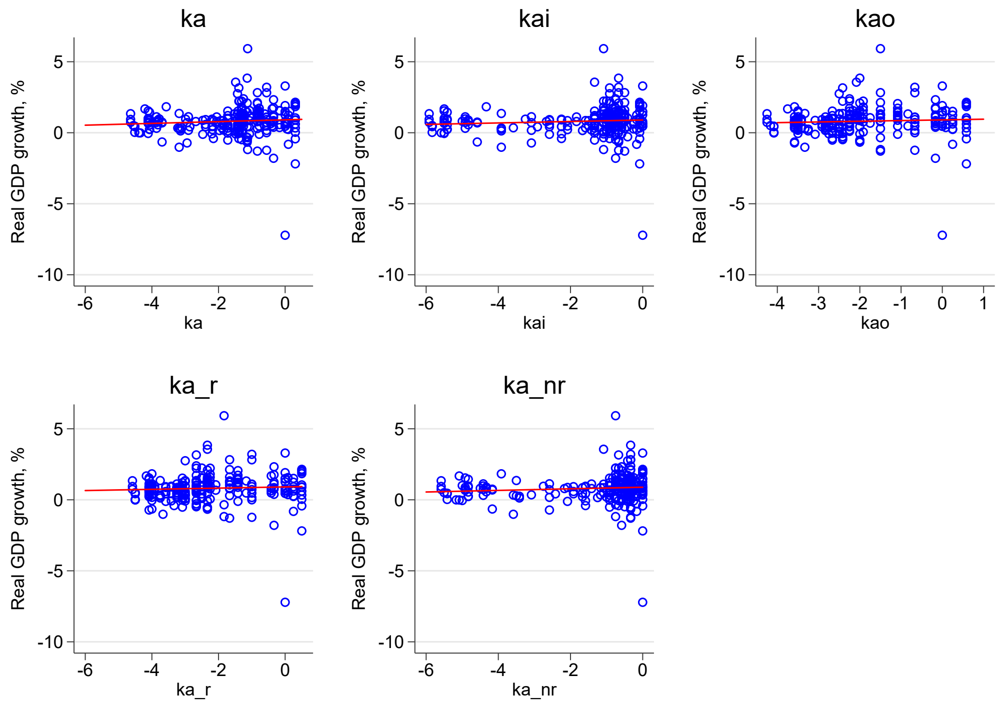
Table 4.3: Policy actions mentioned the objective of economic growth

Date	File Code	Index	Title	Objective
Dec. 23, 2008	HuiFa (2008) No. 73	"cci"	Notice on improving the registration and management system of foreign debts under firm's merchandise trade account	(i) better withstand the negative impact of global financial crisis, (ii) promote stable **economic growth.**
Mar. 17, 2009	HuiFa (2009) No. 14	"fci"	Notice on the verification of short-term external debt of financial institution in 2009	(i) cooperate with the adjustment of national macroeconomic policies, (ii) give full play to the credit intermediary role of financial institutions, (iii) promote real **economic growth** and trade financing.

Source: Capital account and FX management, Policy and Regulations, The State Administration of Foreign Exchange of China (http://www.safe.gov.cn/safe/zbxmwhgl/index.html).

under firm's merchandise trade account" which is published and implemented at December 23, 2008. This notice mentions the objective of "promoting stable economic growth" and it relates to commercial credit inflow "cci". The other is "Notice on the verification of short-term external debt of financial institution in 2009" which is published at March 17, 2009 and implemented at April 1, 2009. This notice also mentioned the objective of "promoting real economic growth and trade financing" and it relates to financial credit inflow "fci". Following Richter et al. (2019), I should drop all policy actions that are motivated by economic growth. However, after I scrutinize the raw data of Chen and Qian (2016), I do not find any change of the index "cci" between December 2008 and January 2009, and any change of index "fci" between March 2009 and April 2009.[10] In other words, the raw data of Chen and Qian (2016) do not contain policy actions motivated by economic growth. In general, the objectives of specific capital control policies announced by the PBoC or SAFE are more detailed and in micro (or more specific) level. For example, the PBoC announced the "Administrative Measures for the RMB Settlement of Cross-Border Trade Pilot Project" in 2009, this regulation emphasizes the objective of promoting trade facilitation, regulating the behavior of commercial banks, and preventing related risks.

[10]In fact, the first notice aforementioned (HuiFa (2008), No.73) is a supplement and adjustment of notice published at July 2, 2008, "Notice on implementing the registration and management system of foreign debts under firm's merchandise trade account (HuiFa (2008), No.30)". This notice stipulates the specifications of (i) advance receipts of export proceeds, and (ii) deferred import payments. The policy actions of this notice have recorded in the raw data where "cci" changed from "1" (in June 2008) to "2" (in July 2008), and from "2" (in October 2008) to "3" (in November 2008).



Source: "China Economy Time Series" by Chang et al. (2016); China's capital control dataset from Chen and Qian (2016).

Figure 4.2: Relationship between aggregated capital control indices and real GDP growth

In Chen and Qian (2016), they summarized that China usually implements (looses) capital control policies in a step-by-step gradual style. They also have several conjectures towards the objective of changing capital control policies. For the period from 2005 to 2008 GFC, China tightens the trade payment (or commercial credit) control and encourages outflows. They believe that China uses capital control policy to rein the booming trade surplus in response to ease political pressure from the US government or other trade partners. Besides, they also propose that China encouraged capital inflows in 2008 to contain the "flight to quality" from China, and tightened capital control on financial credit to restrain hot money inflows in 2003. Above, they believe that the implementation of capital controls in China are more related with political pressure and capital flow factors. In addition, Fernández et al. (2016) suggest that capital controls are remarkably acyclical in booms or busts.

Although I have presented that the capital control indices complied by Chen and Qian (2016) do not have real economic objectives, the policymakers may target real economic

Table 4.4: Checking for balance of treatment and control sub-populations

Difference (Tightening minus Control)					
	ka	kai	kao	ka_r	ka_nr
Real GDP growth	0.003	0.002	0.004	0.002	0.003
	(0.003)	(0.004)	(0.003)	(0.003)	(0.003)
CPI growth	0.001	-0.001	0.001	0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	239	239	239	239	239
Difference (Loosening minus Control)					
	ka	kai	kao	ka_r	ka_nr
Real GDP growth	0.000	0.000	-0.003	-0.003	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
CPI growth	0.000	0.001	0.000	0.000	0.001*
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	239	239	239	239	239

Notes: Each cell in column (2) to (6) is the difference between treatment (tightening or loosening capital control) and control group (no such restriction) for interested economic activity variables (real GDP growth and CPI growth). The null hypothesis is the equality of means for each subpopulation. Standard errors in parentheses. *, **, ***, indicate the significant at 10%, 5%, 1% levels respectively. Standard errors in parentheses.

objectives without stating them explicitly when implementing such actions as proposed by Richter et al. (2019). Thus, I need to do several tests to confirm that there is no systematic relationship between the implementation of capital control policies and real economic variables. Figure 4.2 presents a preliminary inspection of the relationship between aggregated capital control indices and real GDP growth. The fitted linear lines of "ka", "ka_r", "ka_nr", "kai", and "kao" present low (near zero) slopes, and they also display no clear pattern that capital control indices can respond to real GDP growth. Besides, I obtain similar results when I use granular capital control indices as in Figure A.1.

In Table 4.4 and Table 4.5, I formally examine the relationship between the implementation of capital control policies and real GDP growth and also consider another economic activity variable, namely the CPI growth. It should be noted that the distribution of treatment and control group should be the same in an ideal randomized controlled trial. The simple way to test this condition is to compare the mean of those subpopulations and test their equality. Table 4.4 shows the results of checking the balance of treatment and control subpopulations. Following Richter et al. (2019), I differentiate the changing of cap-

Table 4.5: Prediction of implementation of aggregated capital control policies

	(1) ka	(2) kai	(3) kao	(4) ka_r	(5) ka_nr
One lag of real GDP growth	9.60	15.41	4.98	5.23	15.16
	(9.34)	(11.77)	(9.45)	(10.63)	(10.66)
One lag of CPI growth	-30.03	-0.86	-70.95***	-80.19***	8.37
	(22.56)	(27.93)	(24.95)	(27.74)	(25.61)
Observations	238	238	238	238	238
R^2	0.01	0.01	0.03	0.03	0.01

Notes: This table presents OLS regression results. The dependent variables are the aggregated capital control variables of "ka", "kai", "kao", "ka_r", and "ka_nr", respectively. Robust standard errors in parentheses. *, **, ***, indicate the significant at 10%, 5%, 1% levels respectively.

ital control policies into two treatment, a tightening and a loosening, as well as the control group of observations. The upper (lower) panel shows the difference between tightening (loosening) and control group. The results show that there is no statistically significant difference between the two subpopulations. In other words, the results suggest that the capital control indices are truly exogenous events.

Table 4.5 presents the results whether the implementation of capital control policies can be predicted by one month lagged real GDP and CPI growth. Column (1) to (5) show the results from "ka" to "ka_nr". I find that the coefficients for explanatory variables (especially one lag of real GDP growth) are not statistically different from zero even if one month lag of CPI growth has explanatory power for "kao" and "ka_r" to some extent. Meanwhile, I obtain similar results when I use granular capital control indices as in Table A.1. Overall, I conclude that the capital control policies are not predicted by real GDP growth and they can be seen as independent to business cycle.

5 Methodology

In this section, I turn to quantile regression to characterize formally the conditional relationship between real GDP growth and capital control indices. As proposed by Koenker and Bassett (1978), quantile regression is a useful tool that allows to analyze the marginal effects on different quantiles of the dependent variable. This also allows to capture characteristics that are missed when only focusing on conditional mean effects. I denote $\Delta_h y_{t+h} = (y_{t+h} - y_t) / (h/12)$ as the response variables of interest, the cumulative annualized average change of real GDP growth between base month t and month $t+h$ over varying forecasting horizons $h = 1, \cdots, H$, where H is 15 in the specification. y_t is the logarithm of real GDP at period t, $\boldsymbol{X}_t$ is a vector of explanatory and control variables.

The predicted value from quantile regression is the quantile of $\Delta_h y_{t+h}$ conditional on $\boldsymbol{X}_t$

$$\widehat{\boldsymbol{Q}}_{\Delta_h y_{t+h}|\boldsymbol{X}_t} (\tau|\boldsymbol{X}_t) = \boldsymbol{X}_t \hat{\boldsymbol{\beta}}_\tau, \tag{4}$$

where $\widehat{\boldsymbol{Q}}_{\Delta_h y_{t+h}|\boldsymbol{X}_t}$ is the estimated quantile function, and it is also a consistent linear estimator proved by Koenker and Bassett (1978). τ denotes the percentiles. In such quantile regression of $\Delta_h y_{t+h}$ conditional on $\boldsymbol{X}_t$, the regression slope $\boldsymbol{\beta}_\tau$ is chosen to minimize the quantile weighted absolute value of errors:

$$\hat{\boldsymbol{\beta}}_\tau = \underset{\boldsymbol{\beta}_\tau \in \mathbb{R}^k}{\arg\min} \sum_{t=1}^{T-h} \left[\tau \cdot \mathbf{1}_{\Delta_h y_{t+h} \geq \boldsymbol{X}_t \boldsymbol{\beta}} \left| \Delta_h y_{t+h} - \boldsymbol{X}_t \boldsymbol{\beta}_\tau \right| + (1-\tau) \cdot \mathbf{1}_{\Delta_h y_{t+h} < \boldsymbol{X}_t \boldsymbol{\beta}} \left| \Delta_h y_{t+h} - \boldsymbol{X}_t \boldsymbol{\beta}_\tau \right| \right], \tag{5}$$

where $\mathbf{1}_{(\cdot)}$ denotes the indicator function indicating whether the estimated errors are positive or negative.

