Regional Heterogeneity of the Monetary Policy in China

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Abstract

This paper examines the regional heterogeneity in the transmission of China's monetary policy by estimating the effects of national-level monetary shocks on GDP growth across different economic regions. Using a local projections framework and a newly identified M2 monetary policy shock series from Chen, Ren, and Zha (2018), I find that the economically advanced East (coastal) region exhibits a significantly weaker output response compared to the rest of the country. While this pattern suggests that China's monetary policy may have an inequality-reducing effect by disproportionately stimulating less developed regions, a deeper investigation reveals that the underlying mechanisms—particularly land supply policies and muted exchange rate channels—may not yield efficient or welfare-enhancing outcomes. These findings highlight the need for complementary regional policies to ensure that aggregate monetary interventions promote balanced and sustainable growth.

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The effectiveness of the monetary policy is often not uniform across regions within a country or a monetary union, particularly when substantial differences in regional economic development exists. In large economies or currency unions, such as China or Euro Zone, a single monetary policy at the national level can lead to uneven outcomes, exerting heterogeneous impacts depending on different economic structure and institutional arrangement in each region. Such regional heterogeneity is highly consequential for policymakers, as uniform measures intended to stimulate the entire economy may fail to achieve their objectives, which could exacerbate rather than reduce economic inequalities across regions (Beraja, Fuster, Hurst, and Vavra 2019). Thus, a monetary framework that systematically generates regional differences will hardly have future viability without complementary instruments (Micossi, 2015; De Grauwe, 2011).

Many studies have researched this topic for advanced economies, including the Euro Zone, the United States and etc, but the case for China has not been well understood. There exist several differences between China and those regions that have been extensively studied, therefore making China an interesting case to explore. First, unlike the Euro Zone, China is not only a monetary union but also a fiscal union. More flexible fiscal transfers can be made to accommodate the regional differences in economic growth. Second, unlike the United States, factor mobility, especially labor mobility, is much lower due to the internal migration barrier and relatively segregated market. In a case where an external demand shortfall is a reason for a regional economic downturn, a lack of labor mobility can make the region less able to adjust (Farhi and Werning 2014). Third, within the period of the study, China's policy target is broad aggregate money (M2) growth rate instead of the interest rate. All these differences featuring a large transition and emerging market economy could make the monetary policy exert a different effect than that of advanced economies like the United States.

In this paper, I use the Local Projections model to examine how economic activities (regional and provincial GDP growth rate) in four different economic regions specified by the National Bureau of Statistics in mainland China respond to the central banks' monetary policy actions. With the assumption that the monetary policy does not influence the regional population growth rate differentially, I, therefore, estimate the heterogeneity of GDP per capita growth to reflect the well-being at the individual level. My analysis provides the evidence that the East (coastal) region is least responsive in terms of the GDP growth rate under the monetary policy shock, compared to the rest of the country, which contradicts the previous literature for the case of China. My approach differs from previous studies in several ways: First, the timing is different. Guo and Tajul (2014, 2017) used data from 1978 to 2011, and Cortes and Kong (2007) used data from 1980

to 2004. However, during 1949–1978, China was still a Centrally planned economy and 1979 to 1997 was the period of direct control based on the management of total credit. Until 1998, the period of indirect control of aggregate money and credit began and PBC announced that M2 was the sole policy target. Therefore, with those sharp differences in monetary regime, it is essentially inappropriate to study the effect of monetary policy without imposing structural breaks. The time period my study focuses is after 2005, which is the period of indirect control of aggregate money. Second, I adopt a different and newer method to identify the monetary policy shock. Following Chen, Ren, and Zha (2018), I use their identified monetary growth shock in this study, which I believe is a better identification compared to the previous studies.

1 Literature Review

The empirical analyses of asymmetric effects of monetary policy on economic activity date back to the 1970s (Beare, 1976)[1] Until the 1990s, the literature almost exclusively concentrated on the United States (e.g. Garrison and Chang, 1979; Garrison and Kort, 1983; Carlino and DeFina, 1998, 1999) and occasionally on Canada (Beare, 1976). When it comes closer to the end of the century, studies focused on Europe on the occasion of the launch of the Euro (e.g. Gerlach and Smets, 1995; Dornbusch et al., 1998; Tremosa-Balcells and Pons-Novell, 2001; Peersman, 2004). The global financial crisis and the broad use of the monetary policy regain the interests in this issue, for the Euro Zone (e.g. Boivin et al., 2009; Cavallo and Ribba, 2015; Georgiadis, 2015), and Mandler Scharnagl, and Volz, 2021), Australia (e.g. Vespignani, 2015), Brazil (e.g. Rocha et al., 2011), Indonesia (Ridhwan et al., 2014), and India (Nachane et al., 2001).

There are also several studies about China. Cortes and Kong (2007) measure the impact of monetary policy on real output both at the national and regional (provincial) level during the period of 1980–2004 using the Vector Error Correction (VEC) method. They develop a provincial GDP system comprising four endogenous variables (a monetary policy variable (M2 or bank lending rate), exchange rate, price index, and provincial real GDP) and one exogenous variable, world GDP. They find that monetary shocks produce greater responses in coastal, and therefore mostly the East region provinces, than in inland provinces. Guo and Tajul (2014) use the annual data from 1978 to 2011 for the three regions of China to study the regional effects of the single monetary policy. In their follow-up study (Guo and Tajul 2017), they extend their studies

[1] I only refer to a few selected papers. See Dominguez-Torres and Hierro (2019) for a survey of the literature on the sources of heterogeneous regional effects of monetary policy.

to 31 provinces in mainland China and show that bank lending channel is more effective than interest rate channel at the regional level, and the finding is similar to Cortes and Kong in the sense that they also show the East region has a larger response.

