Fiscal Policy Volatility and Capital Misallocation: Evidence from China*

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Abstract

This paper investigates how domestic policy uncertainty stemming from discretionary fiscal policy disrupts the efficient capital allocation across firms. While fiscal policy represents the government's reaction to economic conditions, its volatility presents firms with considerable uncertainty about conditions affecting their future profitability and consequently disrupts firms' decisions on investment in the presence of capital adjustment costs. Using firm-level data from Chinese manufacturing industries spanning from 1998 to 2007, we find that reducing fiscal policy volatility leads to a decrease in the dispersion of marginal revenue product of capital, accounting for 8.9 percent of the observed improvement in capital allocation during the sample period. In addition to various fiscal reforms to curb fiscal policy volatility directly, policies contributing to lower capital adjustment costs and lower reliance of firms on government expenditure can alleviate the adverse effects caused by fiscal policy volatility.

JEL Classification: D24, E62, O23

Keywords: fiscal volatility, capital misallocation, MRPK dispersion, capital adjustment costs, China

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1 Introduction

Variation in marginal products across firms, even within narrowly defined industries, is widely regarded as evidence of frictions that hinder the efficient allocation of resources in the economy. Extensive research has underscored the qualitative significance and quantitative importance of resource misallocation in both developed and developing countries (e.g., Banerjee and Duflo, 2005; Hsieh and Klenow, 2009; Gopinath et al., 2017). Identifying the driving forces behind resource misallocation is of paramount importance to promote the reallocation of resources towards more productive uses and enhance aggregate efficiency and welfare within industries, countries, and over time.

In this paper, our focus is on examining how fiscal policy volatility affects the dispersion of marginal revenue product of capital (MRPK) among firms in the manufacturing sector. By investigating this relationship, we aim to contribute to the understanding of how fiscal policy volatility impacts resource allocation efficiency, shedding light on its policy implications, particularly in the post-pandemic world. As many countries continue to grapple with considerable uncertainty or volatility in fiscal policy after expending substantial resources to mitigate the human and economic impact of the Covid-19 pandemic, understanding the effects of fiscal policy volatility on resource allocation is of utmost importance for policymakers navigating the challenges of recovery and promoting sustainable economic growth. This is especially important for many developing countries, which appear to have about one-third more macro uncertainty than developed countries (Bloom, 2014).

Fiscal policy directly impacts firms' demand through government purchases, as well as indirectly through the provision of basic infrastructure and other public goods and services that influence firms' production costs and sales.[1] While fiscal policy often reflects the government's response to economic conditions, its *volatility*, stemming from discretionary government expenditure, introduces significant uncertainty for firms regarding future profitability. This uncertainty can disrupt firms' decision-making processes concerning capital allocation and investment, in the presence of capital adjustment costs. The increase in MRPK dispersion resulting from higher fiscal policy volatility indicates the extent of capital allocative inefficiency that could be mitigated by reducing volatility while maintaining the level of fiscal expenditure. In this context, the impact of fiscal policy volatility on MRPK dispersion represents capital misallocation. Estimating the magnitude of this impact is crucial for understanding the potential improvement in capital efficiency through the design of less volatile fiscal policies and the mediation of

[1] In China, the share of "Economic construction expenditure" in total government expenditure ranges from 38.7 percent to 26.6 percent during 1998-2006, which is the most important component of fiscal expenditure and directly relates to the manufacturing sector (see Online Appendix Figure OB.1).

this impact by industrial and economic characteristics.

To this end, China serves as an excellent case for this study due to its unique fiscal landscape. China is widely recognized as one of the most fiscally decentralized countries globally, where local governments at various levels, including province, prefecture, county, and township, bear substantial expenditure responsibilities to provide public goods and services that directly impact people's lives. However, these expenditure assignments are inadequately supported by revenue assignments or intergovernmental transfers (Lardy, 2014). Overall, the discretionary government expenditure and fiscal volatility in China can be attributed to two main factors. Firstly, the 1994 fiscal reform, which re-centralizes revenues but left expenditure assignments unchanged, has created a significant mismatch between expenditures and revenues of local governments. This mismatch increases the likelihood of discretionary government spending and unnecessary fiscal volatility. Secondly, the low fiscal transparency and limited provision of information by local governments in China exacerbate the aggressive use of discretionary fiscal policy, leading to further volatility. According to the Penn World Table data, China exhibits quite high fiscal volatility compared with other countries – China ranks the 80^{th} among 135 developed and developing countries in a list ranging from the lowest to highest volatility over the period of 1980-2013. However, the existing research on China's fiscal system focuses mainly on the effectiveness of fiscal reform or the growth impact of fiscal decentralization (e.g., Lin and Liu, 2000; Wong and Bird, 2008). We therefore fill this gap by exploring the *volatility* of fiscal policy in driving resource allocation in China, which is important but largely ignored in the literature.

Second, the issue of resource misallocation, particularly concerning capital, is prevalent in China and has resulted in substantial welfare losses. Hsieh and Klenow (2009) claim that China could benefit with huge aggregate productivity gains (up to 30-50%) if their manufacturing firms are able to achieve the same efficiency in allocating capital and labour across production units as does the United States. While the literature on resource misallocation in China has been growing, the focus has primarily been on specific policy distortions, such as ownership and financial frictions (e.g., Brandt et al., 2013; Wu, 2018). Our contribution lies in examining the role of second-order policy moments, the volatility induced by discretionary fiscal policy, as a novel driver of the observed dispersion of marginal revenue product of capital (MRPK).

Our analysis mainly uses comprehensive panel data from the Annual Survey of Industrial Firms from the National Bureau of Statistics of China over the period 1998-2007. The firms in the data are located in all 31 Chinese provinces. We follow the literature (e.g., Fatás and Mihov, 2003; Woo, 2011; Fatás and Mihov, 2013) to define fiscal policy volatility as the standard deviation of the residuals from province-specific regressions of government expenditure on output, using a panel of 31 provinces at yearly frequency drawn from various issues of China Statistics Yearbook and the "China Compendium of Statistics 1949-2009". This regression-based measure of fiscal volatility captures the portion of discretionary fiscal policy that is not explained by the state of the business cycle. For MRPK, we compute it from Cobb-Douglas production functions by industry. In a static model without frictions, profit maximization implies that MRPK should be equal to the user cost of capital. In the presence of adjustment costs of capital, the dispersion of MRPK across firms rises with the uncertainty of future profitability. In our context, the volatility of fiscal policy contributes to such uncertainty and disrupts efficient capital allocation across firms and industries by influencing firms' future market conditions regarding their costs and demand.