To calculate the impulse response of real GDP growth over time, I use local projection method introduced by Jordà (2005). This allows me to compute impulse responses without specification and estimation of the underlying multivariate dynamic system. Jordà (2005) shows that local projections can be estimated at each period of interest rather than extrapolating into increasingly distant horizons from a given model like VAR models. The estimated baseline model for conditional quantile of future real GDP growth for up to 15 months ahead can be written as

$$\text{For "ka": } \widehat{\boldsymbol{Q}} (\Delta_h y_{t+h} | CaCP_t, CFCI_t, \boldsymbol{x}_t) = \hat{\alpha}_\tau + \hat{\beta}_2^{\tau,h} CaCP_t + \hat{\beta}_3^{\tau,h} CFCI_t + \hat{\beta}_4^{\tau,h} CaCP_t \times CFCI_t + \hat{\boldsymbol{\beta}}_5^{\tau,h} \boldsymbol{x}_t + \varepsilon_t^{\tau,h},$$

$$\text{For "kai" and "kao": } \widehat{\boldsymbol{Q}} \left(\Delta_h y_{t+h} | CaCP_t^{in}, CaCP_t^{out}, CFCI_t, \boldsymbol{x}_t\right) = \hat{\alpha}_\tau + \hat{\beta}_2^{\tau,h} CaCP_t^{in} + \hat{\beta}_3^{\tau,h} CaCP_t^{out} + \hat{\beta}_4^{\tau,h} CFCI_t + \hat{\beta}_5^{\tau,h} CaCP_t^{in} \times CFCI_t + \hat{\beta}_6^{\tau,h} CaCP_t^{out} \times CFCI_t + \hat{\boldsymbol{\beta}}_7^{\tau,h} \boldsymbol{x}_t + \varepsilon_t^{\tau,h}. \tag{6}$$

where $h = 1, \cdots, 15$, $CaCP_t$ denotes the aggregated capital control index. $CaCP_t^{in}$ and $CaCP_t^{out}$ represent inflow and outflow capital control index respectively.[11] $CFCI_t$ represents the China's financial conditions index. Following the specification of Eguren Martin et al. (2021), I also include interaction terms between China's financial conditions index and capital control indices as additional explanatory variables. Thus, the marginal effects of implementing corresponding capital control index on quantile τ of real GDP growth h quarters ahead are calculated by

$$\begin{cases} \partial\widehat{\boldsymbol{Q}}/\partial CaCP_t = \hat{\beta}_2^{\tau,h} + \hat{\beta}_4^{\tau,h} \times \text{mean}\left(CFCI_t\right) & \text{for aggregated index "ka"}, \\ \partial\widehat{\boldsymbol{Q}}/\partial CaCP_t^{in} = \hat{\beta}_2^{\tau,h} + \hat{\beta}_5^{\tau,h} \times \text{mean}\left(CFCI_t\right) & \text{for aggregated inflow index "kai"}, \\ \partial\widehat{\boldsymbol{Q}}/\partial CaCP_t^{out} = \hat{\beta}_3^{\tau,h} + \hat{\beta}_6^{\tau,h} \times \text{mean}\left(CFCI_t\right) & \text{for aggregated outflow index "kao"}. \end{cases}$$

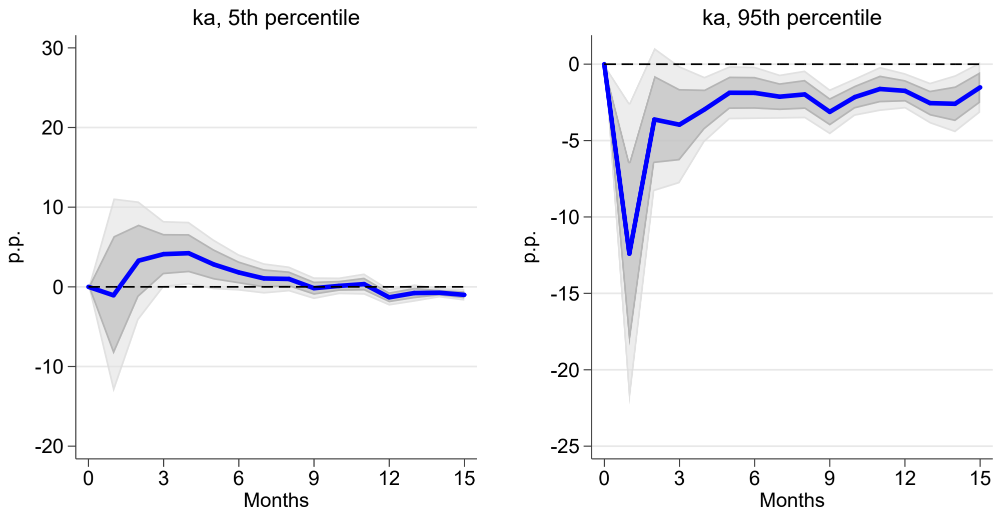
τ represents the estimated quantiles from 5th to 95th percentiles. $\boldsymbol{x}$ is a vector that contains real GDP, CPI, real central bank policy rate, real effective exchange rate. I specify the baseline model in Equation (6) referring Galán (2020) and Franta and Gambacorta (2020) in analyzing the effects of macroprudential policies on GaR, and further add real effective exchange rate for capturing the motivation of capital flows.

6 Empirical Results

To analyze the results from baseline quantile regression in equation (6), I start with the term structure of the impact of capital control policies on GaR. Then I focus on the impact across different percentiles from 5th to 95th at specific time horizons. Besides, I compare the forecast distribution estimated by skewed t-distribution for 3-months-ahead real GDP growth at business cycle upswings and downturns conditional on/without capital control indices. Finally, I provide entropy and expected shortfall to measure the vulnerability of the predicted GDP growth and then compare these measures by conditional on/without capital control indices.

[11] The effects of resident transaction control index $CaCP_t^r$ and nonresident transaction control index $CaCP_t^{nr}$ are also estimated in pairs.

6.1 The term structure of the impact of capital control policies on real GDP growth

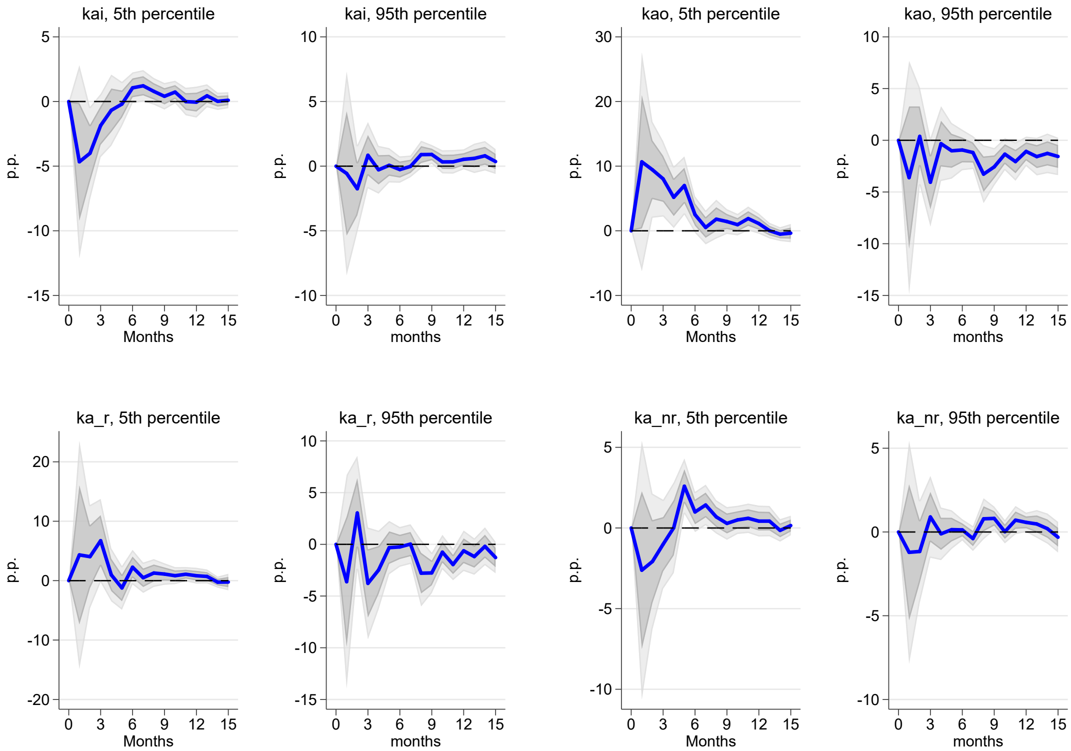


Notes: The blue lines denote the estimated cumulative responses coefficients of a one-point increase in aggregated capital control index "ka" obtained from local projection quantile regressions on real GDP growth at the 5th and 95th percentiles for 1 to 15 months ahead. Shaded areas refer to 1 standard error (dark) and 1.64 standard error (light), and the standard error are calculated by bootstrapping techniques with 500 replications. The y-axis indicates the percentage point change in real GDP growth. The horizontal dashed lines represent the value of zero.

Figure 6.1: Estimated coefficients of 5th, and 95th percentiles of real GDP growth to the implementation of aggregated capital control index "ka" from 1 to 15 month horizons.

In order to evaluate the effects of implementing capital control polices on GaR in the near-term (0-3 months) and medium term (3-6 months), I estimate the term structure of baseline model (6) using local projection quantile regressions. Figure 6.1 and 6.2 show the cumulative response of left tail (5th percentile, GaR) and the right tail (95th percentile) of real GDP growth over entire time horizon from 1 to 15 months, conditional on one point increase in aggregated capital control indices respectively, ceteris paribus. The estimated coefficients are plotted together with 90% and 68% confidence bands.

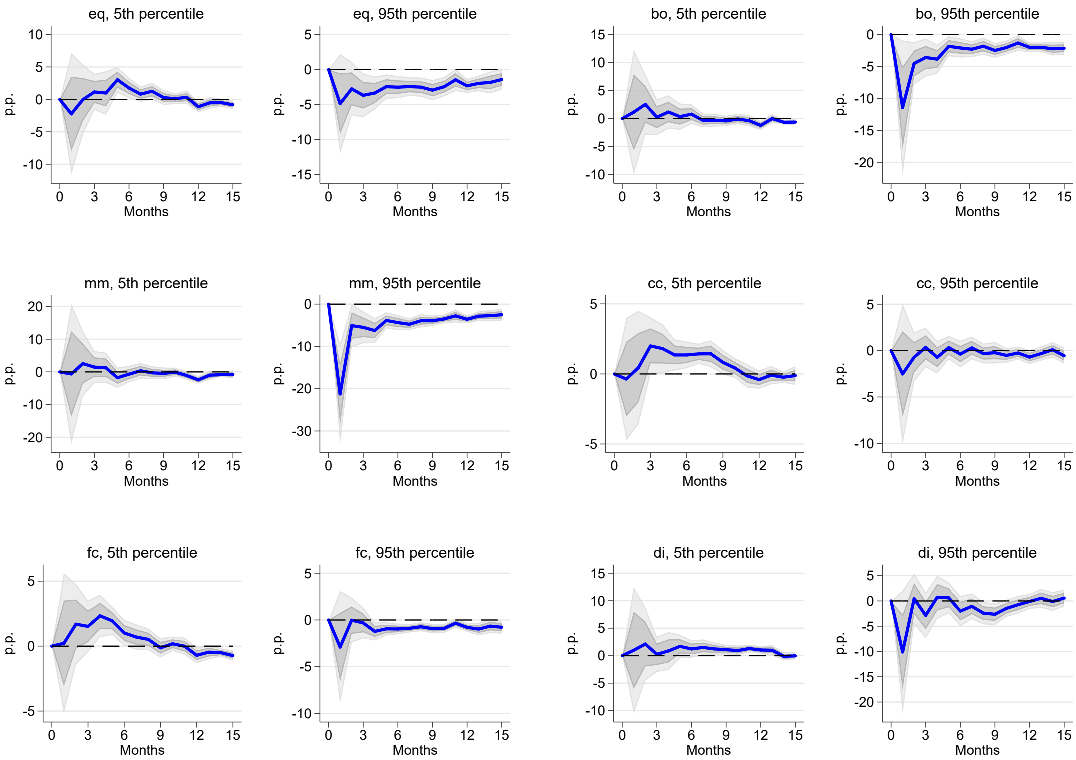
In Figure 6.1, I present the estimated quantile effects of implementing aggregated capital control "ka" on real GDP growth at 5th and 95th percentiles respectively. For 5th percentile of real GDP growth, we can see that in the near-term, the impact of implementing capital control "ka" cannot be distinguished from zero. In the mid-term, however, the benefits of implementing capital control policy are rapidly materialized and the effects are persistent from 3 to 6 months. The maximum benefit in reducing the downturn risk of real GDP growth is reached 4 months after the implementation of an aggregated capital control “ka” and shows around 5% point of real GDP growth, which means that a one point increase in aggregate capital control “ka” is associated with a cumulative increase of 5% point in GaR over 4 months. In the long term, the marginal effects start to diminish after 7 months. In contrast, there are detrimental effects of implementing capital control policy “ka” on 95th percentile of real GDP growth. The maximum impact is reaching after 1 month with a cost of 12.5% of real GDP growth. Then, the effects dissipate in the mid-term to 2% point at period 6 and become persistent in the long term over 1 year.



Notes: The blue lines denote the estimated cumulative responses coefficients of a one-point increase in each capital control aggregated indices obtained from local projection quantile regressions on real GDP growth at the 5th and 95th percentiles for 1 to 15 months ahead. Shaded areas refer to 1 standard error (dark) and 1.64 standard error (light), and the standard error are calculated by bootstrapping techniques with 500 replications. The y-axis indicates the percentage point change in real GDP growth. The horizontal dashed lines represent the value of zero.

Figure 6.2: Estimated coefficients of 5th, and 95th percentiles of real GDP growth to the implementation of aggregated capital control indices from 1 to 15 month horizons.