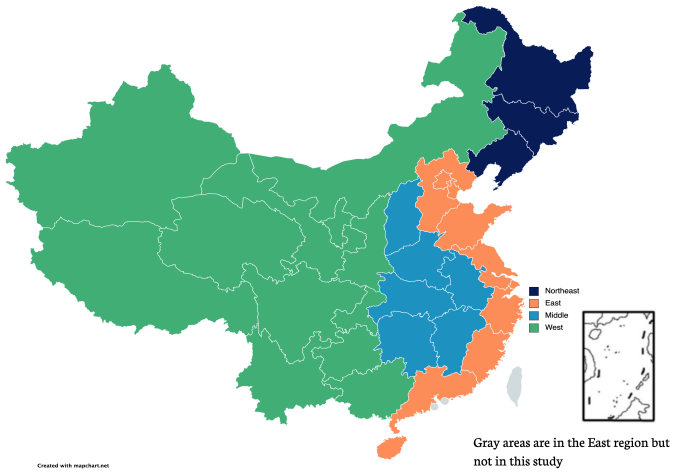
2 China's Monetary Policy and Regional Differences in Economic Development

In this section, I discuss the special features of China's monetary policy, which are key to the empirical analysis in this paper. I aim to address two important aspects: the monetary policy framework, and transmission mechanisms. I also show the regional differences in economic development across China.

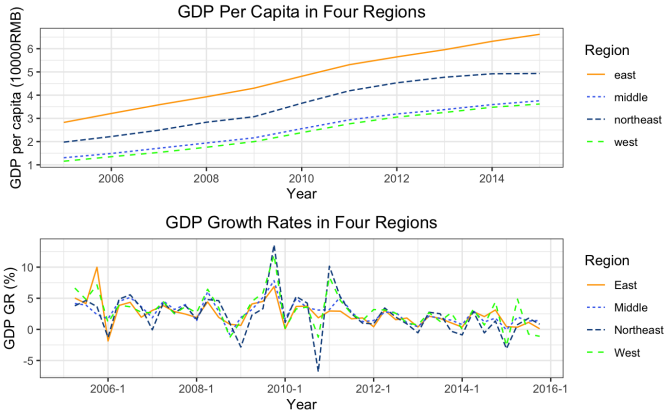
2.1 Monetary Policy Framework

Unlike the monetary authorities in the advanced and some emerging economies who rely on price-based means, the central bank of China (Peoples' Bank of China, or PBC) mainly uses quantity-based instruments to conduct its monetary policy, since China is still in a transitioning stage. In 1998 the PBC announced M2 supply to be the policy target, and Until 2018, it still set a specific monetary aggregate target (Huang, Ge, and Wang 2018). People's Bank of China defined M2 as M1 plus Quasi-Money (Time Deposits + Saving Deposits + Other Deposits). M1 is defined as M0 + Demand Deposits where M0 is the currency in circulation both from financial and non-financial sectors. The central banks' monetary policy objectives are specified by the People's Bank of China Law, article 3: "the objective of the monetary policy shall be to maintain the stability of the value of the currency and thereby promote economic growth".

Nevertheless, Zhou Xiaochuan, the former governor of PBC, stated, "for a long time, the annual objectives of the PBC mandated by the Chinese government have been maintaining price stability, boosting economic growth, promoting employment, and broadly maintaining a balance of payments". According to Huang, Ge, and Wang (2018), Zhou also implied that actually the most important policy objective for the PBC's monetary policy. However, based on the study of Chen, Ren, and Zha (2018), the overriding objective of the central government is to achieve the annual GDP growth target, which will be discussed in detail in the paper. Whether the GDP target or inflation target is more crucial than the other may remain to be debated, it is no doubt that both GDP growth and price stability are priorities of PBC's objectives. Also, though PBC is not as in-



(A) (a) Four Economic Regions Specified by NBS of China



(B) (b) Regional GDP per capita and GDP Growth

Figure 1. Economic Region Division and Heterogeneity in Regional GDP per capita and GDP Growth. Panel (a) displays the four economic regions of mainland China as defined by the National Bureau of Statistics: East, Middle, West, and Northeast. Panel (b) shows the average GDP per capita and GDP growth rate by region during the sample period (2005–2015). The East region consistently exhibits higher income and more stable growth compared to the others.

dependent as the central banks in the advanced economies, but it does have certain level of freedom to conduct the open market operations, which constitutes the shock series used in this study.

2.2 Regional Differences in Economic Development

According to the National Bureau of Statistics of China in 2011, to reflect differences in regional economic development, four economic regions are specified based on economic and geographical factors: East, Middle, Northeast, and West, as seen in the left panel of Figure 1. On the right panel, I calculate the regional GDP per capita and aggreagte GDP growth rate in four regions. The GDP per capita in the East region is much higher than the rest of the country, and com-

pared to the rest of the three regions, the growth rate of GDP in the East region is more stable than the rest of the three regions. The GDP growth rates of the four regions are particularly volatile during the period of the 2008 global financial crisis and two years onward, which are also reflected in the analysis later in this paper.

There are many differences between the East region and the rest of the country. The financial market is more developed in the East region. It also specializes more in export goods compared to the rest of the country. However, the central government also initialized more fiscal projects in the Northeast, Middle and West region than it does in the East region since 1999 [2].

3 Data

GDP, CPI and export data are from the National Bureau of Statistics of China (NBS of China). The land supply data are from China National Land and Resource Statistical Yearbook, and the M2 shock series data are provided by Chen, Ren, and Zha (2018). The data from NBS of China are not seasonally adjusted or deflated. The seasonal adjustment and deflation are done by the author using X-13 ARIMA-SEATS and provincial CPI data. The provincial CPI data are converted to the standard CPI index by the author using YOY (year-over-year) growth and monthly growth data.

The sample period for estimation is from 2005Q1 to 2015Q4. This is a period in which the People's Bank of China has made M2 growth an explicit policy instrument. The GDP data at the provincial level are limited by the provincial Statistical Yearbooks of China which are only available after 2005. PBC's official Monetary Policy Reports have been made available to the public since 2001Q1 through the English version of the website. 31 provinces in mainland China are included in this study.