The identification of the causal relationship between fiscal policy volatility and the dispersion of MRPK stems from the variation in fiscal disparities and fiscal transparency across regions and over time in China. China's fiscal system exhibits a notable characteristic of significant regional disparities. Wealthier provinces in the East, situated along the coast, enjoy ample fiscal revenue, enabling them to provide robust public services and invest in local infrastructure. Conversely, provinces in the Central and Western (i.e., inland) regions, facing serious fiscal challenges, experience a deterioration in public services. Despite the implementation of the "Go West" development strategy by the central government in 1999, aiming to redirect fiscal resources to poorer regions, the outcome has been limited, as reflected by the persistently high fiscal volatility in inland provinces. Furthermore, fiscal transparency at the province level is generally low in China, with substantial variation in the amount of information disclosed by individual provinces from year to year (Deng et al., 2013). These disparities and variations generate significant differences in the volatility of fiscal policy across regions and over time, providing a source of identification for studying its relationship with the dispersion of MRPK within a cross-province panel data framework.[2]

Our findings demonstrate a substantial influence of fiscal policy volatility on the dispersion of MRPK. This relationship maintains its significance even after accounting for a range of factors encompassing policy distortions (e.g., government size and subsidy), market frictions (e.g., financial development and inflation), and trade openness, all of which can potentially impact MRPK dispersion. Specifically, our analysis reveals an elasticity of 0.023 between MRPK dispersion and fiscal policy volatility. This result

[2]The regional differences may also come with a variation in the composition of manufacturing industries across regions, which may be associated with different user costs of capital. This might naturally imply different levels (and consequently dispersion) of MRPK. In order to tease out the role of fiscal policy volatility, we adjust MRPK by taking away the industry- and year-level differences and focus on its within-province dispersion by year.

carries economic significance across three dimensions. Firstly, the magnitude of fiscal policy volatility looms significantly – the degree of uncertainty arising from fiscal policy encompasses around 14.5 percent of the overall uncertainty associated with total factor productivity. Secondly, the effect of fiscal policy uncertainty (as evidenced by the measured elasticity of 0.023) is comparable (about 40 percent) to the impact arising from the overall uncertainty of total factor productivity. Lastly, considering the overall decrease in fiscal policy volatility in China during the period 1998-2007, the estimated impact indicates that this decrease contributed to 8.9 percent of the observed improvement in capital dispersion during this period. Overall, this result underscores the significance of policies aimed at directly reducing fiscal policy volatility, such as expenditure-side reforms to address the mismatch between local government revenue and expenditure, enhanced fiscal transparency, and efforts to alleviate regional fiscal disparities. By adopting such measures, policymakers can effectively enhance firms' capital allocative efficiency.

Despite the largely exogenous nature of our fiscal volatility measure induced by macroeconomic policy and regional disparities, potential endogeneity bias may arise due to reverse causality. For instance, provinces with a higher level of capital misallocation may be more inclined to utilize discretionary fiscal policy to support the least efficient firms. To address this concern, we employ several novel instruments and employ the two-stage least squares (2SLS) approach, as well as the system Generalized Method of Moments (GMM) estimator. Firstly, we utilize an innovative instrumental variable based on the historical and cultural distinctions between China's wheat and rice regions, which have persisted for thousands of years. The underlying concept is that societies with a history of rice farming exhibit greater interdependence due to the extensive cooperation required for water-intensive cultivation, while wheat farming fosters independence as irrigation or labor does not necessitate interdependence (Talhelm et al., 2014). Since paddy rice cultivation increases the value of cooperation within societies, monitoring and control mechanisms are more likely to be established, potentially curbing the discretionary use of fiscal policy and reducing associated volatility in rice regions compared to wheat regions. Moreover, the historical wheat and rice division is unlikely to be influenced by the current MRPK dispersion, rendering it a valid instrumental variable. Secondly, we employ the initial income inequality of each province as an additional instrumental variable. According to Woo (2011), income distribution struggles in highly unequal societies can lead to discretionary spending decisions and more volatile fiscal outcomes. Therefore, provinces characterized by high initial income inequality may experience greater fiscal policy volatility, while the initial income inequality itself is unlikely to be influenced by the current MRPK dispersion. Our empirical findings support these hypotheses and affirm the role of fiscal volatility in the dispersion of MRPK.

We also conduct a large number of robustness tests to secure our causal results from other confounding factors. First, to circumvent the potential endogeneity bias caused by omitted variables and different sorts of uncertainty, we include various factors such as output volatility, total factor productivity growth volatility, and political volatility in the regression analysis. Second, we use alternative and flexible methods to construct the two key variables, fiscal policy volatility and the MRPK dispersion, in order to minimize the potential mismeasurement problem. Overall, the key result regarding the relationship between fiscal policy volatility and the dispersion of MRPK remains robust.

To explore the mechanisms that make fiscal policy volatility matter, we analyze how the types of government expenditure, capital adjustment costs, and firms' reliance on government purchase shape the relationship. First, government investment in infrastructure is mainly included in budgetary expenditure, while extrabudgetary expenditure covers city maintenance and administrative costs. The former expenditure is more relevant in determining manufacturing firms' profitability and thus its volatility is more important in influencing capital allocation in the manufacturing sector. Consistent with this conjecture, we find that only the volatility of budgetary expenditure matters. This result also serves as a placebo test showing that the documented relationship is indeed driven by the volatility that directly affects firm profitability rather than other factors that are confounded with fiscal policy. Second, firms in inland provinces arguably face a higher level of capital adjustment costs, possibly due to more severe capital market imperfections and more obstacles to factor mobility such as the lack of transport infrastructure, compared with their counterparts in coastal provinces. Consistent with the key role of adjustment costs in the literature, we find that the relationship is only significant for inland provinces. Third, the relationship is much muted in provinces where firms are with a lower level of dependence on government purchase. Overall, these results suggest that policies contributing to lower capital adjustment costs and lower reliance of firms on government expenditure can alleviate the capital misallocation caused by fiscal policy volatility.

Our paper is closely related to Asker et al. (2014). They emphasize that the uncertainty of future profitability plays a role in shaping the dispersion of MRPK in the presence of adjustment costs of capital. The mechanism that drive our documented relationship comes from this insight, but we depart from the general profitability uncertainty faced by firms. Instead, we focus on the uncertainty arising from a particular form of policy shock – the excessive discretionary changes in fiscal policy that do not represent a reaction to economic conditions. Focusing on this uncertainty is meaningful because the impact of fiscal policy volatility on MRPK dispersion represents the capital misallocation that can be alleviated by the government's policy toolbox.

Our paper contributes to the literature on policy volatility and economic growth by exploring resource misallocation as a new mechanism for the negative link between the two. Despite the substantial cross-country evidence on the negative effect of policy volatility on long-run economic growth, there is not much consensus on specific mechanisms. The literature emphasizing irreversible investment claims that higher volatility can result in a lower level of investment and slower economic growth. Fatás and Mihov (2003) discover a positive link between policy volatility and output volatility, which ultimately reduces economic growth. We show that fiscal policy shocks can make the existing allocation of resources less optimal, thereby generating efficiency losses and hindering economic growth.

Our paper is also related to the literature emphasizing the importance of domestic policy uncertainty for economic activity, which has attracted considerable research attention recently. Bloom (2009) finds that shocks to stock market volatility (a proxy for uncertainty) delay firm-level investment and employment and dampen productivity growth in the United States. Baker et al. (2016) confirm these findings by using a new index of economic policy uncertainty based on newspaper coverage frequency. However, research on policy uncertainty in China focuses mainly on trade policy uncertainty (e.g., Feng et al., 2017; Crowley et al., 2018). We contribute to the literature by focusing on a major policy uncertainty originating from fiscal policy volatility and investigating its impact on resource allocation across individual firms.

The structure of the paper is as follows. Section 2 discusses the relevant literature. Section 3 describes the background of China's fiscal system with a focus on potential sources of fiscal volatility. Section 4 defines the measures of fiscal policy volatility and the MRPK dispersion and describes the empirical methodology. Section 5 presents the data and stylized facts regarding MRPK and fiscal policy volatility across regions and over time. Section 6 discusses the empirical results of both the baseline model and various tests addressing the reverse causality, omitted variables and mismeasurement problems. Section 7 focuses on economic mechanisms that make fiscal policy volatility matter in affecting capital misallocation. We conclude in Section 8.