These results suggest that the implementing of aggregate capital control policy “ka” would be beneficial in lowering the downside risk of real GDP growth while the effects present a lag and are active usually in the mid-term. In contrast, it would be costly



Notes: The blue lines denote the estimated cumulative responses coefficients of a one-point increase in each capital control granular indices obtained from local projection quantile regressions on real GDP growth at the 5th and 95th percentiles for 1 to 15 months ahead. Shaded areas refer to 1 standard error (dark) and 1.64 standard error (light), and the standard error are calculated by bootstrapping techniques with 500 replications. The y-axis indicates the percentage point change in real GDP growth. The horizontal dashed lines represent the value of zero.

Figure 6.3: Estimated coefficients of 5th, and 95th percentiles of real GDP growth to the implementation of granular capital control indices from 1 to 15 month horizons.

to implement aggregated capital control policy during business cycle upswings and the detrimental effects are immediate and persistent over time horizons. I call it as the *heterogeneous effects* of capital control on real GDP growth.[12][13] As for the delay effects of the policy, Franta and Gambacorta (2020) and Galán (2020) both find a lag impact on GaR after implementing macroprudential policies immediately. Franta and Gambacorta (2020)

[12]Although this beyond the scope/objective of this chapter, further analysis is needed to construct a formulated theoretical model to explain the heterogeneous effects of distribution of GDP growth conditional on capital controls. Eichengreen and Leblang (2003) proposed that an open capital account (also, capital controls) to affect economic growth through two channels: directly (when financial markets are functioning well and other distortions are absent, capital account liberalization achieves a more efficient allocation of resources and a faster economic growth) and indirectly (if there exist domestic distortions conducive to excessive risk-taking, the liberalization of capital account may lead domestic agents to lever up their bets, increasing the risk of financial crises).

[13]The positive effects of capital control for welfaring-improving have been modeled by Bianchi (2011) that he intoduces the pecuniary externality inducing an allocation that is suboptimal, and the capital controls can be used to fully internalized the pecuniary externality.

show the lag effect lasts over 10 quarters, and Galán (2020) identifies these effects last for 6 quarters. Both of them find longer lag periods for macroprudential policy while I find a shorter lag period for China's capital control policy. Besides, different from our results, Franta and Gambacorta (2020) also find lag effects on 95th percentile of real GDP growth. The heterogeneous of response time on different percentiles can be explained by the fact that, the capital controls are "sticky" (Acosta-Henao et al., 2020). Policymakers would not change capital controls policies frequently during downturns. However, during business cycle upswings, the liberalization process of China's capital account is taken gradually (Chen and Qian, 2016).[14] As for policy implementation, the capital control authorities (e.g., the PBoC, and SAFE) should precisely predict the economic status and then take measures in advance to improve GaR.

As I have depicted in the section 4.1, the definition of capital control index "ka" is an aggregation and average of granular types of different catagories. Thus these granular types would be differ in effectiveness and term structure. Eguren Martin et al. (2021) study the impact of CFMs measures on portfolio capital flows-at-risk and they split the CFMs measures between inflows and outflows. Similarly, I introduce capital controls on inflows "kai" and outflows "kao", besides, I also consider capital controls on transactions for resident "ka_r" and nonresident "ka_nr".[15]

In the upper-left and upper-right of Figure 6.2, I plot the estimated quantile response of real GDP growth at 5th and 95th percentiles to implementing capital inflow control "kai" and outflow control "kao" respectively over the projection horizons. These results suggest that outflow control measure (upper right) can significantly boost expected real GDP growth and reduce downside risk, and the detrimental effects are persistent for 95th percentile of real GDP growth in the mid and long term as does the aggregated gross index "ka". As for the results of inflow control (upper left), however, there are negative effects on 5th percentile in the near-term and the positive effects are lagging and only significant at 6 months after implementing this policy and the maximum size of the benefits (2% point of

[14] Due to this fact and the figure 2.1, China's capital controls are rarely implemented in business cycle upward period, thus the implementation practice of the negative effects of capital control on right-tail of GDP growth distribution is rare. However, in turn, the fact that liberalization of capital account could raise economic growth has been found as I have mentioned in section 3.

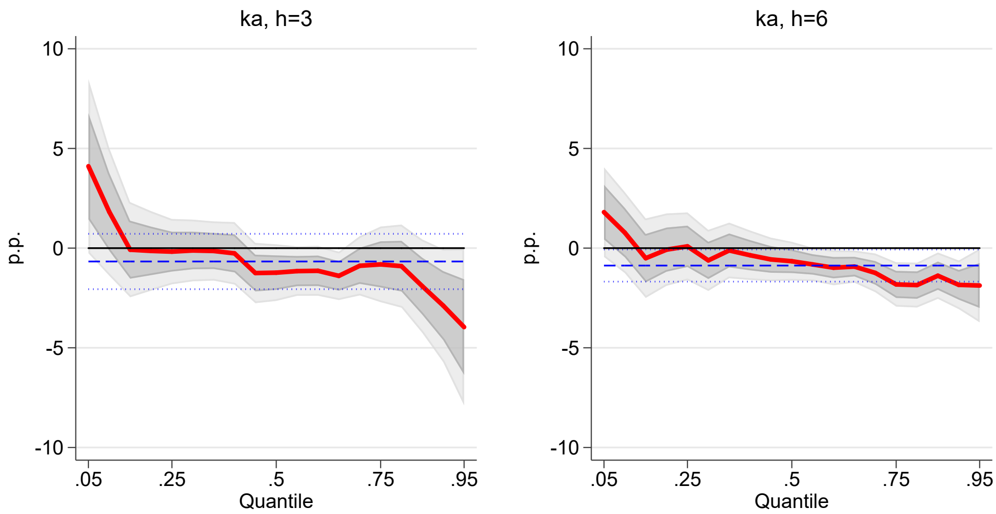
[15] As depicted by Landi and Schiavone (2021), after mid-1990s, the gross outflows and gross inflows tend to move independently. Thus, it is necessary to analyze the effects of capital controls separately for inflows and outflows.

GaR) are lower than outflow control measure. The rapidly materialized negative effects are intuitive because capital inflows are usually welcomed in the crisis periods for compensating the outflows and stemming the depreciation of exchange rate. The negative effects on 95th percentile are statistically insignificant from 0. As for the lower-left and lower-right of Figure 6.2, I present the results for capital controls on transactions for resident "ka_r" and nonresident "ka_nr" respectively. The effects of capital controls on resident "ka_r" are consistent with aggregated and outflow control indices, while the effects of capital controls on nonresident "ka_nr" do not show any heterogeneity for 5th and 95th percentiles of real GDP growth. Although the beneficial effects still exist in the mid-term (implemented after 5 to 7 months) for 5th percentiles of real GDP growth, the effects are limited for other periods. Besides, there is no negative effect on 95th percentile of real GDP growth over all horizons.

Above, I have presented the effects of aggregated capital control indices for different directions (inflow and outflow) and on different agents (residents and nonresidents). In addition, the granularity of capital control indices allows us to study the measures that most directly affect the flows we are interested in. Figure 6.3 shows the effects of six types of granular capital control indices ("eq": shares or securities; "bo": bonds or debt securities; "mm": money market instruments; "cc": commercial credits; "fc": financial credits; "di": direct investment) on 5th and 95th percentiles of real GDP growth. Consistent with the findings using aggregated indices, the effects of "eq", "cc", "fc", and "di" are positive in the mid-term on 5th percentile of real GDP growth respectively. In the long term, all the positive effects fade out and become insignificant within one year. However, the effects of "mm" and "bo" are not found to be statistically different from zero across the projection horizons. As for the impact on 95th percentile of real GDP growth, the cost of adjusting "bo" and "mm" is rapidly materialized in the near-term and persists over one year after their implementation. The cost of changing "eq", "cc", "fc" and "di" is not significant in the short-term. In the long term, "cc" still keeps insignificant but "eq", "fc", and "di" turn to be negative and statistically different from 0 even if these effects are relatively weak. Overall, in line with our previous finding using aggregated indices, I also identify that the granular capital control indices "eq", "fc", and "di" are more heterogeneous for left and right tails of real GDP growth.

Overall, these results suggest that the aggregated capital control indices are beneficial in reducing the downside risk of real GDP growth in the mid-term whereas they are costly on the upswings of business cycle in the near-term. Specifically, these heterogeneous effects are more evident for outflow control index “kao” and resident transaction control index “ka_r”. Besides, for granular indices, these heterogeneous effects are more evident for “eq”, “fc” and “di”. For “bo” and “mm”, the negative effects are more evident on 95th percentile of real GDP growth in the short-term. For “cc”, the positive effects are more obvious on 5th percentile in the mid-term. As I have mentioned previously, these results have important policy implications. To benefit from such policy more rapidly after implementation, the capital control measures should be implemented in advance in accordance with the economic status.

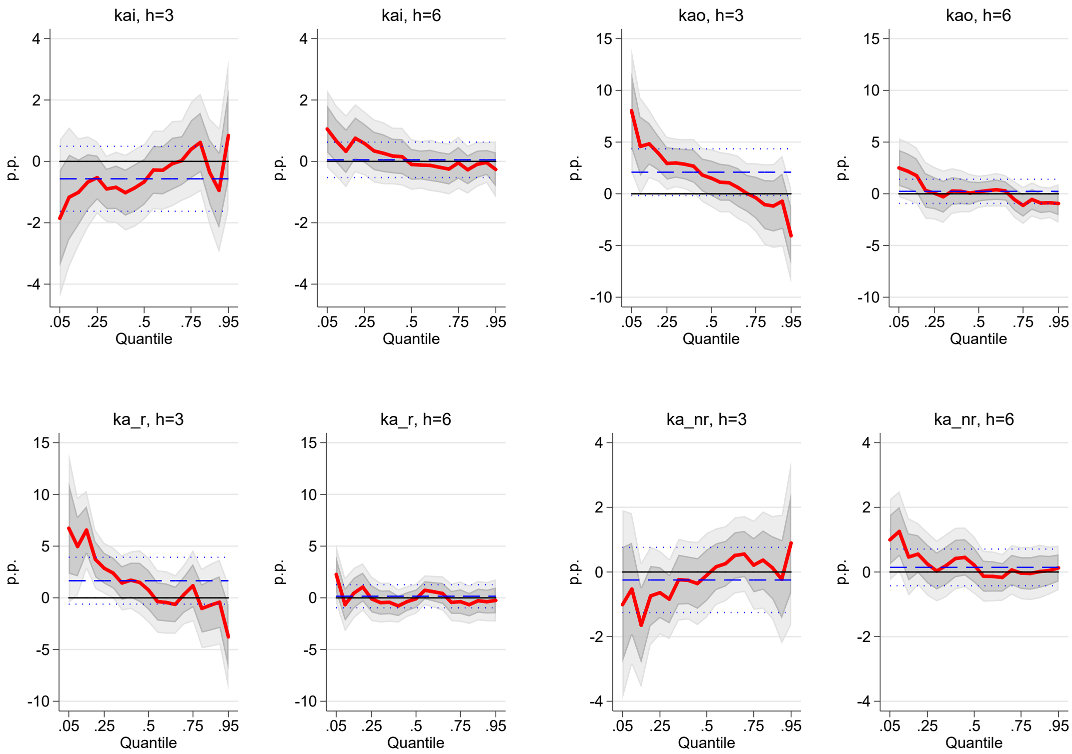
6.2 The impact of capital control policies on real GDP growth over quantiles



Notes: The red lines denote the estimated cumulative responses coefficients of a one-point increase in aggregated capital control index “ka” obtained from local projection quantile regressions on real GDP growth across quantiles at 3 and 6 months ahead. Shaded areas refer to 1 standard error (dark) and 1.64 standard error (light), and the standard error are calculated by bootstrapping techniques with 500 replications. The y-axis indicates the percentage point change in real GDP growth. The horizontal solid lines represent the value of zero. The blue dashed lines show the OLS estimates and dotted lines represent 1.64 standard error confidence band.

Figure 6.4: Estimated quantile regression coefficients of aggregated capital control index “ka” on different quantiles of real GDP growth at 3 and 6 month horizons.