4 Empirical Framework

4.1 Monetary Policy Shock

Chen, Ren, and Zha (2018) developed a tractable rule characterizing the essential part of the otherwise intractably complex operations of China's monetary policy. Unlike the advanced economies such as the U.S., the Taylor Rule does not apply to China for two major reasons: First, China is an emerging market economy with unbalanced growth the rising share of investment in GDP since

[2] In 1999, the government initiated the Trillion Western Development Plan; in 2001, Northeast Area Revitalization Plan; in 2003, 2-3 Trillion Rise of Central Plan; in 2008, 2 Trillion Post-Earthquake Reconstruction Fund

the late 1990s (Chang, Chen, Waggoner, and Zha, 2016). Second, financial markets in China are underdeveloped and no interest rates have become the policy target of the monetary authority.

At the end of each year, the central government sets the target of M2 growth consistent with targeted GDP growth for the next year. Within each year, the Monetary Policy Committee meets at the end of each quarter to make a policy decision for the next quarter. The monetary policy they propose is formalized as

$$g_{m,t} = \gamma_0 + \gamma_t g_{m,t-1} + \gamma_\pi(\pi_{t-1} - \pi^*) + \gamma_{x,t}(g_{x,t-1} - g^*_{t-1}) + \epsilon_{m,t}, \tag{4.1}$$

where $g_{m,t}$ is the $M2$ growth rate, $\pi_t = \Delta P$ is the actual CPI inflation, π^* is the inflation target, $g_{x,t}$ is the actual GDP growth, $g^*_{x,t}$ is the target GDP growth. $\epsilon_{m,t}$is a serially independent random shock that has a normal distribution with mean zero and time-varying standard deviation $\sigma_{m,t}$.

Since the GDP target serves as a lower bound,which means that it is very likley that the M2 growth response will be more aggressive when GDP is below the target, Chen, Ren, and Zha (2018) allow the output coefficient to be time-varying with the form

$$\gamma_{x,t} = \begin{cases} \gamma_{x,a} & \text{if } g_{x,t-1} - g^*_{x,t} \geq 0 \\ \gamma_{x,b} & \text{if } g_{x,t-1} - g^*_{x,t} < 0 \end{cases}$$

The monetary policy shock identified by the method above and used in this paper are the residuals $\epsilon_{m,t}$, and has shown by Chen, Ren, and Zha (2018) that M2 growth shock is orthogonal to changes in the reserve requirement ratio and thus reflects only the outcome of open market operations. The estimated result also shows that the overriding objective of the central government is to achieve the annual GDP growth target(Chen, Ren, and Zha, 2018) The shock series is shown in Figure 2 and their estimated coefficients are shown in Table 1.

4.2 Estimation of Impulse Response Function

A Local Projections framework developed by Jordà (2005) is used to estimate the effect of monetary policy on GDP growth in the four different regions and later extended to data at the provincial level. Although Chen, Ren, and Zha (2018) employed a state-dependent framework when they estimate the M2 growth shock, no such framework will be applied in this study when estimating the GDP growth response. There are two reasons: first, due to the limited observation of data, a state-dependent framework can hardly yield a reasonable result; second, the “state" in the pol-

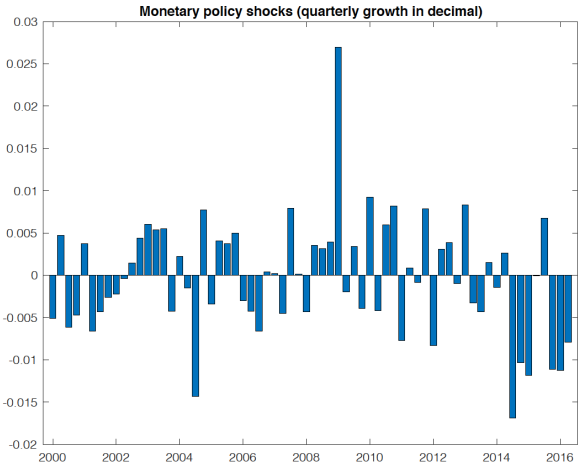


Figure 2. Quarterly M2 Shock by Chen, Ren, and Zha (2018). This figure plots the residual monetary policy shocks estimated by Chen, Ren, and Zha (2018), based on deviations from a policy rule targeting M2 growth. These shocks represent exogenous components of monetary policy after accounting for inflation and GDP targets, and are used as the main policy variable in the empirical analysis.

Coefficient	Estimate	SE	p-value
γ_m	0. 391***	0.101	0.000
γ_π	-0.397^{***}	-0.121	0.001
$\gamma_{x,a}$	0.183^{***}	0.060	0.002
$\gamma_{x,b}$	-1.299^{***}	0.499	0.009
$\sigma_{x,a}$	0.005^{***}	0.001	0.000
$\sigma_{x,b}$	0.010^{***}	0.002	0.000

Table 1. Estimated Monetary Policy, Table 3 in Chen, Ren, and Zha (2018). This table reports the parameter estimates from the monetary policy rule specification in Chen, Ren, and Zha (2018), used to construct the monetary policy shock series employed in this paper. The dependent variable is quarterly M2 growth. The rule includes lagged M2 growth, lagged CPI inflation, and deviations from GDP growth targets. Parameters $\gamma_{x,a}$ and $\gamma_{x,b}$ capture asymmetry in response to GDP deviations above and below target, respectively. Standard errors are robust and p-values are reported.

icy rule proposed in their paper is based on the government targeted GDP growth rather than a more objective measure of the true "state" of the economy. Therefore, it is not the case that the GDP growth response to the monetary policy shock is essentially dependent of this government's perceived "state". The specification is the following:

$$\ln GDP_{r,t+h} - \ln GDP_{r,t-1} = \beta_h Z_t + \sum_{l=0}^{n} \gamma_h^l (CPI_{t-l}) + \sum_{l=1}^{n} \alpha_h^l (\ln GDP_{t-l}) + \epsilon_{r,t+h}, \tag{4.2}$$

where h = 0, 1, 2, ..., 12, $\ln GDP$ is the deseasonalized GDP log level, Z_t is the identified monetary policy shock, $r \in \{\text{East, Northeast, West, Middle}\}$, and the model is estimated for each

region is estimated. β_h is the parameter of interest, a series of which are the impulse response function of monetary policy shock on cumulative GDP growth rate. In the main results, $n = 4$, and I will change the number of lags later for a robustness check.