2 Related literature

2.1 Literature on resource misallocation

A large literature shows that misallocation of resources across firms/plants in an economy lowers aggregate total factor productivity (TFP).[3] That is, aggregate productivity can be low because inputs are misallocated across heterogeneous production units[4]. Market imperfections, adjustment costs, and policy distortions are commonly identified as potential candidates for explaining the dispersion of TFP or marginal revenue products of inputs in the literature. Trade openness, on the other hand, is found to be conducive to the improvement of resource allocation.

Taking capital market imperfections as an example, Midrigan and Xu (2014) examine the role of financial frictions in driving the dispersion of returns to capital across individual producers using cross-country data and find that this misallocation channel accounts for a moderate degree of efficiency loss due to firms' ability to use internal funds to mitigate borrowing constraints. Based on a sample of manufacturing firms in the US, Gilchrist et al. (2013) reach a similar finding that the efficiency loss due to misallocation associated with financial market frictions is relatively small, where they use the dispersion of firms' borrowing costs to measure resource misallocation caused by capital market imperfections. Using a dataset of Indian manufacturing plants, Galle (2016) finds that in the presence of financial constraints, capital wedges of firms can be amplified by competition because the reduced markups that are driven by competition lower the scope for internally-financed capital accumulation and impede the process of convergence to the firm's optimal capital level. Using a structural model with both policy distortions and financial frictions, Wu (2018) identifies a non-trivial role of financial frictions in explaining capital misallocation in China over the period of 1998-2007 (about 30%).

The misallocation literature acknowledges the role of factor adjustment costs in driving the dispersion of marginal revenue products. Asker et al. (2014) find that adjustment costs of capital, coupled with TFP shocks, lead to differences in MRPK among producers in a dynamic investment model. Their empirical evidence shows that variation in the volatility of productivity across industries and countries can explain 80%-90% of the cross-industry and cross-country variation in the dispersion of marginal revenue product of capital. Costly adjustment costs of capital are more pervasive in developing countries. Wu (2015) claims that if Chinese firms had faced a lower level of adjustment

[3]Throughout this paper, we use TFP to refer to revenue-based total factor productivity for convenience.

[4]See, for instance, Banerjee and Duflo (2005); Foster et al. (2008); Restuccia and Rogerson (2008); Hsieh and Klenow (2009); Syverson (2011); Restuccia and Rogerson (2013); Asker et al. (2014); Midrigan and Xu (2014).

costs such as that in the US, China's aggregate output would be 25% higher.

Non-market distortions induced by government policies are argued to be another important contributing factor to the observed misallocation. Restuccia and Rogerson (2008) focus on the effect of firm-level variation in taxes and subsidies which create heterogeneity in the prices faced by individual producers. Hsieh and Klenow (2009) relate the TFP gaps between China/India and the US to policy distortions, such as the state ownership in China and licensing and size restrictions in India. Da Rocha and Pujolas (2011) consider policy distortions (such as subsidizing low-productivity plants or taxing high-productivity plants) in a model where plants face idiosyncratic shocks and find that the cross-sectional dispersion of productivity increases as the time-series volatility of idiosyncratic shocks rises. Brandt et al. (2013) examine the effect of factor market distortions (such as barriers to factor mobility across regions and forms of ownership) in both manufacturing and services sectors in China from 1985 to 2007. They find that the misallocation of factors across provinces and sectors leads to an aggregate TFP loss in the non-agriculture economy of 20% and almost all the within-province distortions were due to misallocation of capital between the state and non-state sectors induced by government policies. Based on a unified framework, David and Venkateswaran (2019) claim that the presence of substantial distortions to firm investment such as the size-dependent policies accounts for a major component of observed capital misallocation in China, as measured by the dispersion of average revenue products of capital (ARPK).

The international trade literature has long recognized the role of trade openness in enhancing resource allocation and thus aggregate productivity. In the seminal work of Melitz (2003), trade liberalization shapes sector dynamics by inducing reallocation of resources towards more efficient use, i.e. the exposure to trade induces the more productive firms to enter the export market and forces the least productive firms to exit, so that the aggregate productivity increases due to selection and market share reallocation. A similar mechanism works for imports in both theory and empirical evidence (Melitz and Ottaviano, 2008; Ding et al., 2016).

2.2 Literature on (policy) volatility

The literature on (policy) volatility mainly relates to economic growth. In theory, the volatility-growth relationship is ambiguous. Endogenous growth can be negatively affected by volatility due to irreversibility or diminishing returns to investment; on the other hand, the effect can be positive in the presence of precautionary saving, innovative creative destruction, liquidity constraints, or if high returns technologies also entail high risks (Imbs, 2007). The negative link between volatility and growth is well established in the empirical literature. For instance, Ramey and Ramey (1995) show that aggregate volatility is low in fast-growing economies. Aghion et al. (2010) find that financial frictions play an important role in shaping the negative link between volatility and growth by affecting the cyclical composition of investment.

Turning to the growth impact of policy volatility, research based on macroeconomic data suggests that policy volatility has detrimental effects on economic growth. Using a cross-section of 91 countries, Fatás and Mihov (2003) find that the aggressive use of discretionary fiscal policy amplifies business cycle fluctuations, generates undesirable volatility, and leads to lower economic growth. In other words, they regard output volatility as a vital channel through which policy volatility affects economic growth. Using a similar dataset but a better technique to control for reverse causality, Fatás and Mihov (2013) discover a direct negative effect of volatility induced by fiscal policy changes on long-term growth rates. Institutional factors (such as the presence of political constraints on executives) are found to play an important role in shaping the relationship between policy-induced volatility and economic growth.

Based on a large sample of countries over the period of 1960-2000, Woo (2011) views fiscal policy volatility as a new mechanism for the negative link between income inequality and growth, i.e. struggles over income distribution in highly unequal societies may lead to discretionary spending decisions of governments and volatile fiscal outcomes, which in turn reduces economic growth. Using cross-industry data, Aghion et al. (2014) find that a more countercyclical fiscal policy enhances value-added and productivity growth more in more financially constrained industries. Using the vector autoregression (VAR) model and impulse response functions, Fernández-Villaverde et al. (2015) show that unexpected changes in fiscal volatility shocks have a sizable adverse effect on economic activity (such as output, consumption, investment, hours, and real wages) in the US, and the main transmission mechanism is through a fall in investment triggered by higher uncertainty about future returns on capital.

Microeconomic evidence echos the above findings. For instance, Chong and Gradstein (2009) examine the volatility-growth nexus using a large panel of firms in different countries and find that perceived policy volatility has an adverse impact on firms' sales growth, and such effects can be amplified by various institutional obstacles. Kandilov and Leblebicioğlu (2011) discover a negative effect of exchange rate volatility on plant-level investment in the Colombian manufacturing sector, and both higher markup and export exposure can help mitigate such effects.

3 Background on China's fiscal system

The fiscal system in China has undergone dramatic changes since 1978, accompanied by significant volatility in fiscal policy over time and substantial variations across provinces. These dynamics provide the necessary foundation for investigating the relationship between fiscal policy volatility and the dispersion of MRPK. To better comprehend the factors driving discretionary government spending and fiscal volatility in China, it is essential to consider the background of China's fiscal reforms. Two key factors contribute to these phenomena: (i) the mismatch between expenditure and revenue of local governments resulting from the 1994 fiscal reform and (ii) the low fiscal transparency.