I have analyzed the heterogeneous effects of aggregated and granular capital control

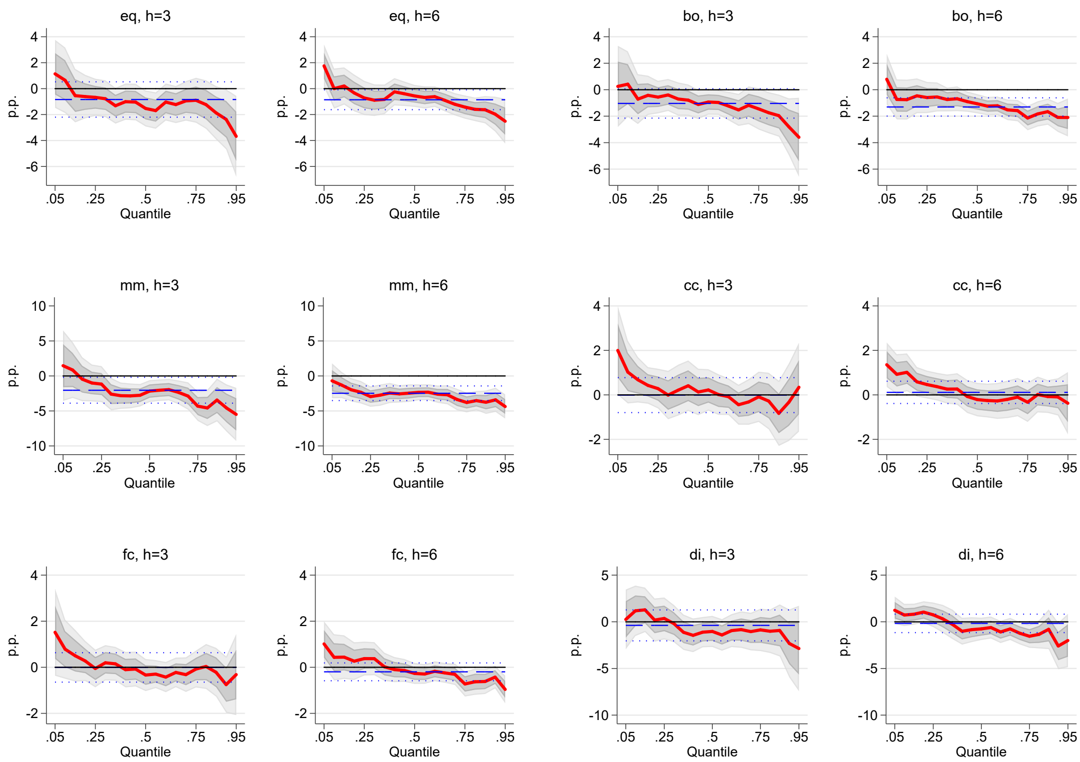


Notes: The red lines denote the estimated cumulative responses coefficients of a one-point increase in each aggregated capital control indices obtained from local projection quantile regressions on real GDP growth across quantiles at 3 and 6 months ahead. Shaded areas refer to 1 standard error (dark) and 1.64 standard error (light), and the standard error are calculated by bootstrapping techniques with 500 replications. The y-axis indicates the percentage point change in real GDP growth. The horizontal solid lines represent the value of zero. The blue dashed lines show the OLS estimates and dotted lines represent 1.64 standard error confidence band.

Figure 6.5: Estimated quantile regression coefficients of aggregated capital control indices on different quantiles of real GDP growth at 3 and 6 month horizons.

indices on the left-tail (5th percentile) and right-tail (95th percentile) of real GDP growth across different time horizons. In this section, I extend the analysis of capital control indices across quantiles (from 5th to 95th percentiles) of real GDP growth distribution at specific near-term (3rd month) and mid-term (6th month) horizon. Figure 6.4 and 6.5 present the estimated quantile regression coefficients of aggregated capital control indices. The OLS regression (conditional mean, in blue dashed lines) results are also plotted for comparison.

In Figure 6.4, I present the estimated quantile effects of implementing aggregate capital control “ka” index. In the near-term ($h = 3$), the beneficial effects of capital control on real GDP growth do exist on the left-tail of the distribution and the effects are 4% point and



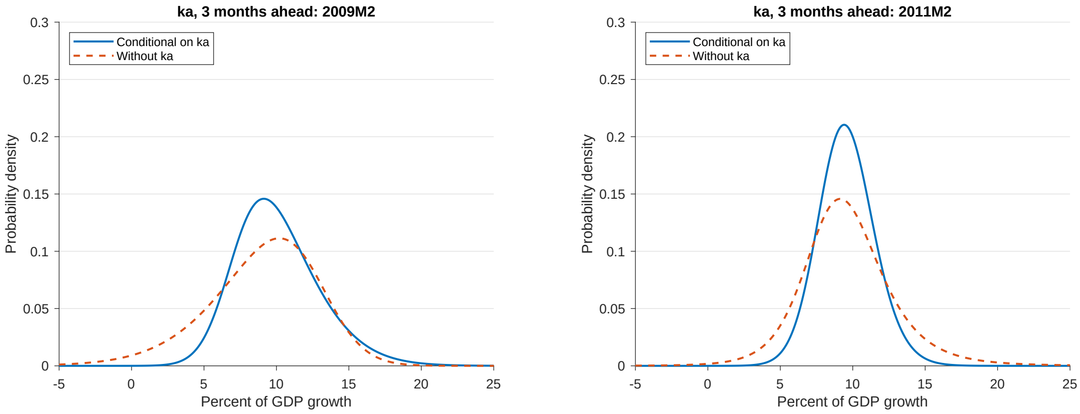
Notes: The red lines denote the estimated cumulative responses coefficients of a one-point increase in each granular capital control indices obtained from local projection quantile regressions on real GDP growth across quantiles at 3 and 6 months ahead. Shaded areas refer to 1 standard error (dark) and 1.64 standard error (light), and the standard error are calculated by bootstrapping techniques with 500 replications. The y-axis indicates the percentage point change in real GDP growth. The horizontal solid lines represent the value of zero. The blue dashed lines show the OLS estimates and dotted lines represent 1.64 standard error confidence band.

Figure 6.6: Estimated quantile regression coefficients of granular capital control indices on different quantiles of real GDP growth at 3 and 6 month horizons.

statistically different from zero. However, on the right-tail of the distribution, the marginal effects are negative and significant that means using capital control policy is detrimental to the real GDP growth. This result is in line with the OLS counterpart's negative result. At the medium horizon ($h = 6$), implementing aggregated capital control policy also has significantly beneficial effects on the left-tail of real GDP growth even if the effects are only 2% point. As for the right-tail, the detrimental effects are also statistically significant and only -2% point. The negative results also hold for median and OLS counterparts and the impact is clearly significant than in the near-term. Overall, the heterogeneous effects of implementing capital controls on real GDP growth are larger in the short term, and these results are also consistent with the results in section 6.1 where the effects are dissipating gradually in the long-term.

The upper-left and upper-right of Figure 6.5 show the effects of inflow control index and outflow control index respectively. In the short term, the inflow control has a negative (positive) but not statistically significant effects on the left-tail (right-tail) of real GDP growth. In mid-term, the effects are positive on the left-tail and negative on the right-tail even if the effects are statistically insignificant for the right-tail. Compared with inflow control index, the outflow control index shows more heterogeneous across the distribution in short term. The detrimental and beneficial effects are more statistically significant at 95th percentile and 5th percentile, respectively. In the mid-term, however, the heterogeneous effects are weakened across the distribution. The characteristics of inflow control index also hold for nonresident capital control index in lower-right of Figure 6.5 and the results of outflow control index are similar to resident capital control index in lower-left of Figure 6.5. Overall, I find two main results here. First, there exist heterogeneous effects of aggregated capital control indices over the quantiles of real GDP growth distribution and the heterogeneous effects are stronger in the short term. Second, the heterogeneous effects are stronger in short term for outflow control indices and resident control indices.

As was described in section 6.1, I also plot the estimated quantile regressions coefficients of granular capital control indices. These results are depicted in Figure 6.6. In the short term, capital control of “cc” shows positive and significant effects on the left-tail, but the negative effects are not significant on the right-tail. On the contrary, capital controls of “eq”, “bo”, and “mm” show negative and significant effects on the right tail, while the positive effects are not significant on the left tail. Besides, the effects of “fc” and “di” are more symmetric and are not significantly different from 0. In the mid-term, capital control of “eq”, “fc”, and “di” present heterogeneous effects across the distribution. As for other capital control indices, the positive effects of “bo” are not significant on the left-tail, and the negative effects of “cc” are not significant on the right-tail. Overall, the granular indices also show broadly heterogeneous impact even if the impact of several capital controls is insignificant across the distribution.



Notes: The panels in this figure show the estimated probability density function for 3-months ahead real GDP growth at recession (2009M2) and tranquil (2011M2) period. The densities are estimated using a kernel-based method by Adrian et al. (2019). The red dashed lines represent the condiotional ditribution without aggregate capital control index "ka". The blue solid densities show the estimated distribution by conditioning on aggregate capital control index "ka".

Figure 6.7: Estimated conditional GDP growth ditribution after the implementation of aggregate capital control index "ka"

6.3 The conditional distribution of real GDP growth

The results presented so far analyze the marginal effects of aggregated and granular capital control indices on real GDP growth over quantiles and time horizons. It is necessary to also visualize the estimated empirical distributions such that we will have a more evident view of the integrated shapes of distributions and the shifts arising from implementing the capital control indices. Following Adrian et al. (2019), I fit a skewed t-distribution developed by Azzalini and Capitanio (2003) to smooth the quantile function and obtain an estimated distribution. At each month, I choose four parameters of the skewed t-distribution: μ_t (location), σ_t (scale), α_t (shape), and ν_t (fatness) to minimize the squared distance between the estimated quantile function $\widehat{Q}_{y_{t+h}|x_t}(\tau)$ from equation (6) and the inverse cumulative distribution function of the skewed t-distribution $F^{-1}(\tau; \mu_t, \sigma_t, \alpha_t, \nu_t)$ by matching the 5th, 25th, 75th, and 95th percentiles:

$$\{\hat{\mu}_{t+h}, \hat{\sigma}_{t+h}, \hat{\alpha}_{t+h}, \hat{\nu}_{t+h}\} = \underset{\mu,\sigma,\alpha,\nu}{\arg\min} \sum_{\tau} \left(\widehat{Q}_{y_{t+h}|x_t}(\tau|x_t) - F^{-1}(\tau; \mu, \sigma, \alpha, \nu)\right)^2, \quad h = 1, \cdots, 15 \tag{7}$$

where the skewed t-distribution can be written as

$$f(\tau;\mu,\sigma,\alpha,\nu)=\frac{2}{\sigma}t\left(\frac{y-\mu}{\sigma};\nu\right)\times T\left(\alpha\frac{y-\mu}{\sigma}\sqrt{\frac{\nu+1}{\nu+\left(\frac{y-\mu}{\sigma}\right)^2}};\nu+1\right), \tag{8}$$

where $t(\cdot)$ and $T(\cdot)$ denote the probability density function (PDF) and cumulative density function (CDF) respectively of the t-distribution. Proposed by Adrian et al. (2019) and Eguren Martin et al. (2021), the skewed t-distribution has the shape parameter α that can flexibly accommodate fat tails or skewing effects of the PDF, which is consistent with the features related with real GDP growth.

Figure 6.7 shows the conditional forecast distribution estimated by skewed t-distribution for 3-months-ahead real GDP growth at business cycle upswings (2011M2), and downturns (2009M2).[16] The blue solid lines show the density estimated conditional on aggregated capital control index "ka" and other control variables according to baseline model (6). For comparison, the red dashed lines denote the estimated density conditional on control variables without "ka" and the interaction term. It is observed that the shapes of the real GDP growth distribution differ between blue and red lines in each sub-figure and the difference is evident for 3-months (one quarter) ahead forecasting.

During downturns (2009M2, left), the distribution conditional on "ka" (blue lines) shows it has a lower variance, positive skewness and a higher conditional mean than the distribution conditional without "ka" (red dash lines). In addition, the left tail contracts and shrinks obviously indicating a decrease in the downside risk after the implementation of capital control index "ka". Meanwhile the right tail expands marginally, resulting a relatively higher probability of high GDP growth. During upswings (2011M2, right), the distribution conditional on "ka" also has a lower variance, positive skewness and a higher conditional mean than the distribution conditional without "ka". Moreover, the left tail shows lower probability of low GDP growth and the right tail also shrinks resulting a smaller likelihood of large real GDP growth. Above, these results supplement the findings with the facts that the implementation of capital control policy can be beneficial to improve GDP-at-risk during downturns and upswings, but it is detrimental to higher real

[16] I choose the upwing and downturn periods based on the cyclical component of real GDP. As we can see in Figure 2.1, the solid line of real GDP detrended shows that the highest peak and lowest trough are 2011M2 and 2009M2, respectively.

GDP growth during upswings.

For further analysis, Figure A.2 provides the aggregated capital control indices using inflow, outflow, resident and nonresident control measures for 3 months ahead. These results suggest that outflow control index and resident transaction control index could decrease the probability of lower GDP growth and raise the probability of higher GDP growth during downturns in 2009M2. During business cycle upswings, however, the implementation of such policies could reduce the probability of both left- and right-tail of GDP growth distribution similar to the effects of "ka" in Figure 6.7. In opposition to our results, Gelos et al. (2022) find that the CFMs are ineffective in reducing or increasing the probability of net outflows. They believe that the ineffectiveness is likely due to the facts that the implementation of capital control may have not been sufficiently comprehensive or were operationally unenforceable. As for the distribution of inflow control index and nonresident transaction control index, although the beneficial effects are still marginally effective during downturn compared with the effects of outflow and resident control index, the detrimental effects are limited for decreasing the probability of higher real GDP growth.