I also estimate a panel Local Projections both at the regional and provincial level:

$$\ln GDP_{r,t+h} - \ln GDP_{r,t-1} = \beta_h Z_t + \beta_h^E Z_t \times 1[r = East] \tag{4.3}$$
$$+\gamma_h^E \ln CPI_{t-l} \times 1[r = East] + \gamma_h \ln CPI_t + \sum_{l=1}^{4} \gamma_{h,l}^X X_{t-l} + \epsilon_{r,t+h}.$$

Here r indicates the region or province in the two different specifications and $X_t s$ are lagged $\ln GDP$, $\ln CPI$ and interaction term of the East dummy and $\ln CPI$

To account for the potential output spillover effect across the provinces and regions, following Bräuning and Sheremirov (2019) I extend the model in Equation (3) to directly include provincial output spillovers:

$$\ln GDP_{r,t+h} - \ln GDP_{r,t-1} = \beta_h Z_t + \beta_h^E Z_t \times 1[r = East] + \sum_{l=1}^{n} \alpha_h^l \mathbf{W} \ln GDP_{t-l} \tag{4.4}$$
$$+\kappa \text{Controls} + \epsilon_{r,t+h}.$$

W is the spatial weighting matrix, which is based on the distance between the capital cities in each province rather than the center of the province, to better reflect the economic activity.

5 Results

5.1 Impulse responses of Four Regions Separately

The estimated impulse responses of monetary policy shock on GDP growth in each region display differences in magnitude and precision as shown in Figure 3. In general, the monetary policy shock has a positive effect on GDP growth in each region, although at around quarter 9, the responses in the Northeast and West region are much noisier and are not statistically different from zero. For the East region, the cumulative growth rate (the log difference between h periods of lead of GDP and 1 period of lag of GDP) peaks within 10 quarters of 2 % and fall back to 1.4 % at quarter 12, under a 1% of M2 growth shock.

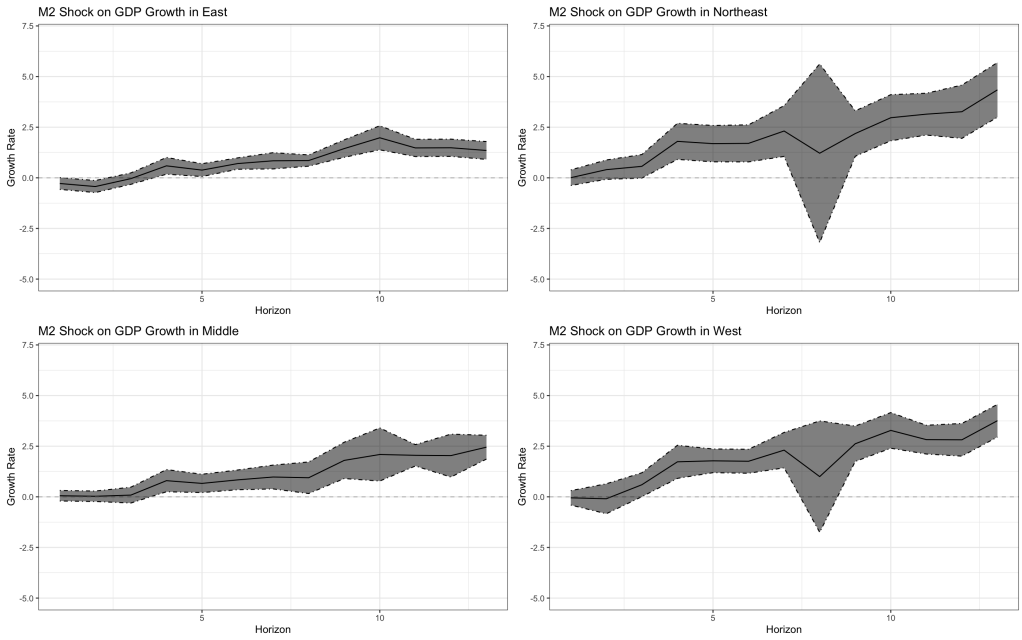


Figure 3. IRF of Monetary Policy on GDP Growth in Each Region. These impulse response functions are estimated separately for each economic region using the local projections method. The shock corresponds to a 1 percentage point increase in quarterly M2 growth. Shaded areas represent 68% confidence intervals. Responses are cumulative over the horizon and measure the effect on log GDP.

For the Middle, Northeast, and West regions, the means of impulse response functions are larger than that of the East region. Up to 12 quarters, the rest of the three regions show 2.5 %, 4.3 %, and 3.8% cumulative GDP growth respectively. The higher volatility of growth rates in the rest of three regions than that of the East region (as shown in Figure 1.) can explain the phenomenon that those three regions have more volatile impulse response functions. The growth rates are especially volatile during the period of the 2008 global financial crisis. At a first glance, contrary to previous literature, (Kong et al., 2007, Guo and Tajul 2014; 2017) which shows the East region is more responsive than the rest of the regions in China, my result here tells a different story. Nonetheless, at the regional level and with % 68 error band, in most of the horizons, the impulse response functions of the four regions are not statistically different from each other.

Since the goal of this study is to investigate whether the GDP growth rates in the rest of the country have a jointly different response to the monetary policy shock than the East does, I also estimate a panel Local Projections at the regional level. In addition, to take the advantage of the availability of provincial-level data, I estimate a Panel Local Projections at the provincial level to measure the response of the provinces in East region and the rest of the three regions anddiscuss the results in section B.