Mismatch between expenditure and revenue of local governments. The original Chinese fiscal system was a highly centralized one, where the central government had absolute control over revenue collections and budget appropriation. That is, the tax system rested on the local collection of revenues that were then remitted to the centre, and essentially all expenditures were determined at the centre. The earlier waves of fiscal reform in the 1980s (1980, 1985, and 1988) aimed at decentralizing this unitary fiscal system by relinquishing fiscal controls from the central government to local governments in order to increase economic efficiency. For instance, an income tax on SOEs was introduced to replace profit remittances in 1985; and a fiscal responsibility system was introduced in 1988, which allows local governments to keep revenues above certain stipulated remittances to the central government. Fiscal decentralization is argued to be conducive to China's economic growth by boosting investment at the local level (Lin and Liu, 2000). However, one direct outcome of fiscal decentralization is the dramatic decline of "two ratios". The ratio of fiscal revenue to GDP falls from 28.4% in 1978 to 12.6% in 1993, and the central government's share in total fiscal revenue drops from 46.8% in 1978 to 31.6% in 1993, which implies the erosion of allocative control by the central government.

Thus, a major fiscal reform started in 1994 to restrengthen the central government's role in the fiscal system through a tax-sharing system, where taxes were assigned to the central government, local governments, or shared. A national tax administration office was established to collect central and shared taxes, and a local tax administration was responsible for collecting local taxes. On the one hand, the 1994 reform has turned out to be effective in improving both ratios by providing fiscal incentives to all levels of governments; on the other hand, the fact that the reform recentralized revenues but left expenditure assignments unchanged has created a significant mismatch of expenditures and revenues between the levels of governments. This did not only lead to distortions that impair the role of central and local governments in providing public goods and services but also generated discretionary government spending and unnecessary fiscal volatility.

Many local governments have to face a huge fiscal gap, and rely heavily on extrabudgetary revenue and/or accumulate a large amount of government debt to cope with their increasing fiscal problems. [5] Neither way is without problems. Despite the fact that extrabudgetary funds (including both extrabudgetary revenue and expenditure) provide considerable autonomy to local governments, they are prone to abuse without an effective system of monitoring and control (Wong and Bird, 2008). Rising local government debt has also become a key source of concern in terms of fiscal sustainability in China (Huang, 2014).[6] Overall, it is the fiscal reform of 1994 that led to a significant mismatch between expenditure and revenue of local governments and consequently induced discretionary government spending and significant volatility in regional fiscal policy.

Low fiscal transparency. Fiscal transparency comprises clarity of role and responsibility, open budget processes, public availability of information, and assurances of integrity (Rehm and Parry, 2007). The International Budget Partnership (IBP) published an "Open Budget Index" in 2008, which is a cross-country comparative measure of budget transparency by evaluating the quantity and type of information available to the public in a country's budget documents (Carlitz et al., 2009). China ranks the 63^{rd} among 85 developed and developing countries with a score of 14 out of 100, indicating that the Chinese government provides scant or no information to the public. Deng et al. (2013) find that fiscal transparency at the province level is low in China and there is significant volatility in the amount of information disclosed by individual provinces from year to year. Low fiscal transparency is likely to facilitate the aggressive use of discretionary fiscal policy and lead to excessive volatility. Indeed, using a fiscal transparency index from the 2005 Chinese governments' performance evaluation website published by the Ministry of Commerce of China, we find a negative relationship between the fiscal transparency index and fiscal policy volatility across Chinese provinces.[7]

Thus, more recent fiscal reforms focus on improving fiscal transparency. Since 2000, China has legalized and publicized government expenditures through several reforms such as a treasury centralized payment system, a government procurement system, and revenue and expenditure separate management. Since January 2011, all extrabudgetary funds have been merged into budgetary management to eliminate the discretionary use of the former and therefore enhance fiscal transparency. These reforms may have contributed to the declining fiscal policy volatility since 2000, which is used as a source of identification of its relationship with the MRPK dispersion in the time dimension.

[5] According to Fan (2013), local governments providing public services at the local level finance half or more of their expenditures from extrabudgetary revenue.

[6] Only until August 2016, China launched a new wave of major fiscal reform targeting on better balancing central and local governments' fiscal obligations by moving some public service duties to the central government in order to relieve local governments' fiscal burden.

[7] The relationship is illustrated by Online Appendix Figure OB.2.

4 Empirical methodology

4.1 Measure of fiscal policy volatility

While fiscal policy may represent the government's reaction to economic conditions, its *volatility*, which may be caused by discretionary government expenditure due to the mismatch between revenue and expenditure of local governments and low fiscal transparency, presents firms with considerable uncertainty about conditions affecting their future profitability. Our objective is to explore how such uncertainty can disrupt firms' decisions on capital allocation and investment.

For this purpose, it is crucial to distinguish fiscal volatility from adaptability to sudden changes in economic conditions such as countercyclical fiscal response to macroeconomic shocks as the latter can mitigate allocative inefficiency over the business cycles. Following the recent literature (Fatás and Mihov, 2003; Woo, 2011; Fatás and Mihov, 2013), we define fiscal policy volatility as the standard deviation of the residuals from province-specific regressions of government expenditure growth on output growth.

Specifically, we estimate the following regression for 31 provinces over the period of 1994-2013:[8]

$$\Delta \log G_{p,t} = \alpha_p + \beta_p \Delta \log Y_{p,t} + \gamma_p \Delta \log G_{p,t-1} + \varepsilon_{p,t}, \tag{1}$$

where Δ denotes the rate of growth from $t-1$ to t. $Y_{p,t}$ is the real GDP in province p in year t and $G_{p,t}$ is the real government expenditure in province p in year t.[9] Finally, $\varepsilon_{p,t}$ is the residual term, reflecting the policy decisions exogenous to the state of the economy.

This regression model is based on the evolution model of fiscal policy analyzed in Fatás and Mihov (2003), who specify three components in the evolution process: (i) automatic stabilizers; (ii) fiscal policy that reacts to the state of the economy; and (iii) discretionary policy that is implemented for reasons other than smoothing out output fluctuations or responding to macroeconomic conditions. Because our focus is on the volatility of the last component and its relationship to the dispersion of MRPK, we adopt the regression-based measure of fiscal volatility to capture the portion of discretionary fiscal policy that is not explained by the state of the business cycle and contributes to the uncertain future profitability faced by firms.[10]

[8]We choose the starting year as 1994 because the 1994 fiscal reform can be viewed as a major structural break in the Chinese fiscal system and the tax sharing system has been in place until now.

[9]In this baseline model, government expenditure includes both budgetary and extrabudgetary expenditure. We examine different implication of the two types of expenditure volatility in Section 7.1.

[10]As a result, this definition helps to identify the role of the volatility of discretionary policy from large countercyclical fiscal policy changes aiming to mitigating allocative inefficiency over business cycles.

To be precise, our measure of fiscal policy volatility is the standard deviation of the residual, $\sigma(\varepsilon_{p,t})$. Given the short time span of our final sample (1998-2007), we use the 5-year moving window method to construct our fiscal policy volatility for province p in year t.[11]

Remark: In fiscal policy volatility measure used in the baseline result in Section 6.1, we estimate (1) using Ordinary Least Squares without any further control variables (other than the provincial fixed effect included). Nonetheless, in Section 6.3.2, we conduct a wide range of robustness checks of different versions of the fiscal policy evolution process. First, we extend (1) to include CPI, time trend, and a further lagged dependent variable ($\Delta \log G_{p,t-2}$) as control variables. Second, we adopt a two-stage IV approach to estimate (1), where lagged provincial GDP growth ($\Delta \log Y_{p,t-1}$) is used to instrument current GDP growth. Third, we opt for non-parametric regression methods (locally weighted average estimator and local constant estimator) to compute fiscal policy volatility from (1). Finally, we use the multi-year (3 or 4 years) non-overlapping time intervals (as opposed to the 5-year moving window in the baseline calculation) to compute the fiscal policy volatility for each period. Overall, we find that our results do not rely on a specific version of the fiscal policy evolution process.