What impact do granular capital control indices have on the distribution? Figure A.3 plots the results for granular capital control indices. During downturns, the distributions conditional on capital control indices "eq", "bo", "cc", "fc" and "di" all display lower variance and higher conditional mean. Although "eq", "bo", and "di" have negative skewness, the left tail contracts and shrinks, implying lower probability of downside risk. As for "mm", even if it has larger negative skewness than the estimated distribution conditional without "mm", it has equal level of probability at the left-tail of real GDP growth. Besides, it has larger probability in increasing the right-tail of real GDP growth. During upswings, the distributions conditional on "eq", "bo", and "mm" show lower probability of high real GDP growth, while the distribution conditional on "cc" and "fc" present lower possibility of low real GDP growth. Besides, the distributions conditional on "di" has no significant difference conditional without "di".

6.4 Measuring Vulnerability

Mentioned by Adrian et al. (2019), policymakers are more interested in the downside and upside risks to GDP growth, namely, the vulnerability of the predicted GDP growth path. There are two types of indicators used to measure such vulnerability. One is the relative indicator – upside and downside entropy. These indicators quantify the "shifts" induced in the tail region by implementing capital control policies. Given a fitted distribution $\hat{g}_{y_{t+h}}(y)$ the unconditional density calculated by matching the unconditional empirical distribution of GDP growth, $\hat{f}_{y_{t+h}|x_t}(y|x_t)$ the estimated skewed t-distribution conditional on aggregated capital control policy "ka" and other control variables in baseline model (6), I compute downside $\mathcal{L}^D$ and upside $\mathcal{L}^U$ relative entropy as

$$\mathcal{L}^D = \int_{-\infty}^{\hat{F}^{-1}_{y_{t+h}|x_t}(0.5|x_t)} \log\left(\frac{\hat{f}_{y_{t+h}|x_t}(y|x_t)}{\hat{g}_{y_{t+h}}(y)}\right) \hat{f}_{y_{t+h}|x_t}(y|x_t)\, dy, \tag{9}$$

$$\mathcal{L}^U = \int_{\hat{F}^{-1}_{y_{t+h}|x_t}(0.5|x_t)}^{\infty} \log\left(\frac{\hat{f}_{y_{t+h}|x_t}(y|x_t)}{\hat{g}_{y_{t+h}}(y)}\right) \hat{f}_{y_{t+h}|x_t}(y|x_t)\, dy, \tag{10}$$

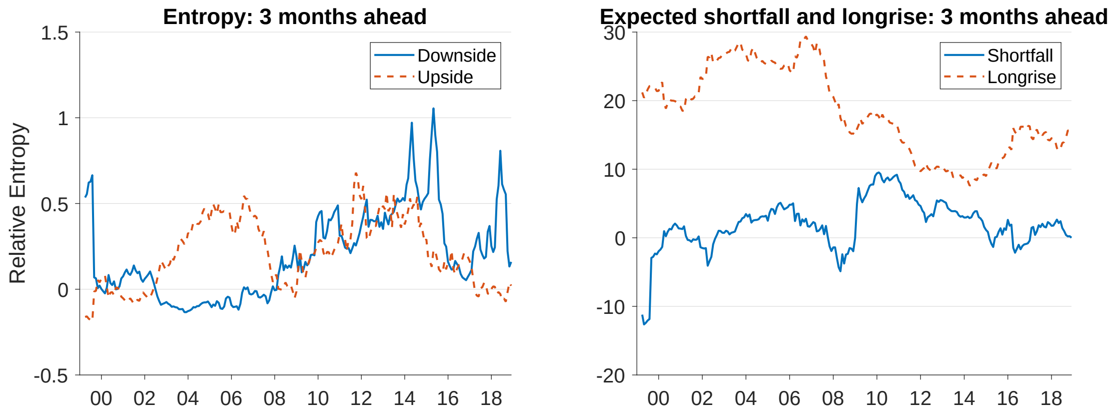
where $\hat{F}_{y_{t+h}|x_t}(y|x_t)$ is the CDF of $\hat{f}_{y_{t+h}|x_t}(y|x_t)$ and $\hat{F}_{y_{t+h}|x_t}(0.5|x_t)$ denotes the conditional median. In other words, downside (upside) entropy measures the divergence between the unconditional density and the conditional density that occurs below (above) the median of the conditional density. A higher downside entropy denotes more positive probability are assigned to extreme left tail of GDP growth than unconditional density.[17] Other indicators of characterizing absolute vulnerability are expected shortfall and longrise. I choose a target probability of 5%, the expected shortfall and longrise are computed as

$$SF_{t+h} = \frac{1}{5\%}\int_0^{5\%} \hat{F}^{-1}_{y_{t+h}|x_t}(\tau|x_t)\, d\tau, \tag{11}$$

$$LR_{t+h} = \frac{1}{5\%}\int_{95\%}^{1} \hat{F}^{-1}_{y_{t+h}|x_t}(\tau|x_t)\, d\tau. \tag{12}$$

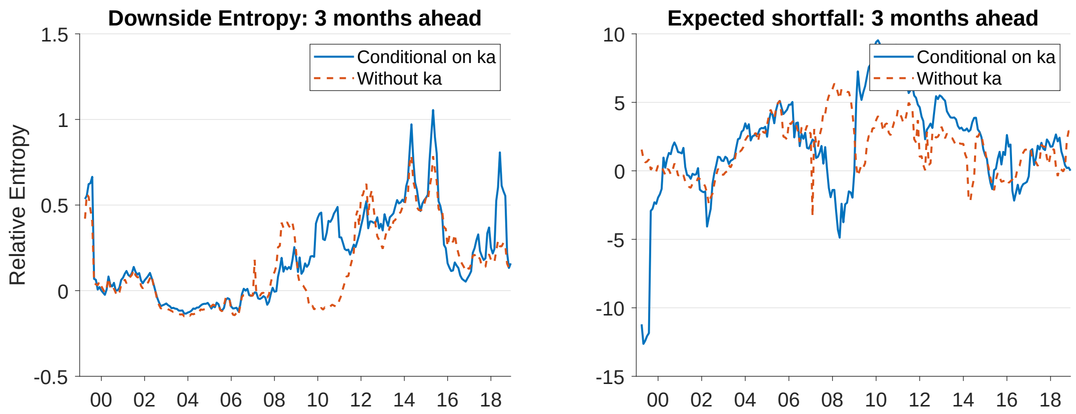
Intuitively, expected shortfall (longrise) measures the average realization drawn from below the 5th percentile (above the 95th percentile) of the predictive distribution (Gu et al., 2021).

[17] Adrian et al. (2019) show that unlike the full relative entropy between two distributions, downside and upside entropy can be negative.



Notes: These figures show the time series evolution of relative downside and upside entropy together with the 5% expected shortfall and 95% expected longrise. The left panel displays the evolution of upside (red dashed lines) and downside (blue solid lines) entropy of predicted distribution over time, conditional on “ka” and other control variables according to baseline model (6). The right panel presents the 5% expected shortfall (blue solid lines) and the 95% expected longrise (red dashed lines) over time.

Figure 6.8: Relative entropy and expected shortfall and longrise



Notes: These figures show the time series evolution of downside entropy together with the 5 percent expected shortfall conditional on “ka” (blue solid lines) and without “ka” (red dashed lines).

Figure 6.9: Downside entropy and expected shortfall: Comparison

The left panel of Figure 6.8 shows the evolution of GDP upside and downside entropy 3 months ahead, and the right panel presents the 5% expected shortfall and the 95% expected longrise. The results show a high degree of similarity for these measures, implying that the non-Gaussian features of the conditional distribution are mainly abstracted from the unconditional distribution. Besides, although downside and upside entropy as well as expected shortfall and longrise are positively correlated, downside entropy and expected shortfall are more volatile and has more evident nonlinearities.

Next, to specify the role of capital control in these tail risk measures, I calculate them for both the conditional densities considering aggregated capital control index "ka" (blue solid lines) and the estimated densities do not (red dashed lines) in Figure 6.9. In the left panel, I find that the empirical distribution considering the capital control index would decrease the downside risk during downturn periods (e.g., 2008-2009, 2012-2013, and 2015-2016). Hence, the distribution that does not consider capital control index would overestimate the risk during downturn periods. Similarly, considering capital control index "ka" seems to influence the expected shortfall of real GDP growth. From 2000 to 2006 and 2009 to 2016, the expected shortfall shows a upward deviation than the expected shortfall that does not incorporate capital control index "ka". Especially for 2009, the expected shortfall conditional on "ka" was skyrocketing and the expected shortfall without "ka" was plummeting, implying that using capital controls can reduce the expected shortfall during financial crisis period. Overall, considering the capital control index "ka" has the potential to reduce downside risks of China's economy.

7 Robustness

In this section, I show that the baseline results are robust to a series of robustness checks.

7.1 Further analysis of granular capital control measures

So far, I have analyzed the effects of both aggregated and granular capital control indices on real GDP growth at the 5th and 95th percentiles in section 6.1. In this section, I analyze the effects of granular indices further by breaking down into inflows and outflows, as well as transactions on residents and nonresidents. Panel (a) and (b) of Figure A.4 plot the results for inflow and outflow granular indices respectively. In panel (a), granular inflow control indices "eqi", "boi", and "dii" all present the beneficial effects at 5th percentile of real GDP growth in the mid-term, and the detrimental effects at 95th percentile of real GDP growth in the near-term even if some of indices are not statistically significant. Panel (b) shows that the heterogeneous effects hold for outflow control indices "eqo", "boo", "cco", and "fco". Panel (a) and (b) of Figure A.5 plot the results for granular resident and nonresident transaction control indices respectively. The heterogeneous effects can be observed for "eq_r", "cc_r", "fc_r" and "di_r" for resident transaction index. While for nonresident transaction index, the heterogeneous effects are pronounced for “eq_nr”, “bo_nr” and “di_nr”, other indices are more symmetric over the time horizons.

Table 7.1: The granular capital control indices that have heterogeneous effects

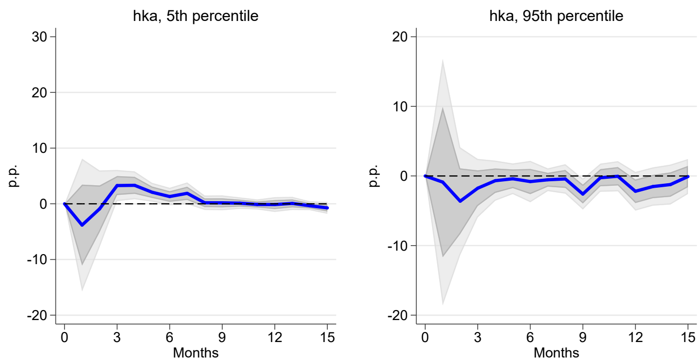
Term	Type	“eq”	“bo”	“mm”	“cc”	“fc”	“di”
Near Term	inflow						
	outflow	✓	✓		✓	✓	
(3 months)	resident	✓			✓	✓	
	nonresident		✓				
Medium Term	inflow	✓	✓				✓
	outflow	✓					
(6 months)	resident	✓					
	nonresident	✓					✓

Notes: The heterogeneous effects mean that the capital control indices have beneficial effects at 5th percentile of real GDP growth and have detrimental effects at 95th percentile of real GDP growth. The capital control index with “✓” mark means such index has heterogeneous effects.

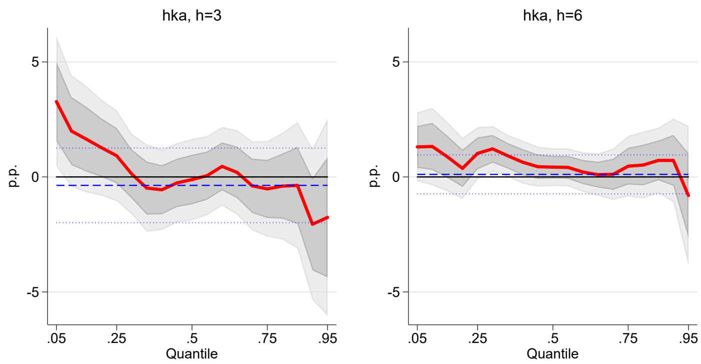
In Figure A.6 and A.7, I also provide the estimated quantile regression coefficients across quantiles at 3 and 6 months ahead for inflow and outflow as well as resident and nonresident transaction granular capital controls respectively. In panel (a) of Figure A.6, the heterogeneous effects are more evident for “eqi” and “dii” in the medium term. The sub-figures of “boi” and “fci” show negative effects in the lower tail of the distribution and positive effects in the upper tail of the distribution. These results are consistent with the results of the term structure of conditional distribution. As for panel (b) of Figure A.6, in the short term, most of the granular measures display the heterogeneous effects across quantiles except “mmo” and “dio”. In the medium term, however, most the outflow control measures show symmetric effects over quantiles except “eqo”. This is also in line with the results of term structure. In panel (a) of Figure A.7, all resident transaction indices display the heterogeneous effects except “bo_r”, “mm_r”, and “di_r” in the near term, while the heterogeneous effects are also not pronounced in medium term except “eq_r”. In panel (b), only “bo_nr” are heterogeneous in the near term and “eq_nr” and “di_nr” are heterogeneous in the medium term.