5.2 Impulse responses of Pooled Results at the Regional and Province Level

The estimated impulse responses in the Panel Local Projections with 68 % confidence intervals show a similar qualitative result in section A. As panel A and B in Figure 4 show, the GDP growth rate of the rest of the three regions is mostly larger than the GDP growth in the East region, both at the regional and provincial level, except for quarter 8, when there's a drop in the impulse response of all regions. The impulse response functions in panel A and B are very similar, and the result in the provincial panel Local Projections show more statistical power in distinguishing the responses in the East and non-East region. Similar to the result shown in Figure 3, the GDP growth of the East region peaks within 10 quarters of 2.2 % and fall back to 1.7 % at quarter 12, under a 1% of M2 growth shock. For the rest of the country, the impulse response reaches its maximum at quarter 12 at 3.5 % and this is the horizon when the growth rates of the East region and the rest of the regions differ the most.

We observe more similar results in panel A and B of Figure 4 and a more statistically different result between panel A of Figure 4 and Figure 3. This fact implies that the insignificance in Figure 3 (when estimating results for each region separately) is likely due to the limited observation of data, rather than the uncaught dynamics using the provincial level data such as the strong spillover effect within the regions.

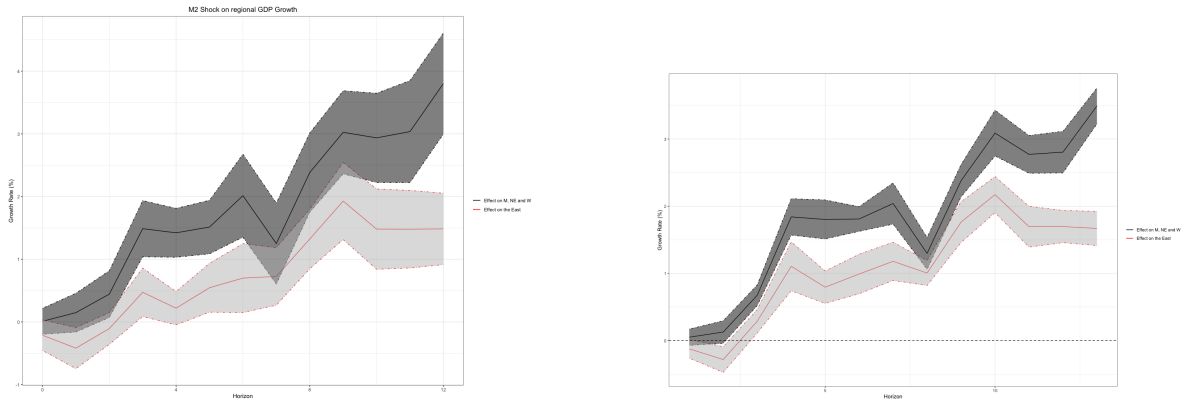
The result of the specification with the spatial weighting matrix is displayed in panel (b) of Figure 5, and panel (a) shows the spatial linkages within 2000 km. Before quarter 8, the difference in GDP growth rates is less salient compared to the result in Figure 2(b). Nonetheless, we still see a significant difference between the East and non-East regions after quarter 10, a similar pattern to Figure 4(a).

5.3 Robustness Check

In this section, I alter the specifications in Figure 4 and Figure 5 by changing the number of lags of control variables from 1 to 3. Also, to make sure the consistency of results across different econometric methods, I also run a three-variable simple VAR(4) for each region separately using the following specification:

$$y_{r,t} = C_r + \sum_{i=1}^{4} B_{r,t} y_{r,t-i} + \epsilon_{r,t} \tag{5.1}$$

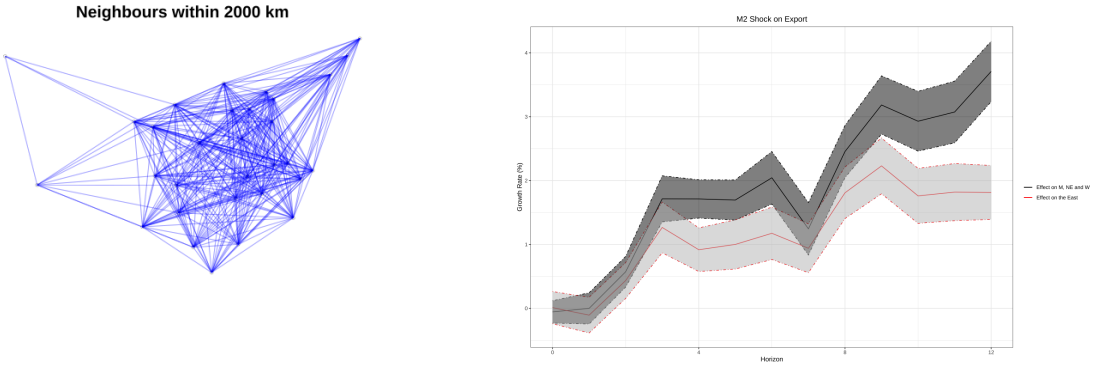
where $y_{r,t} = [M2GR_t \ CPIGR_t \ GDPGR_{r,t}]$, $r \in$ {E, NE, W, M}



(A) Regional Panel Local Projections

(B) Provincial Panel Local Projections

Figure 4. Impulse Responses of M2 Shock on GDP Growth (Pooled IRF). Panel (a) shows pooled regional-level estimates, and panel (b) shows provincial-level estimates using panel local projections. The estimates capture differential effects of M2 shocks between the East region and the rest of the country. Each line represents cumulative GDP response, and shaded bands denote 68% confidence intervals.



(A) Spatial Network

(B) IRFs with the Network Effect

Figure 5. IRF of M2 Shock on GDP Growth with the Network/Spillover Effect. Panel (a) displays spatial linkages constructed using inter-capital distances within 2000 km. Panel (b) shows IRFs of GDP growth incorporating spatial spillovers via a spatial weighting matrix. The estimates suggest regional dependencies in output responses to monetary shocks.