In addition, we choose to use government expenditure in (1) to measure fiscal policy volatility for two reasons. First, government expenditure is argued to be more exogenous than other fiscal policy variables such as fiscal balances which are more likely to suffer the simultaneity problem in the determination of output and the budget and to be affected by changes in macroeconomic conditions (Fatás and Mihov, 2003). Second, we prefer government expenditure to tax revenue because the latter does not represent an overall picture of fiscal revenue, because, in China, a large part of the local government's revenue comes from various administrative fees and land sales.

4.2 Measure of the MRPK dispersion

In our context, the dispersion of MRPK is defined within provinces in a year. There are multiple industries in each province and the composition of industries can be different across provinces. To simplify the notation, we suppress the superscript of industry. We start from a Cobb-Douglas production function of a profit-maximizing firm in a given industry:

$$Q_{it} = A_{it} K_{it}^{\alpha_K} L_{it}^{\alpha_L} M_{it}^{\alpha_M}, \tag{2}$$

[11] That is the standard deviation over $\varepsilon_{p,t-2}, \varepsilon_{p,t-1}, \varepsilon_{p,t}, \varepsilon_{p,t+1}, \varepsilon_{p,t+2}$. Our full sample for (1) is 1994-2013, which is long enough for us to compute the corresponding figure for the final sample 1998-2007 used in the analysis. In Section 6.3.2, we show that our result is robust to different windows and ways of computing the volatility.

where Q_{it} is quantity output of firm i in year t, and K_{it}, L_{it}, and M_{it} are the capital input, labour input and intermediate materials, respectively. A_{it} presents the firm's technical efficiency of production.

Assume the demand curve for firm's product is with a constant elasticity: $Q_{it} = B_{it}P_{it}^{-\eta}$, where B_{it} is a demand shifter. The revenue-based production function can be written as:

$$S_{it} = \Omega_{it} K_{it}^{\beta_K} L_{it}^{\beta_L} M_{it}^{\beta_M}, \tag{3}$$

where S_{it} is total revenue of firm i in year t, $\beta_X = \alpha_X[1-(1-\eta)]$ for $X \in (K, L, M)$, and $\Omega_{it} = A_{it}^{1-(1/\eta)} B_{it}^{1/\eta}$ is the revenue-based total factor productivity as usually defined in the related literature.[12]

Thus, the marginal revenue product of capital is written as:

$$\frac{\partial S_{it}}{\partial K_{it}} = \beta_K \frac{\Omega_{it} K_{it}^{\beta_K} L_{it}^{\beta_L} M_{it}^{\beta_M}}{K_{it}}. \tag{4}$$

With a slight abuse of notation, we define the marginal revenue product of capital (in natural logarithm) as:

$$MRPK_{it} = \log(\beta_K) + \log(S_{it}) - \log(K_{it}) = \log(\beta_K) + s_{it} - k_{it}, \tag{5}$$

where s_{it} is the natural logarithm of firm's revenue and k_{it} is the natural logarithm of firm's capital input, which is computed using the perpetual inventory method following Brandt et al. (2012).

Our focus is on the MRPK dispersion at the *province-year* level and its relationship with the fiscal policy volatility. Potentially, there are a few factors in addition to fiscal policy volatility that can drive the MRPK dispersion. First, when there is capital misallocation (or friction) across *industries*, β_K (i.e., the output elasticity of capital), appears as a part of MRPK in (5) and varies across industries due to differences in production technologies. Because the composition of industries differs across provinces, the dispersion of MRPK naturally varies accordingly. Second, a set of variables that influence MRPK, such as user costs of capital, technologies involved in installing capital, and industry policies, may also be industry-specific and vary over time.

In order to address the above issues, we adjust MRPK by industry and year.[13] That

[12] Note that the production and demand functions are industry-specific. Nonetheless, we suppress the industry superscript because our focus is the dispersion of marginal revenue product of capital, which is adjusted by industry and time.

[13] Of course, firm-level characteristics such as ownership types may also affect firm MRPK. In an unreported specification, we have considered a version of (6) where extra firm characteristics (e.g., private or state ownership) are controlled for in computing adjusted MRPK. Our baseline results in

is, we isolate these industry- and time-specific components from the observed MRPK before computing its dispersion within a province in a year. Specifically, we regress the computed MRPK on the interaction between industry fixed effects (at 4-digit level, indexed by j) and year fixed effect (indexed by t):

$$MRPK_{it} = \sum_{t,j} \gamma_t^j * D_t^j + e_{it}, \tag{6}$$

where D_t^j is the industry-time specific dummy. The residual term, e_{it}, is our industry- and year-adjusted MRPK. We refer to it as the adjusted MRPK and denote it as $MRPK^A$. Then, our measure of within-province dispersion of marginal revenue product of capital is computed as the standard deviation of $MRPK^A$ of firms in province p in year t. We denote it as $\sigma(MRPK^A_{p,t})$.

Overall, this adjustment allows us to isolate all industry-and time-specific factors (such as user costs of capital, production technology, and market competition) and potential measurement errors at the industry and year level when measuring the within-province dispersion of MRPK.[14]

4.3 Fiscal policy volatility and capital misallocation

In a static model without friction, the profit-maximizing firm will equalize its marginal revenue product of input to its unit input cost. In the case of capital, MRPK should be equal to the user cost of capital, and uncertainty of future profitability does not affect the dispersion of MRPK. Nonetheless, as emphasized by Asker et al. (2014), in the presence of adjustment costs of capital, the uncertainty of future profitability plays a role in shaping the dispersion of MRPK. This is because the capital stock determined in the previous period may no longer be optimal after a profitability shock. This consequently implies that the MRPK dispersion rises with the degree of uncertainty.

The mechanism that shape the relationship in our paper comes from this insight, but we explore further in the context when the firms' future profitability is influenced by the government policy distortion (i.e., fiscal policy volatility).[15] The increase of MRPK dispersion due to higher fiscal policy volatility represents the size of capital allocative

Section 6.1 are quantitatively and qualitatively similar.

[14] In the rest of the paper, we always use the adjusted marginal revenue product of capital. We refer to it as MRPK when applicable in order to simplify notations. When the raw MRPK was used to compute the dispersion of MRPK, one has to estimate the output elasticity of capital, β_K. This involves estimating the production functions by industry. In Section 6.3.2, we show that our baseline result is robust to the use of raw MRPK and different production function estimation approaches such as Olley and Pakes (1996), Levinsohn and Petrin (2003), Wooldridge (2009), and Ackerberg et al. (2015).

[15] We provide a stylized model similar to that in Asker et al. (2014) to describe the mechanism in detail in Online Appendix OC.

inefficiency that could be reduced by eliminating the *volatility* but maintaining the *level* of fiscal expenditure. In this sense, the impact of fiscal policy volatility on the MRPK dispersion represents capital misallocation.

Putting this in the context of Chinese manufacturing industries where firms face considerable adjustment costs of capital (Wu, 2015; Tang, 2022), fiscal policy significantly affects firm profitability but is volatile. The volatility of fiscal policy presents firms with uncertainty regarding their future profitability and thus affects the dispersion of MRPK. Our goal is to understand how much of the MRPK dispersion (capital misallocation) can be attributed to the fiscal policy volatility and thus can be alleviated by the government's policy toolbox.