Overall, I summarize the granular capital control indices that have heterogeneous effects in Table 7.1. These results show that the heterogeneous effects are more evident in near term for outflow granular control indices, while in medium term, the inflow granular control indices present more heterogeneous effects. Besides, equity control index “eq” presents more heterogeneity.

7.2 Using *hybrid* capital controls



(a) Estimated coefficients of 5th, and 95th percentiles of real GDP growth to the implementation of aggregated hybrid capital control index "hka" from 1 to 15 month horizons.



(b) Estimated quantile regression coefficients of aggregated hybrid capital control index "hka" on different quantiles of real GDP growth at 3 and 6 month horizons.

Figure 7.1: The effects of aggregated hybrid capital control index "hka"

Above, I have identified the effects of capital controls on real GDP growth using *de jure* capital control indices. However, the aggregated *de jure* indices are computed by simply averaging indices of different asset categories, and hence, these indices do not consider the relative importance of each asset categories. In order to address this issue, Chen and Qian (2016) consider a weighted average method that the weight are computed using a *de facto* measure of the share of a subcategory asset value in the total value of all asset categories. Based on BOP data from SAFE, they use a four-year retrospective-style moving average window to generate the weights.[18] Compared with the exclusive *de jure* or *de facto* measures, the hybrid measures solve the issues of lack of importance measures and endogeneity by using weights in the compiling process and using a retrospective-style moving average window to weight the *de jure* indices. Thus, I re-estimate the quantile model in equation (6) after replacing the aggregated *de jure* capital control index "ka" by the hybrid capital control index "hka".

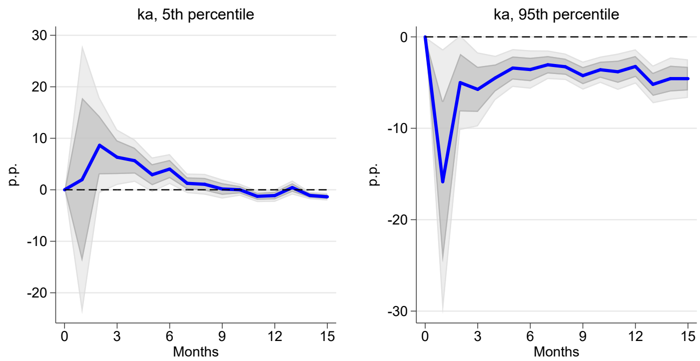
In Figure 7.1, I plot the term structure of real GDP growth at 5th and 95th percentile in panel (a) and the estimated response of real GDP growth over quantiles at 3 and 6 months ahead in panel (b). In general, the heterogeneous results are consistent with those obtained above using *de jure* capital control index "ka". Panel (b) shows that one point increase in "ka" would improve GaR by 3% point in the near-term. This positive effect is larger in the near-term than medium term and would persist for 7 months. On the other hand, 95th percentile of real GDP growth would be negatively affected by this policy. Nevertheless, such negative effects are not fully statistically significant in the near-term, and even if it is marginally significant in medium term (9th month), the negative effects are weak for only -3% point.

7.3 Using IMF's financial conditional index

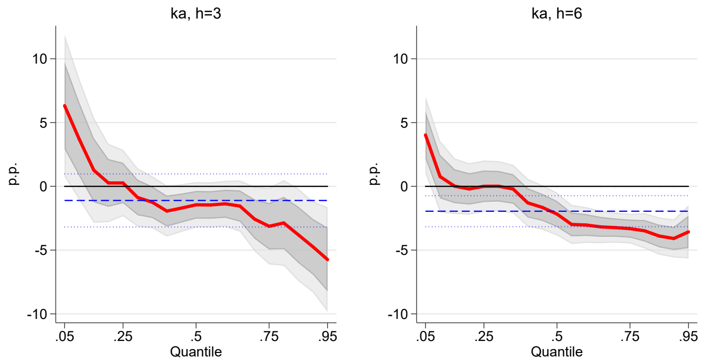
As I mentioned above, the panel data for financial condition index has been compiled by Arregui et al. (2018) and used for IMF's 2017 GSFR, which they estimate FCI from 1990 to 2016 for 43 advanced and emerging markets using 10 financial indicators. They estimate such index based on the FAVAR models with time-varying coefficients (TVP) and stochastic volatility (SV) developed by Koop and Korobilis (2014) that we have used in section 4.1. This dataset is widely used in previous literature (see Adrian et al., 2018; Eguren Martin et al., 2021; Galán, 2020) for panel data analysis, while the FCI data are available only until the end of 2016 and would not be updated regularly. Thus, I only use IMF's CFCI for robustness test.

For robustness check, I substitute our "FCI_noDMA" with Arregui et al. (2018)'s FCI (namely, "FCI_IMF") in the baseline model and the results are depicted in Figure 7.2. I

[18] They use a retrospective style to calculate the weights, thus the data of current year and forward year are not included in computing current year's weight. This way can mitigate the endogeneity issues of implementing capital control policies.



(a) Estimated coefficients of 5th, and 95th percentiles of real GDP growth to the implementation of aggregated capital control index "ka" from 1 to 15 month horizons.



(b) Estimated quantile regression coefficients of aggregated capital control index "ka" on different quantiles of real GDP growth at 3 and 6 month horizons.

Figure 7.2: The effects of aggregated capital control index "ka": using "FCI_IMF" instead of "FCI_noDMA".

still find the positive effects of aggregated capital control index "ka" on 5th percentile of real GDP growth in the medium term and the negative effects on 95th percentile of real GDP growth in the near term. Although the effects are marginally stronger using IMF's CFCI index, the results are in line with main findings in section 6.1 and 6.2.

8 Conclusion

The capital control liberalization has been generally believed to be beneficial to developing and emerging countries, such that capital controls would stem growth and lead to higher implementation cost. However, if there is a downside risk in one country, with an underdeveloped domestic financial market and banking system as well as a fully liberalized capital account, the country would suffer from capital flight which would depreciate the domestic currency and trigger further outflows, leading to a totally recession. Therefore, policymakers are cautious about fully liberalizing their capital account and they need to use capital controls prevent capital flight and dampen the volatile capital flows. Besides, If capital control policies effectively decrease systemic risk, one could forecast the benefits to be observed in the downside risk of GDP growth distribution.

I study the marginal effects of China's capital control policies on GDP growth distribution and the term structures of such distribution. To this end, I use the framework extended by Adrian et al. (2019) calculate the quantile marginal effects of real GDP growth forward to 15 months on different types of capital control indices and fit a skewed t-distribution to obtain the estimated distribution. Building on the delicately collected China's capital control indices by Chen and Qian (2016), I use a narrative approach to identify the causal relationship between capital control policies and real GDP growth. The results show that there exist heterogeneous effects of aggregated capital control indices over the real GDP growth distribution. Specifically, the aggregated capital control indices are beneficial in reducing the downside risk of real GDP growth in the medium term whereas they are costly on the upswings of real GDP growth in the near-term. After I estimate the marginal effect of capital controls policies on real GDP growth over quantiles, the result shows that the heterogeneous effects are stronger in the near-term than medium term. Besides, the heterogeneous effects are more evident in the short term for outflow control index and resident transaction control index. The granular indices show broadly heterogeneous effects even if several of them are insignificant. As for policymakers, in order to obtain benefits more rapidly after implementation, the capital control measures should be implemented in advance in accordance with the economic status.

A further line of research is the extent to which capital controls will influence GDP growth distribution in emerging countries. To address this research question, further data collection on capital control measures in emerging countries is essential. Although dataset by Fernández et al. (2016) is a regularly updated dataset for advanced and emerging countries, it is in yearly basis and cannot measure the effects of capital control every each month/quarter. In addition, the theoretical (mechanism) link between capital controls and GDP growth distribution is unknown, and further analysis on the relationship between financial volatility and economic growth would be meaningful. I leave these for future research.

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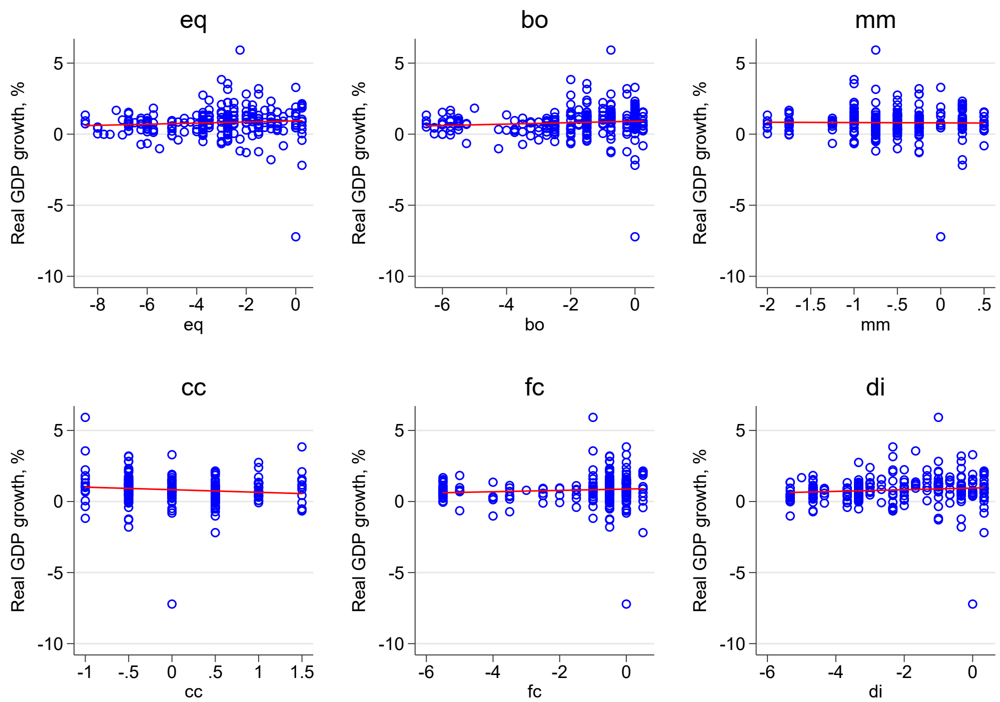
A Figures and Tables



Source: "China Economy Time Series" by Chang et al. (2016); China's capital control dataset from Chen and Qian (2016).

Figure A.1: Relationship between granular capital control indices and real GDP growth

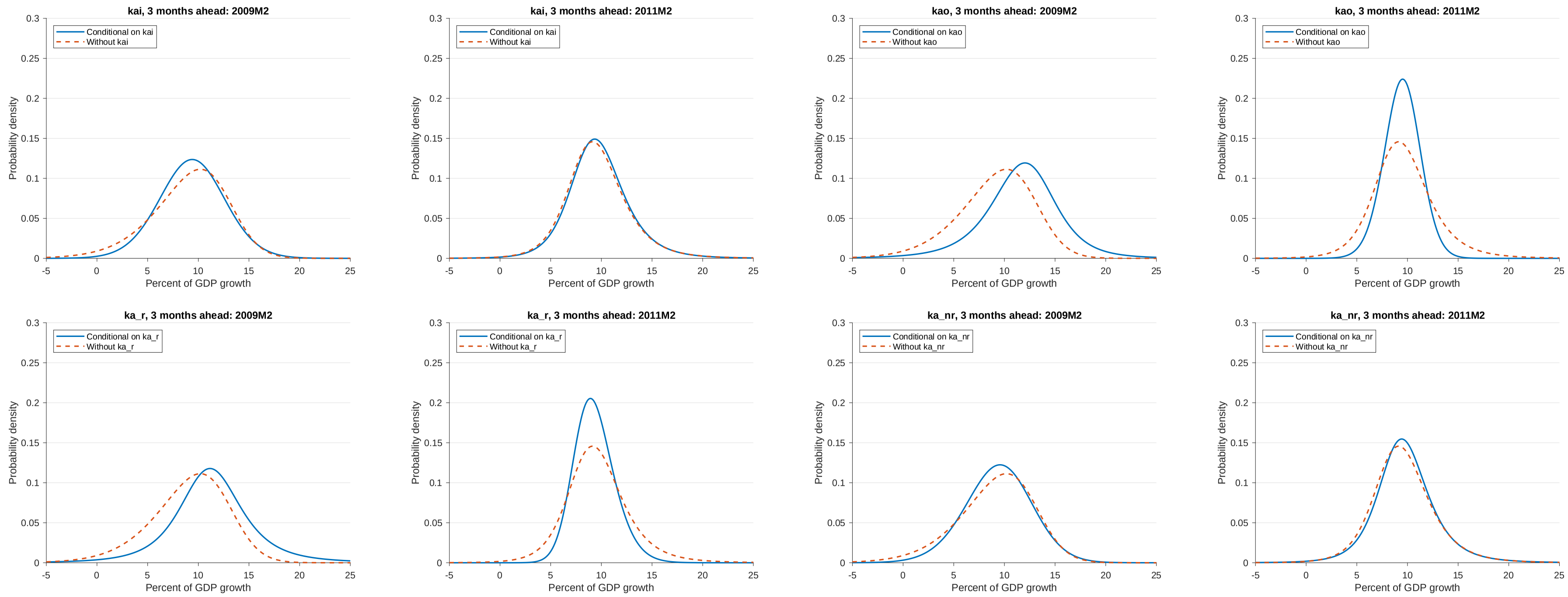
Table A.1: Prediction of implementation of granular capital control policies

	(1) eq	(2) bo	(3) mm	(4) cc	(5) fc	(6) di
One lag of real GDP growth	15.24	16.96	-1.48	-6.67	18.97	14.57
	(17.11)	(13.50)	(2.94)	(4.75)	(12.60)	(13.77)
One lag of CPI growth	-64.39	-29.80	-32.97***	-10.79	25.54	-67.80**
	(40.12)	(32.50)	(10.28)	(14.61)	(30.45)	(34.27)
Observations	238	238	238	238	238	238
R^2	0.02	0.01	0.03	0.01	0.01	0.02

Notes: This table presents OLS regression results. The dependent variables are the granular capital control variables of “eq”, “bo”, “mm”, “cc”, “fc” and “di”, respectively. Robust standard errors in parentheses. *, **, ***, indicate the significant at 10%, 5%, 1% levels respectively.