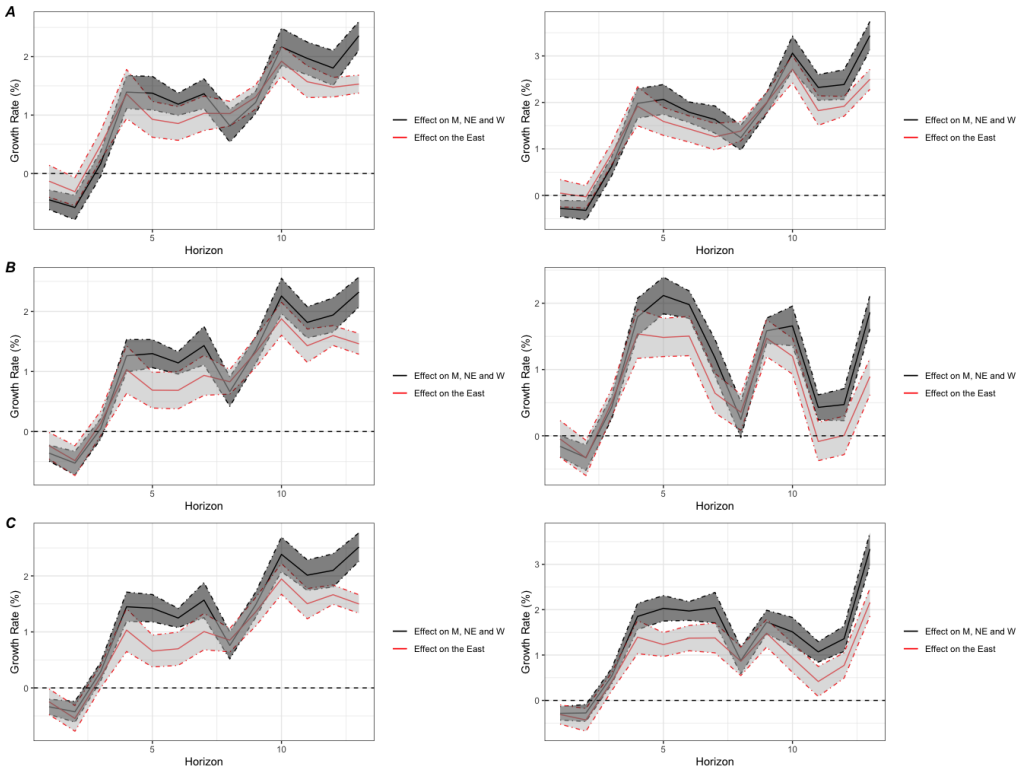


Figure 6. Impulse Response Functions with different control variables. This figure presents IRFs under alternative specifications with 1 to 3 lags of control variables. Results confirm robustness of baseline findings: the East region responds less to monetary shocks. Controls include national CPI and lagged GDP growth.

I use the Cholesky identification and order the identified M2 growth shock the first and GDP growth rate in each region the last. This ordering follows the monetary policy rule discussed in section IV. A that the current policy (growth) rate is determined by variables in the last period and should have a contemporaneous effect on the variables in this period. Assuming the identified M2 growth shock is reasonably exogenous, it should not respond to any contemporaneous variables.

The results of impulse response functions are shown in Figure 7. The responses of the GDP growth rate of the four regions in this VAR analysis display similar patterns as those in the Local Projections estimated for each region separately. The point estimates in the Northeast, Middle, and West region are larger than that of the East region. However, again, the GDP growth responses are not statistically different from each other due to large error bands and are again probably a result of lack of degrees of freedom discussed in section B.

5.4 Drivers of the Different Output Effects across Regions

At a first glance, it seems reassuring that the monetary policy is not accelerating the difference in economic growth within China, for it is having a larger impact on provinces or regions which