For this purpose, the variation of fiscal policy volatility due to fiscal transparency and fiscal disparities across provinces and over time as discussed earlier (in Sections 1 and 3) helps to identify their relationship. Specifically, we examine the relationship between fiscal policy volatility and capital misallocation by estimating the baseline equation using a fixed effect model:[16]

$$\log(\sigma(MRPK^A_{p,t})) = \alpha + \beta \log(FisVol_{p,t}) + \gamma Z_{p,t} + \varsigma_p + \eta_t + \xi_{p,t}, \tag{7}$$

where $\sigma(MRPK^A_{p,t})$ is the dispersion of the industry- and year-adjusted MRPK in province p and in year t, and $FisVol_{p,t}$ is fiscal policy volatility of province p in year t (i.e., $\sigma(\varepsilon_{p,t})$ as defined in Section 4.1). The error term in (7) comprises three components: (i) ς_p is the province-specific fixed effect, capturing geographic factors that influence capital misallocation; (ii) η_t is the year-specific fixed effect, accounting for possible business cycles and other macroeconomic shocks such as influences from monetary policies; and (iii) $\xi_{p,t}$ is an idiosyncratic error term.

To take into account other factors that can potentially influence the MRPK dispersion, we include several control variables as $Z_{p,t}$ in (7).[17] These variables consist of factors capturing policy distortions, capital market imperfections/frictions, and trade openness, as discussed in Section 2.1.[18] Although all of these variables may affect the dispersion of

[16]In Online Appendix OC, we examine the impact of fiscal policy volatility on the dispersion of the marginal products of other inputs – labour and intermediate materials. We find the results are similar to that of capital. If there exist adjustment costs of labour and intermediate materials, the mechanism that shapes the relationship is similar to that of capital. Even without these adjustment costs, we show in Online Appendix OC that fiscal policy volatility may still have an impact on the dispersion of the marginal products of labour and intermediate materials via the distorted choice of capital.

[17]All these variables are in natural logarithm, unless otherwise stated. See Online Appendix OA for detailed definitions.

[18] These variables are in (logarithm) levels rather than volatility, with the purpose to capture the frictions/imperfections examined in the literature (as discussed in Section 2.1). In Section 6.3.1, we show that our baseline result is robust even after other sorts of volatility are taken into account. Furthermore, in Section 7.2, we also consider the role of capital adjustment costs to show that it is not capital

MRPK, their associations are not necessarily causal. Instead, our purpose is to control for these factors in the analysis in order to tease out the impact of fiscal policy volatility. We explain these variables as follows.

First, we use government size ($GovSize_{p,t}$) as a proxy for the extent of government intervention in the process of resource allocation. This variable is defined as the natural logarithm of total government expenditure as a share of GDP in province p in year t. Government intervention may represent friction that prevents firms from making optimal decisions on capital allocation, as self-interested politicians utilize political power to exercise control over firms for their own political and social objectives (Shleifer and Vishny, 2002). This is particularly the case for China given the prevalence of state ownership in its manufacturing sector (Chen et al., 2011).

Second, government subsidy ($Subsidy_{p,t}$) is included as an additional measure of policy distortion. This variable is defined as the natural logarithm of total subsidized income divided by total sales income of all manufacturing firms in province p in year t. Subsidies (especially to inefficient firms) can generate significant distortions in factor prices and adversely affect resource allocation (Restuccia and Rogerson, 2008). In China, many SOEs receive substantial government subsidies and poss great advantages over private firms in terms of obtaining bank loans at subsidized rates, preferential tax treatment, market entry, and many other resources, which can be viewed as distortions introduced by governments to compensate inefficient SOEs for their cost disadvantages.

Third, we include a financial dependence variable ($FD_{p,t}$) as a proxy for capital market imperfections due to financial frictions in China. This variable is defined as the natural logarithm of total bank loans as a share of GDP in province p in year t. Financial markets are generally found to improve the allocation of capital by mitigating information asymmetry, exerting corporate governance, and thus channeling funds to the most productive uses (Wurgler, 2000; Levine, 2005). However, China's financial system is argued to be inefficient and "repressed", where the government has intervened, and continues to intervene, in bank lending to favour the state sector in order to keep unprofitable SOEs afloat during the reform process (Riedel et al., 2007). By contrast, private firms, the driving force of the economy, are generally discriminated against by the formal financial system and have to rely on internal funds or other forms of informal finance for investment (Allen et al., 2005; Ding et al., 2013; Cull et al., 2015).

Fourth, inflation ($Inflation_{p,t}$) is included as a measure of informational friction faced by producers and consumers, defined as the growth rate of the natural logarithm of the Consumer Price Index (CPI) in province p in year t. The traditional view is that

adjustment costs alone that drive the impact on MRPK dispersion.

low or stabilizing inflation improves the informational content of the price system and favours a more efficient allocation of resources (Friedman, 1977), whereas high inflation and the inflation-induced variation in relative prices shorten agents' horizons, disrupt the organization of markets and generate resource misallocation (Tommasi, 1999). On the other hand, Tobin (1972) proposes that inflation greases the wheel of the labour market by allowing real wages to fall even when nominal wages are sticky downwards. Akerlof et al. (1996) support this view and claim that creeping inflation is associated with the dynamics of resource allocation and a moderate steady rate of inflation permits maximum employment and output.

Lastly, we use the share of exports in provincial GDP in year t ($Export_{p,t}$) as a proxy for trade openness to examine whether the Melitz-type mechanism works in China. The benefits of exposure to foreign competition/markets enjoyed by the more productive domestic firms may drive the least efficient domestic producers out of business, thereby reducing the dispersion of MRPK.

5 Data

5.1 Sample and data sources

We use an integrated, rich sample drawn from several data sources for this research. First, the computation of MRPK dispersion and some related variables (such as government subsidy and ownership) is based on a comprehensive firm-level dataset drawn from the annual accounting reports filed by industrial firms with the National Bureau of Statistics (NBS) of China over the period of 1998-2007. This dataset includes all SOEs and other types of enterprises with annual sales of five million yuan (about \$817,000) or more. These firms operate in the manufacturing sectors and are located in all 31 Chinese provinces or province-equivalent municipal cities. Standard cleaning rules are applied following the literature.[19]

Second, the data used to compute our fiscal policy volatility measure and other provincial-level control variables are from various issues of the China Statistics Yearbook and the "China Compendium of Statistics 1949-2009" compiled by the National Bureau of Statistics. The final sample consists of a panel of 31 provinces with annual data for the period 1998-2007. However, due to the use of the moving window method for the

[19] We drop observations with negative total assets minus total fixed assets, negative total assets minus liquid assets, and negative sales, as well as negative accumulated depreciation minus current depreciation. Firms with less than eight employees are also excluded as they fall under a different legal regime (Brandt et al., 2012). Lastly, to isolate our results from potential outliers, we exclude observations in the one percent tails of each of the regression variables.

construction of fiscal policy volatility, the full sample for this calculation is 1996-2009. All nominal variables are deflated using a provincial GDP deflator to convert to real values (at 1978 constant price).[20]

Lastly, we draw information from a range of supplementary data sources for variables that are used for robustness checks. Specifically, historical and political datasets are used to construct instrumental variables (such as wheat-rice ratio) and omitted variables (such as political volatility) to tackle the problem of endogeneity in Section 6.3. Industry-level data (such as industry-specific financial dependence and capital resalability index) are obtained from the US Bureau of the Census and are merged into the Chinese data. Firm-level information from the World Bank Investment Climate dataset is used to calculate the industry-specific reliance on government demand. The summary statistics of all variables and detailed variable definitions are provided in Online Appendix OA.