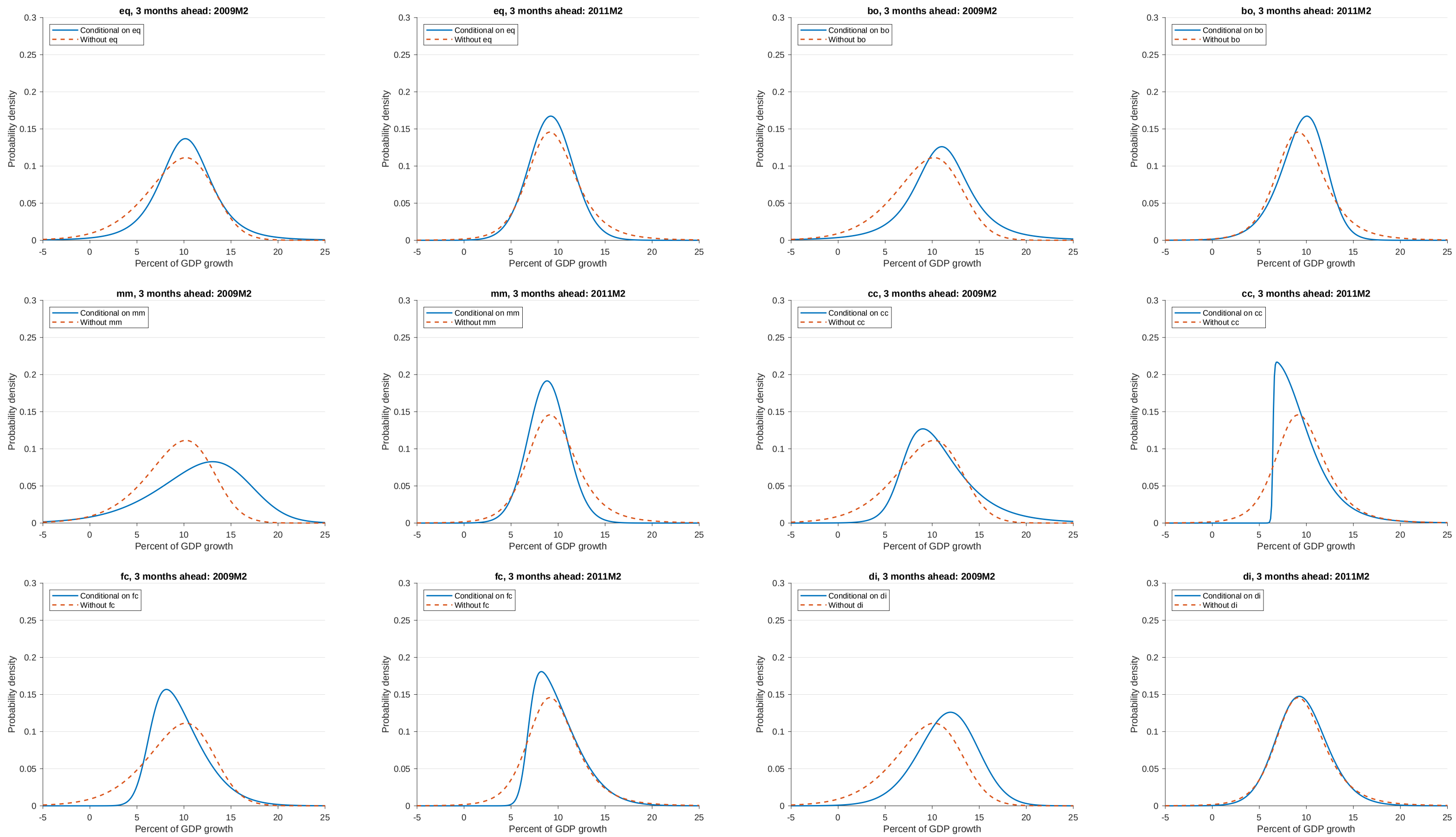
Table A.2: Data source used to compute China's FCI: Comparison

Variables	Data used by Arregui et al. (2018)	Data used by us	Source	Periods
Financial Variables				
Term spreads	Yield on 10-year government bonds minus yield on 3-month Treasury bills	Yield on 10-year ChinaBond government bond minus yield on 3-month ChinaBond government bond	WIND	2002M1 to 2021M10
Interbank spreads	Interbank interest rate minus yield on three-month Treasury bills	3-month Interbank lending weighted interest rate minus 3-month ChinaBond government bond	WIND	2004M5 to 2021M10
Change in Long-Term Real Interest Rate	Percentage point change in the 10-year government bond yield	Percentage point change in the 10-year ChinaBond government bond	WIND	2002M1 to 2021M10
Corporate Spreads	Corporate yield of the country minus corporate yield of the benchmark country	3-month ChinaBond Corporate yield minus 3-month ChinaBond government bond	WIND	2006M3 to 2021M10
Equity Returns	Log difference of the equity indices	Log difference of Shanghai composite index	WIND	1999M1 to 2021M10
House Price Returns	Percent change in house price index	Percent change in Price index of new commercial housing in 70 large and medium-sized cities	WIND	2005M7 to 2021M10
Equity Return Volatility	Exponential weighted moving average of equity price returns	Exponential weighted moving average of Shanghai composite index	WIND	1999M1 to 2021M10
Change in Financial Sector Share	Percentage point change in market capitalization of the financial sector to total market capitalization	Percentage point change in market capitalization of the financial sector to total market capitalization	WIND	1999M1 to 2021M10
Credit Growth	Percent change in the depository corporations' claims on private sector	Percent change in the new RMB loan for financial institutions	WIND	2001M1 to 2021M10
Sovereign Spreads	Yield on 10-year government bonds minus the benchmark country's yield on 10-year government bonds	Yield on 10-year ChinaBond government bond minus the U.S. 10-year government bonds	WIND	2002M1 to 2021M10
Macroeconomic Variables				
Industrial Production Growth	Percent change in the industrial production index	Percent change in the China's industrial production index	WIND	1999M1 to 2021M10
Inflation	Percent change in the consumer price index	Detrended (HP filtered) China's consumer price index	FRED	1999M1 to 2021M10



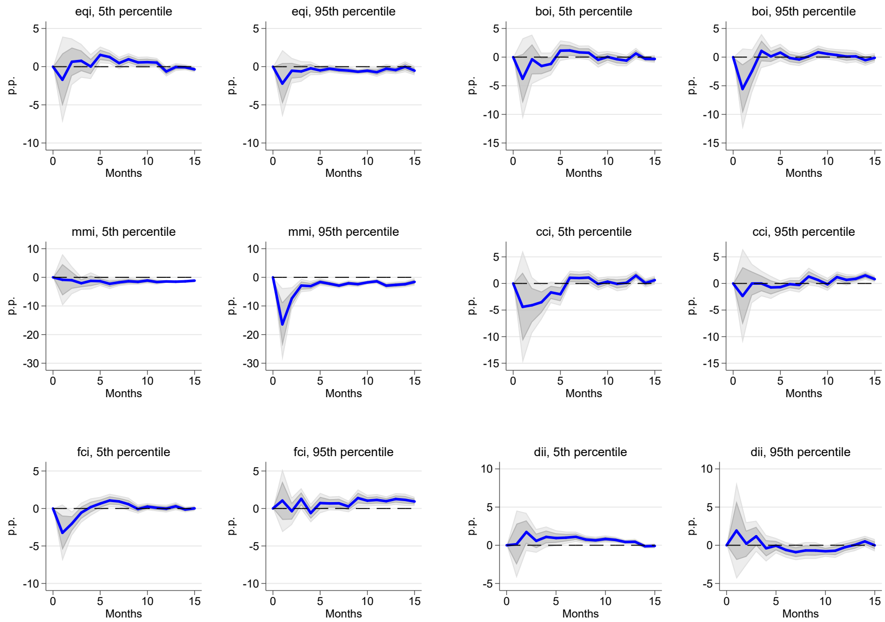
Notes: The panels in this figure show the estimated probability density function for 3-months-ahead real GDP growth at recession (2009M2) and tranquil (2011M2) period. The densities are estimated using a kernel-based method by Adrian et al. (2019). The red dashed lines represent the condiotional ditribution by conditioning without each aggregated capital control index. The blue solid densities show the estimated distribution by conditioning on each aggregated capital control index.

Figure A.2: Estimated conditional GDP ditribution after the implementation of aggregate capital control indices

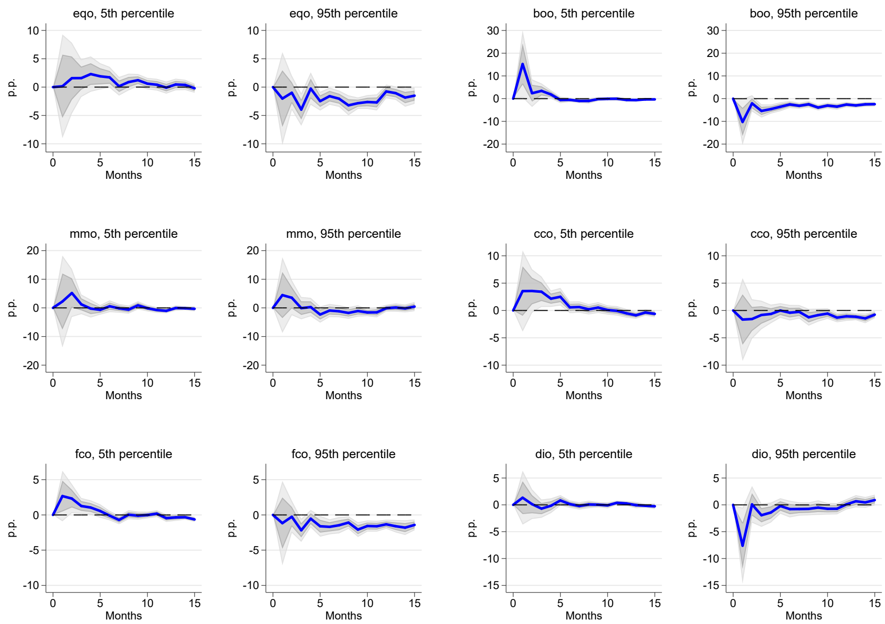


Notes: The panels in this figure show the estimated probability density function for 3-months-ahead real GDP growth at recession (2009M2) and tranquil (2011M2) period. The densities are estimated using a kernal-based method by Adrian et al. (2019). The red dashed lines represent the condiotional ditribution by conditioning without each granular capital control index. The blue solid densities show the estimated distribution by conditioning on each granular capital control index.