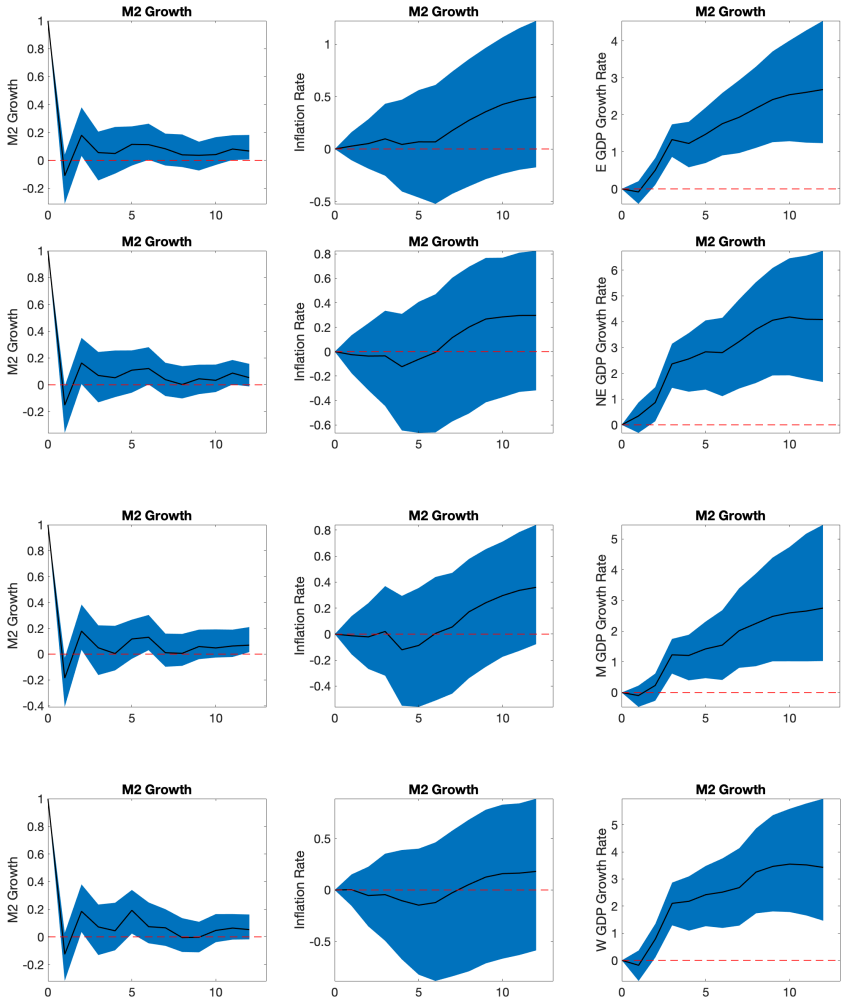


Figure 7. IRFs of three-variable VAR(4) for each economic regions separately. IRFs are derived from a three-variable VAR (M2 growth, CPI growth, GDP growth) estimated separately for each region. Cholesky ordering assumes M2 growth is exogenous. The estimates broadly replicate local projection results, with stronger responses outside the East.

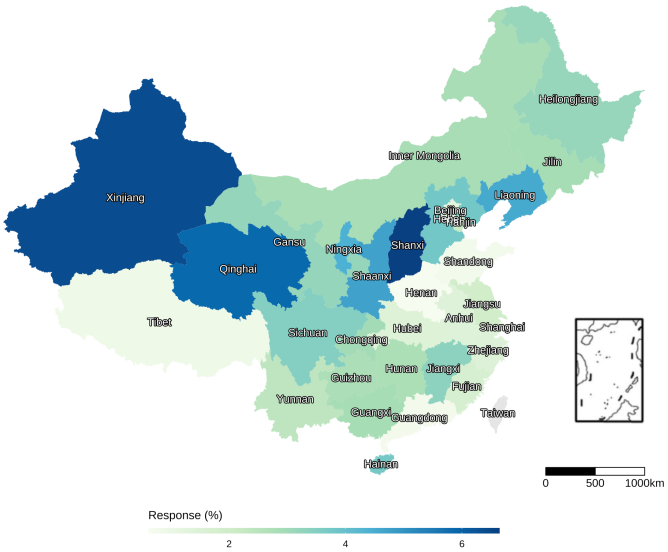


Figure 8. Horizon-12 response rates estimated from the Local Projections Model for Each Province. This heatmap shows the estimated GDP response at horizon 12 for each province following a 1% M2 shock. Estimates are obtained via province-level local projections. Darker shades indicate stronger output responses. The East shows systematically weaker effects.

are less developed. However, it is still important to investigate what is the driving force behind these heterogeneous responses. Only then we can make a judgment call about whether this phenomenon is truly welfare-improving and inequality-reducing.

Two channels are investigated in this study: the exchange rate and land supply channel. To better examine the mechanisms by using the cross-sectional variation, I run the Local Projections Model for each province as I have done for each region. Following Georgiadis (2015), I then take their horizon-12 response point estimates (shown as a heatmap in Figure 8) for the simple OLS regression with the export-GDP ratio and annualized state-owned land growth rate. A more detailed description will be provided in the following subsections.

5.4.1 Exchange Rate Channel

The first possibility is the muted channel of the exchange rate. Two branches of studies tell two parts of the story of the exchange rate channel. It turns out that monetary policy does not influence the exchange rate (Zhang and Huang 2011). This phenomenon could be attributed to two possible reasons. First, the exchange rate regime remains rigid, and therefore it does not sensitively respond to changes in monetary policy. In addition, variation of the exchange rate is determined by many factors in addition to monetary policy, such as external economic environment, trends of economic

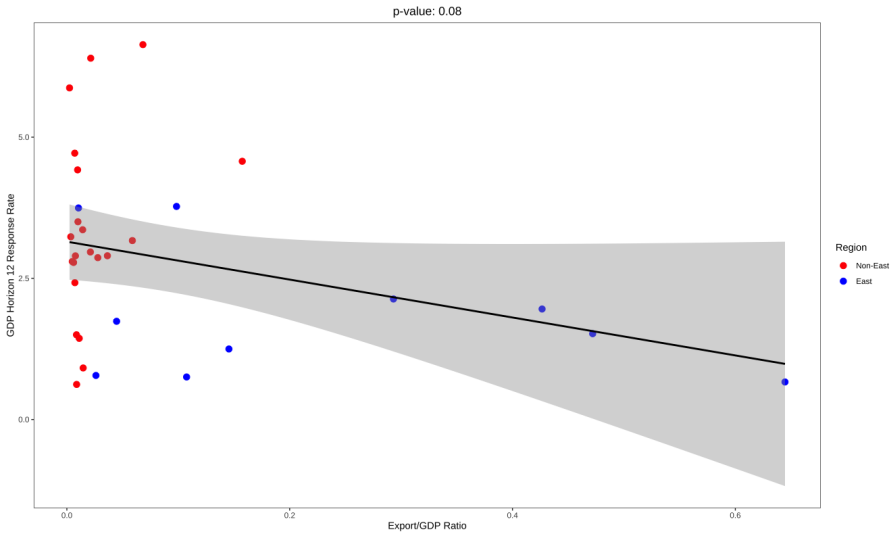


Figure 9. Export/GDP Ratio Plotted against the horizon-12 Response from the Local Projections estimate for each province. This scatter plot regresses each province's horizon-12 GDP response on its average export-to-GDP ratio (2005–2015). The negative slope suggests that provinces with greater export dependence, primarily in the East, are less responsive to monetary shocks—consistent with a muted exchange rate channel.

growth, and others (Huang, Ge, and Wang 2018). However, in terms of the part that the exchange rate to the real economy, Lv (2007) showed that it works relatively well. The characteristic of this channel is key to the analysis in this paper when it comes to the difference between the East region and the rest of the country. Because export takes a larger GDP share in the East region, we can expect the exchange rate channel to have differential impacts across regions in China.