5.2 Stylized facts

This subsection presents stylized facts regarding the MRPK dispersion and fiscal policy volatility that motivate our research.

First, there is a significant dispersion of MRPK across firms within provinces, but the degree of the dispersion systematically varies by region. The mean of province-year level MRPK dispersion is 1.34.[21] This is significant and is close to the high end of the levels reported by Asker et al. (2014), who show that country-level MRPK dispersion ranges from 0.98 in the United States to 1.56 in Slovenia. Nonetheless, there exist regional disparities in the dispersion. As shown in the top of Figure 1, the firms in the Eastern (coastal) region have a lower degree of MRPK dispersion than firms in the Central and Western (inland) regions. This implies that the capital allocation efficiency is higher in coastal provinces than in inner provinces. This is consistent with the literature that firms in Central and Western regions face higher capital adjustment costs, more obstacles to factor mobility, and more financial frictions due to the lack of financial development in inland provinces (Wu, 2015; Tang, 2022).

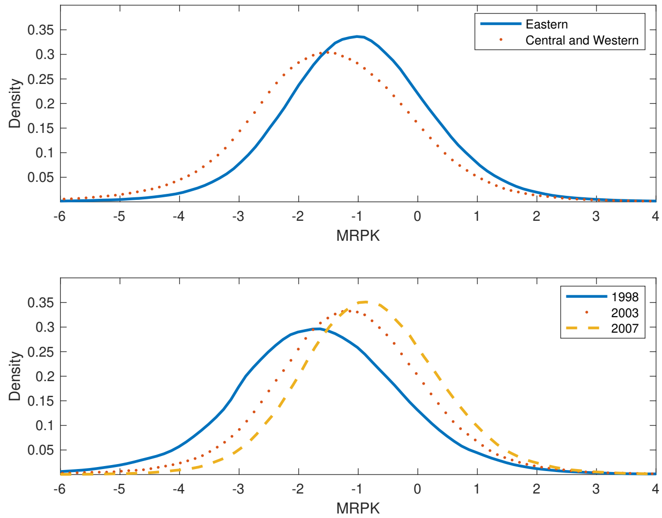
Second, there is a decreasing trend of dispersion degree in the MRPK distribution over time. Specifically, the bottom of Figure 1 illustrates the time evolution of MRPK distributions over the sample period.[22] In particular, there is a truncation from the

[20] Provincial CPI is used as an alternative price deflator as a robustness check because there is concern that China's implicit GDP deflator based on the Material Product System approach has understated inflation and thus exaggerating the real GDP figure in China.

[21] Because the statistics of this variable reported in Online Appendix Table OA.2 is in natural logarithm, the (geometric) mean is computed as $\exp(0.294) = 1.34$.

[22] To demonstrate the evolution of MRPK dispersion over time, we use the raw MRPK rather than the industry- and year-adjusted MRPK.

Figure 1: MRPK distributions: by region and by year



[1] Top figure: The distributions are based on the raw MRPK of firms in different regions. The Eastern region includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Shandong, Guangdong, Fujian, and Hainan (11 provinces); the Central region includes Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan, and Guangxi (10 provinces); and the Western region includes Sichuan, Chongqing, Guizhou, Tibet, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, and Xinjiang (10 provinces).
[2] Bottom figure: The distributions are based on the raw MRPK of firms in three different years.

lower end of the MRPK distribution as indicated by the thinner left tail of the MRPK distribution in 2007 than that in 1998 and 2003. Despite a significant amount of welfare loss due to resource misallocation discovered in the literature (Hsieh and Klenow, 2009; Brandt et al., 2013; Wu, 2015), we observe a gradual improvement of capital allocation efficiency within China over the period of 1998-2007 as indicated by a decrease in the MRPK dispersion.

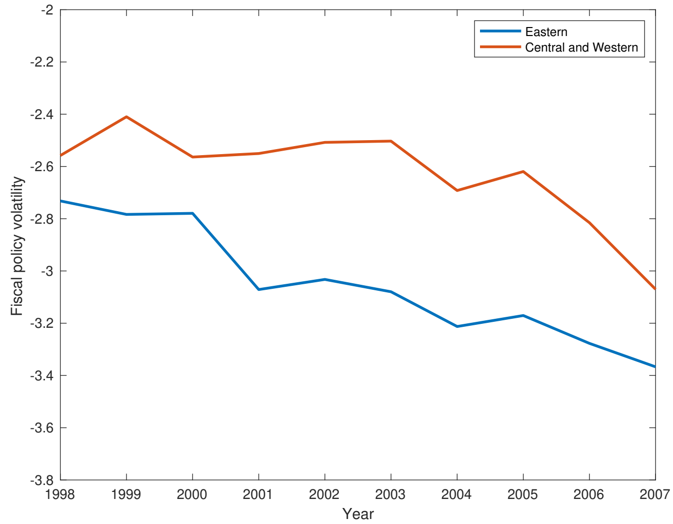
Third, the significance of fiscal policy volatility is notable. Within the sample, the average volatility measures 0.062, indicating that a one-standard-deviation change in discretionary fiscal policy leads to a 6.2 percent shift in fiscal expenditure, according to (1).[23] This magnitude aligns with findings reported by Fatás and Mihov (2003).[24] When compared with the volatility in total factor productivity growth, calculated in accordance with the approach outlined by Asker et al. (2014), the level of uncertainty stemming from fiscal policy amounts to approximately 14.5 percent of the overall uncertainty associated with total factor productivity.[25]

[23]The level of mean volatility is calculated as $0.062 = e^{-2.78}$. We take exponentiation because the volatility in the figures and tables is presented in the natural logarithm.

[24]For example, the fiscal policy volatility of Portugal and Spain are 3.9 percent and 2.6 percent, respectively, as reported by Fatás and Mihov (2003), who estimate an equation similar to (1) to compute fiscal policy volatility using data from 1960 to 2000.

[25]The calculation is based on the summary statistics reported in Online Appendix Table OA.2: exp(-2.78)/exp(-0.85)= 14.5%.

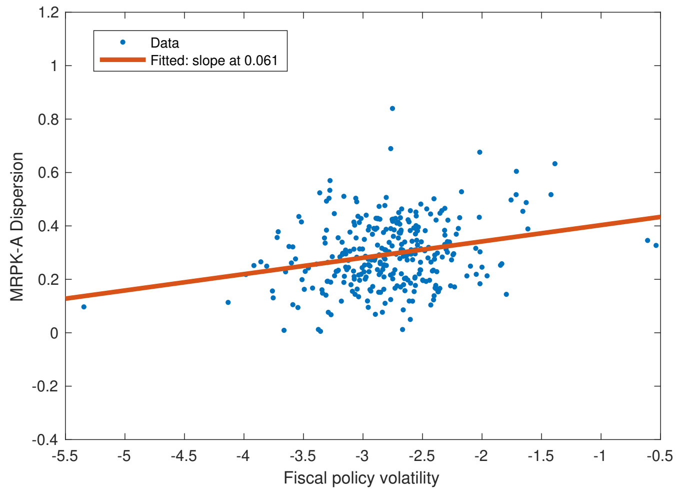
Figure 2: Fiscal policy volatility evolution, by region



Note: Fiscal policy volatility is in natural logarithm; region classification is the same as in Figure 1.