Figure A.3: Estimated conditional GDP ditribution after the implementation of granular capital control policies



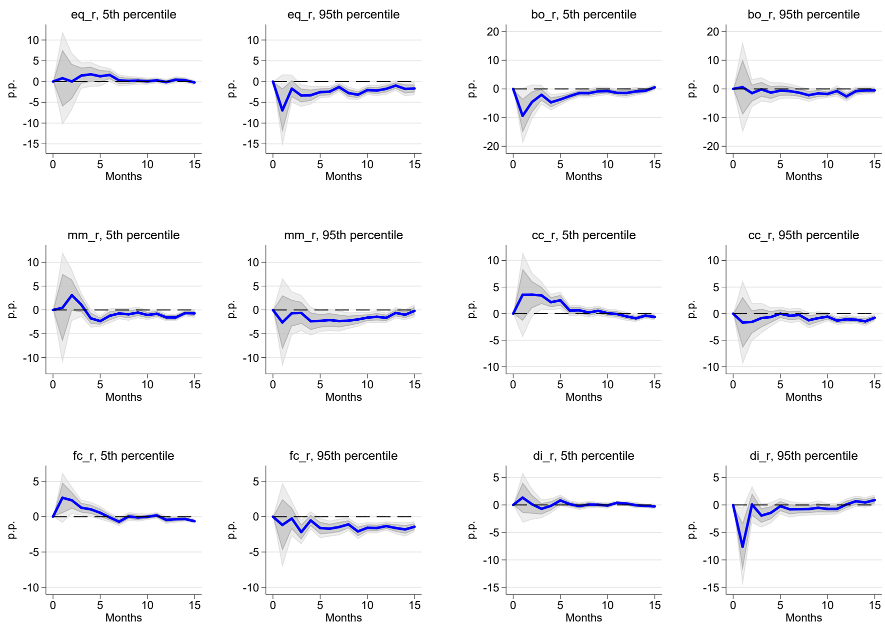
(a) The impact of capital inflow control policies



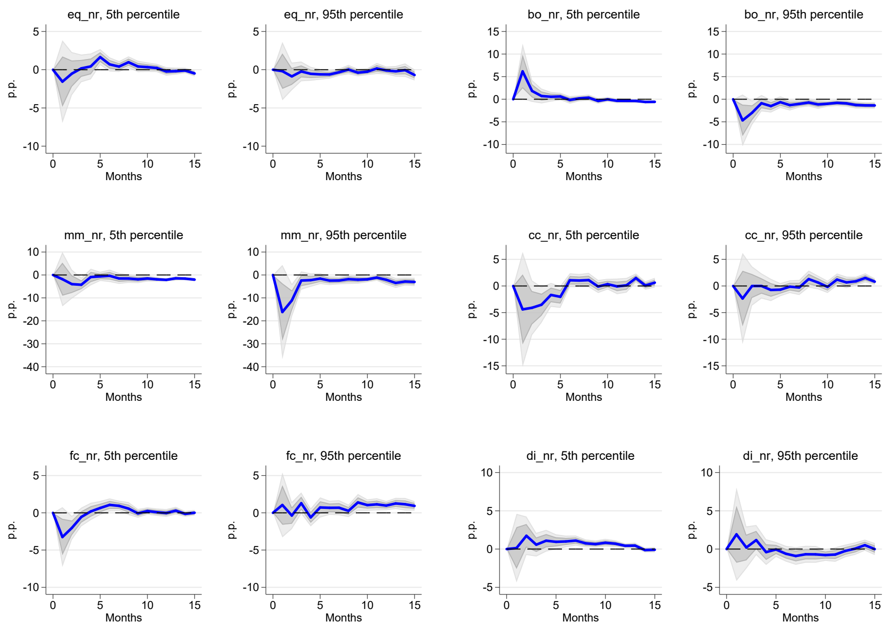
(b) The impact of capital outflow control policies

Notes: The blue lines denote the estimated cumulative responses coefficients of a one-point increase in each capital inflow and outflow control indices obtained from local projection quantile regressions on real GDP growth at the 5th and 95th percentiles for 1 to 15 months ahead. Shaded areas refer to 1 standard error (dark) and 1.64 standard error (light), and the standard error are calculated by bootstrapping techniques with 500 replications. The y-axis indicates the percentage point change in real GDP growth. The horizontal dashed lines represent the value of zero.

Figure A.4: Estimated coefficients of 5th, and 95th percentiles of real GDP growth to the implementation of inflow and outflow granular capital control indices from 1 to 15 months horizons.



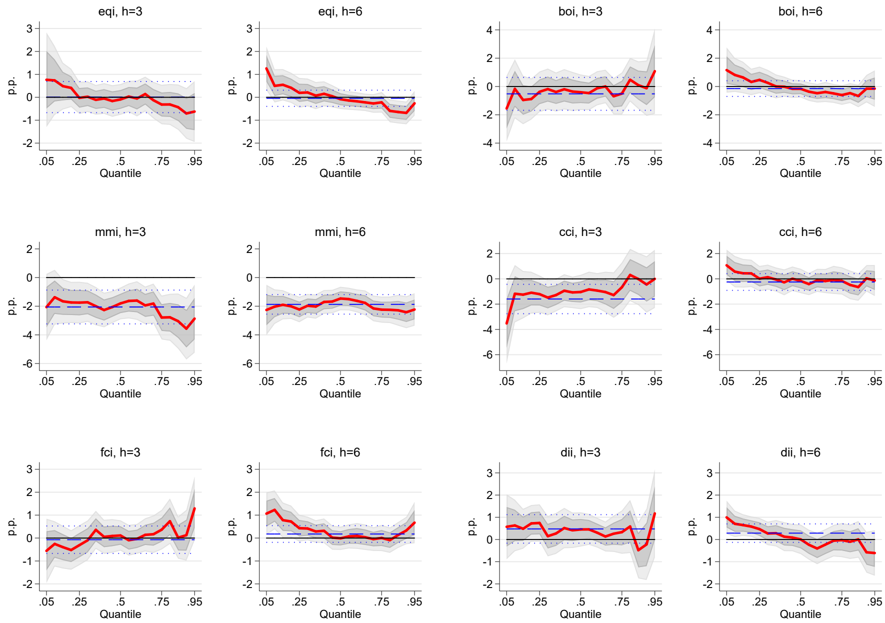
(a) The impact of capital control policies on residents



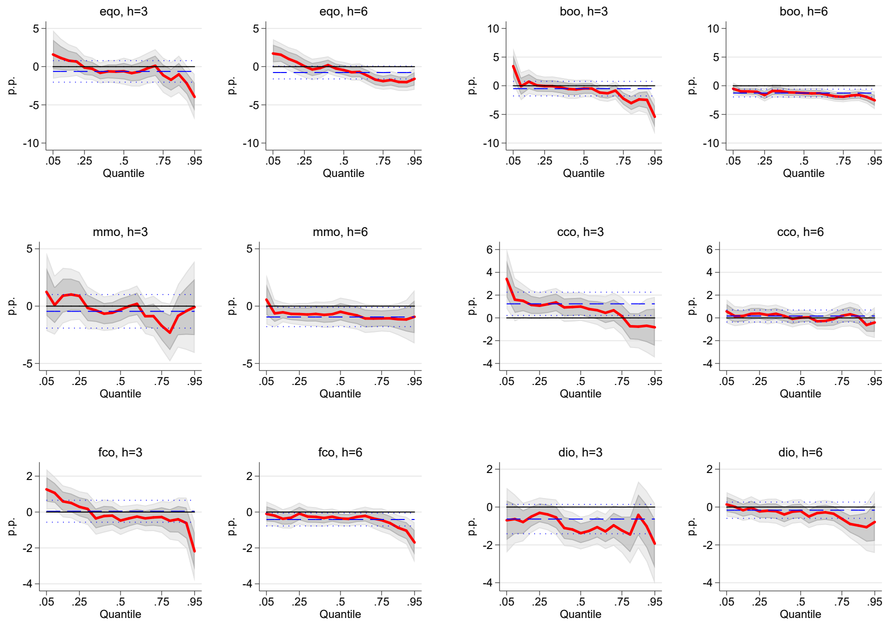
(b) The impact of capital control policies on nonresidents

Notes: The blue lines denote the estimated cumulative responses coefficients of a one-point increase in each capital control indices on residents and nonresidents respectively obtained from local projection quantile regressions on real GDP growth at the 5th and 95th percentiles for 1 to 15 months ahead. Shaded areas refer to 1 standard error (dark) and 1.64 standard error (light), and the standard error are calculated by bootstrapping techniques with 500 replications. The y-axis indicates the percentage point change in real GDP growth. The horizontal dashed lines represent the value of zero.

Figure A.5: Estimated coefficients of 5th, and 95th percentiles of real GDP growth to the implementation of granular capital control indices on residents and nonresidents respectively from 1 to 15 months horizons.



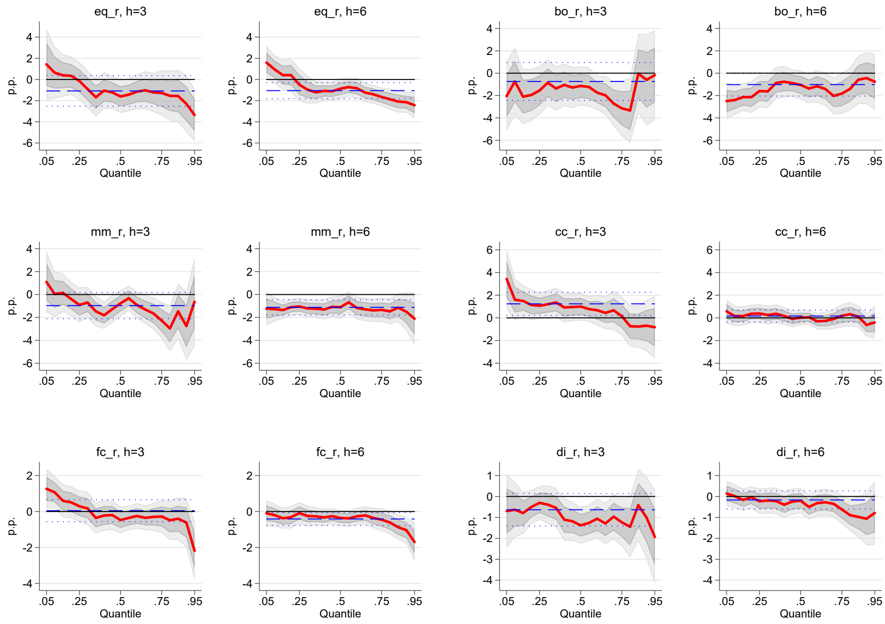
(a) The impact of capital inflow control policies



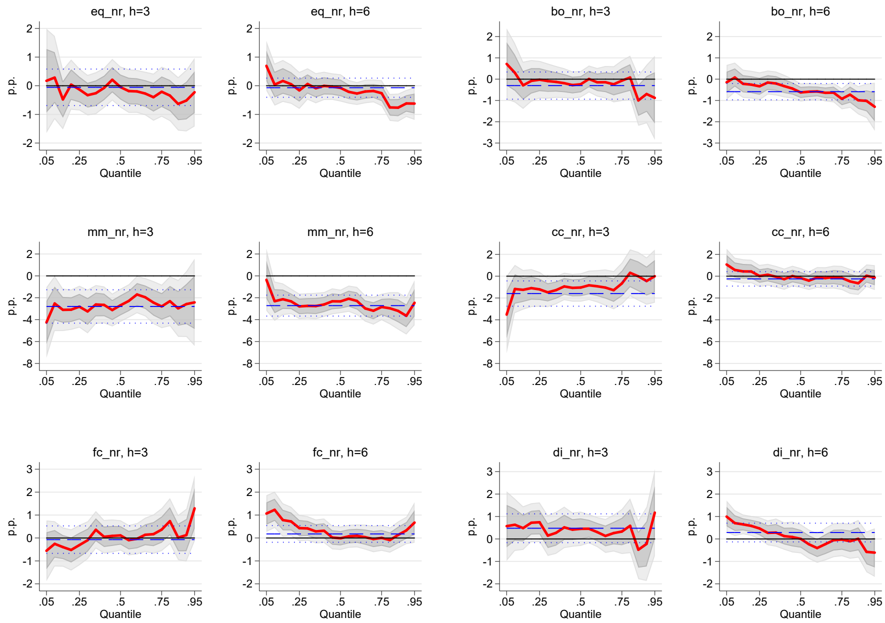
(b) The impact of capital outflow control policies

Notes: The red lines denote the estimated cumulative responses coefficients of a one-point increase in each capital inflow and outflow control indices obtained from local projection quantile regressions on real GDP growth across quantiles at 3 and 6 months ahead. Shaded areas refer to 1 standard error (dark) and 1.64 standard error (light), and the standard error are calculated by bootstrapping techniques with 500 replications. The y-axis indicates the percentage point change in real GDP growth. The horizontal solid lines represent the value of zero. The blue dashed lines show the OLS estimates and dotted lines represent 1.64 standard error confidence bands.

Figure A.6: Estimated quantile regression coefficients of inflow and outflow granular capital control indices on different quantiles of real GDP growth at 3 and 6 months horizons.



(a) The impact of capital control policies on residents



(b) The impact of capital control policies on nonresidents

Notes: The red lines denote the estimated cumulative responses coefficients of a one-point increase in each capital control indices on residents and nonresidents respectively obtained from local projection quantile regressions on real GDP growth across quantiles at 3 and 6 months ahead. Shaded areas refer to 1 standard error (dark) and 1.64 standard error (light), and the standard error are calculated by bootstrapping techniques with 500 replications. The y-axis indicates the percentage point change in real GDP growth. The horizontal solid lines represent the value of zero. The blue dashed lines show the OLS estimates and dotted lines represent 1.64 standard error confidence bands.

Figure A.7: Estimated quantile regression coefficients of granular capital control indices on residents and nonresidents respectively on different quantiles of real GDP growth at 3 and 6 months horizons.

B Official file's titles and objectives

In this appendix, we have double checked the rules, regulations, and notices associated with capital account listed in the website of SAFE. We collect all the official file's titles and extract their objectives and translate them in English.