The idea goes as follows: if the exchange rate channel is well-functioning, when there is an expansionary monetary policy, the domestic currency is depreciated against foreign currencies, making the export goods relatively cheaper, and therefore could increase in quantity demanded for the export good. However, since the channel is malfunctioning, this way of increasing the GDP growth rate is blocked. Figure 9 shows the simple OLS between the point-estimate response of each province and their respective 11-year average export-GDP ratio. The result suggests that the provinces with larger shares of export-GDP ratio are associated with smaller responses of GDP growth rates, significant at 10%, indicating the possible story of the shut-down of the exchange rate channel. However, we can see the responses within the non-East regions are very volatile, suggesting this exchange rate channel could be weak.

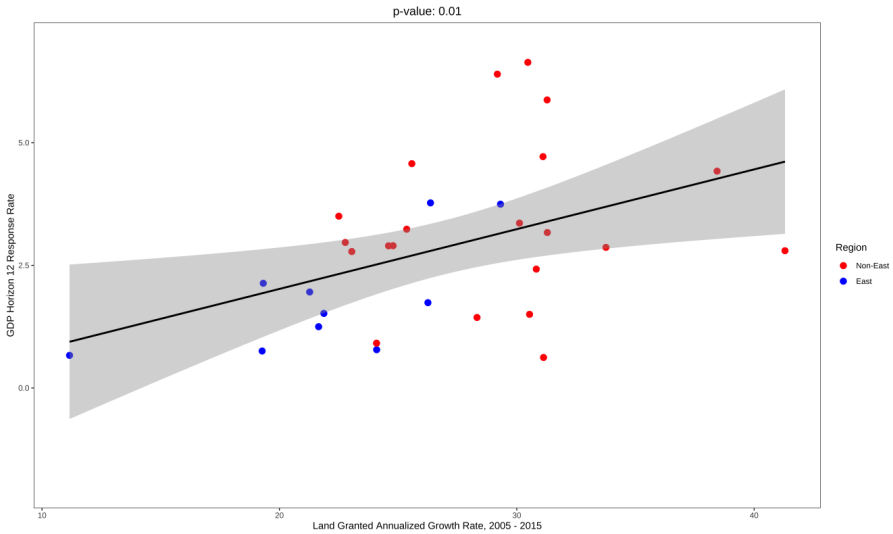


Figure 10. Annualized Growth Rate of the State-owned Land Granted Plotted against the horizon-12 Response. fhis figure plots the relationship between each province's GDP response and its annualized growth in state-owned land supply. The positive correlation indicates that increased land supply may explain stronger monetary transmission in less developed regions.

5.4.2 Land Supply Channel

In China, all land in the non-rural areas is state-owned (rural land is collectively owned), and to use the land, each region needs to obtain the land use right from the central government. Since 2003, the policy regarding the land supply started to favor the central and western regions. Also, the cities where land supply generally has been restricted after 2003 are basically coastal cities and large inland metropolises that are attracting population inflow (Han and Lu, 2018). As shown in Figure 10, larger responses of GDP growth can be accounted for by higher annualized state-owned land supply growth.

This seems to be a good result because less developed regions are getting more resources (in this case, land supply) and therefore the monetary policy is having a larger impact on those regions. However, this may not be as desirable as it may look from the surface. In fact, there exist many industrial parks not in use in the non-East region (Lu, 2017). In Fang et al (2021), they show that even though it seems that the inland-favoring land supply policy achieved its original goal of shrinking regional output gaps, it in reality hurts workers from underdeveloped areas. People's incomes from almost all places were decreased and the convergence of the income is due to the fact that people from developed regions were hurt more.

5.4.3 Other Important Channels Which are Left Behind

Interest Rate Channel The interest rate channel is the one that mostly gets discussed in the monetary policy literature, but this study is not going to discuss it. For the case of China, early studies discovered that it only plays a relatively moderate role in the real economy. For example, Maino (2007) and Koivu (2009) show that the interest rate channel does not function properly. There exist a couple of possible reasons including repressive financial policies that grant the large state-owned a more favorable interest rate and floor and ceiling imposed on lending/deposit rates. Nonetheless, this phenomenon is changing as China is gradually going through the interest rate liberalization process. (Huang, Ge, and Wang 2018) Indeed, more recent studies gave evidence that interest rates play an important role in economic activities and inflation (Fernald et al., 2014; Zha and Chen, 2017; Ge, 2019).

Credit Channel Another possibility lies in the credit channel. Chen, Higgins, Waggoner, and Zha (2016) show that there exists strong evidence for the credit channel unique to China's monetary policy transmission. As seen in Figure 8, after 2009 Q2, the growth rate of loans is consistently higher in the Middle, Northeast, and West regions combined than that of the East. It is possible that the rest of the three regions are less developed compared to the East and they have more incentives to invest and/or are getting more loans. However, without province or region-specific investment and credit supply data, this channel is hard to examine.

6 Conclusion

Regional heterogeneity is no doubt an important topic when it comes to evaluating the influence of monetary policy, especially if it is generating more regional inequality. In this paper, I use a newly proposed method of identifying monetary policy shock by Chen, Ren, and Zha (2018) and the Local Projections method to estimate the differential effects of China's monetary policy on GDP growth across different regions. Contrary to the previous studies, this paper shows that the response of GDP growth under the monetary policy shock is in fact less salient than the rest of the country, which could be partly explained by the difference in annualized land supply growth between the East and non-East region.

On the surface it looks like it is a desirable phenomenon, for the monetary policy is having a larger positive effect on less developed regions. But after taking a deeper look, the increasing land supply to the non-East region is not as desirable as it looks. With an increasing migration inflow

to the more developed East region, the land-allocated policy may very likely not yield sustainable economic growth (including other resources) while limiting the potential of the development of the East region. More careful implementation of the policy for reducing inequality across regions needs to be considered for better economic development and overall welfare in the future.

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