Fourth, there is a dramatic, decreasing trend of fiscal policy volatility over time. The magnitude reduced from 0.073 in 1998 to 0.042 in 2007 on average across all provinces. This reflects the positive outcome of various fiscal reforms discussed in Section 3. Nonetheless, regional disparities are sizable and persistent. We compute the fiscal policy volatility of different regions (i.e. Eastern and Central/ Western) as the mean value of fiscal policy volatility of all provinces in each region in each year and present its evolution throughout 1998-2007 in Figure 2. The Eastern (coastal) region has lower volatility than that of the Central/Western (inland) region, although both of them declined significantly over time.

Figure 3: Relationship between the MRPK dispersion and fiscal policy volatility



Note: Both fiscal policy volatility and MRPK dispersion are in natural logarithm.

Lastly, we observe a positive relationship between the MRPK dispersion and fiscal policy volatility. Figure 3 shows that the two variables are strongly and positively related (fitted slope: 0.061, significant at 1 percent level) using the province-year level measures. Furthermore, this relationship holds both in the time dimension and spacial dimension. Over the sample period, the MRPK dispersion reduced by 14.4 percent, and the volatility of fiscal policy decreased by 55.5 percent.[26] At the same time, provinces with lower fiscal policy volatility turn out to have lower dispersion of MRPK. In the formal analysis in Section 6, we control for a range of covariates and account for endogeneity to examine how fiscal policy volatility influences the capital allocation efficiency of firms. Importantly, our formal analysis includes time dummies and province dummies to control for the fixed effects so that the documented impact is not confounded by unobservable year-level or province-level forces that drive both the MRPK dispersion and fiscal policy volatility.

6 Empirical findings

6.1 Baseline results

We present the baseline results of different specifications of (7) in Table 1. We find that fiscal policy volatility has a significant effect on the MRPK dispersion in all specifications. This indicates that shocks generated from distortionary government policies (i.e., fiscal policy volatility) are one of the key drivers of resource misallocation across manufacturing firms within Chinese provinces. The marginal effect is 0.07 in column (1). This implies that a 10 percent fall in fiscal policy volatility is associated with a drop of 0.7 percent in the MRPK dispersion.

As expected, factors other than fiscal policy volatility also influence the MRPK dispersion. The coefficients of both government size and government subsidy are significantly positive in columns (2) and (3), showing that government intervention may generate distortions in the allocation of capital across manufacturing firms. The effect of financial dependence on MRPK dispersion is significantly positive in column (4), suggesting that the malfunctioning financial system in China has generated significant financial frictions which exacerbate capital misallocation. Inflation is found to have a negative impact on MRPK dispersion in column (5), indicating that an increase in inflation from a low level could improve resource allocation in China as suggested by Tobin (1972) and Akerlof et al. (1996).[27] Besides, since inflation and real interest rates are always found to move in opposite directions (Mishkin, 1993), creeping inflation from a low level may re-

[26] Both of the changes are averaged over provinces.

[27] The average inflation rate was merely 1.2 percent per year over the sample period.

Table 1: The effect of fiscal policy volatility on the MRPK dispersion

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FisVol	0.071***	0.056***	0.066***	0.069***	0.048***	0.040**	0.031**	0.023**
	(0.010)	(0.013)	(0.011)	(0.009)	(0.010)	(0.015)	(0.014)	(0.010)
GovSize		0.155***					0.049	-0.082
		(0.040)					(0.035)	(0.061)
Subsidy			0.030**				0.009	0.003
			(0.013)				(0.013)	(0.014)
FD				0.113**			0.083*	0.012
				(0.052)			(0.047)	(0.030)
Inflation					-0.012***		-0.005**	-0.004*
					(0.002)		(0.002)	(0.002)
Export						-0.103***	-0.073***	-0.012
						(0.022)	(0.018)	(0.017)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	No	No	No	Yes
R^2	0.140	0.213	0.161	0.174	0.238	0.240	0.306	0.462
Observation	310	310	310	310	310	310	310	310

Note: The dependent variable is $\log(\sigma(MRPK^A))$ at the province and year level; all independent regressors are in natural logarithm unless otherwise stated – see Online Appendix OA for detailed definitions of all variables; *** p<0.01, ** p<0.05, * p<0.1.

duce firms' borrowing costs and facilitate better allocation of capital across firms. Lastly, we find a negative effect of exports on the MRPK dispersion in column (6), suggesting the beneficial effect of trade liberalization in terms of inducing inter-firm reallocations and improving aggregate efficiency.

Finally, in columns (7) and (8), we include all control variables above in the regression. Interestingly, when year fixed effects are added in column (8), most control variables become insignificant, presumably because the year fixed effects have absorbed the influences of these control variables. Nonetheless, the impact of fiscal policy volatility remains robust. In particular, the result in column (8) suggests that, after accounting for various factors that can influence MRPK dispersion, the elasticity between MRPK dispersion and changes in fiscal policy volatility is 0.023. Considering that the fiscal policy volatility in Chinese provinces decreased by half over the ten-year sample period, we find that, on average, the implied reduction of MRPK dispersion due to fiscal policy volatility accounts for 8.9 percent of the observed improvement in capital allocation during 1998-2007.[28] This result suggests that measures to reduce fiscal policy volatility, for instance, by implementing the expenditure-side reform to mitigate the mismatch between revenue and expenditure of local governments, enhancing fiscal transparency, and

[28]The calculation is as follows. The change of fiscal policy volatility (in logarithm) during 1998-2007 is -0.556 (i.e., about half in level, exp(-0.556)=0.574). Its implied effect on the MRPK dispersion, according to the coefficient estimate of last column of Table 1, is $0.023 \times (-0.556) \times 100\% = -1.3$ percentage points. Because the overall reduction of MRPK dispersion (i.e., $\sigma(MRPK^A)$) during the period is 14.4 percentage points, the implied reduction of MRPK dispersion due to fiscal policy volatility accounts for $(-1.3)/(-14.4) = 8.9$ percent of the overall MRPK dispersion change.

alleviating regional fiscal disparities, are important to improve firms' capital allocative efficiency.

6.2 Addressing the reverse causality problem

Despite the largely exogenous nature of the fiscal volatility measure induced by macroeconomic policy, it is possible that provinces with higher levels of MRPK dispersion are more likely to use discretionary fiscal policy to support the least efficient firms. To tackle this potential endogeneity bias induced by reverse causality, we adopt the two-stage least squares (2SLS) approach and the System GMM estimation method.

Three sets of instrumental variables are used in the 2SLS approach. Several diagnostic tests are conducted to verify the quality of the three sets of instruments. Specifically, as the first check, we adopt the traditional approach of using the lagged value of fiscal policy volatility ($L.FisVol_{p,t}$) as an instrumental variable. We lag this variable by three years to avoid the potential reverse causality.[29]

Second, we introduce a novel instrumental variable derived from the historical and cultural distinctions between China's wheat and rice regions. This instrumental variable is defined as the natural logarithm of the ratio between wheat output and rice output in province p in year t ($WheatRice_{p,t}$). China's wheat-growing north and rice-growing south have been geographically separated by the Yangtze River for thousands of years. According to Talhelm et al. (2014), a history of rice farming fosters a more interdependent culture, as the cultivation of rice necessitates significant water resources, requiring intensive cooperation during planting and harvesting. Rice farmers must collaborate to develop and maintain the necessary infrastructure, fostering an interdependent culture in the southern region. In contrast, wheat farming fosters a more independent culture, as wheat can be grown on dry land without requiring irrigation or extensive cooperation. Consequently, individualism is more prevalent in northern Chinese culture, as wheat farmers rely on themselves and rain for moisture. These cultural legacies, shaped by generations of farming practices, result in distinct psychological cultures in northern and southern China, which influence the behavior of individuals in modern society. For example, the economic incentives to cooperate embedded in rice culture may motivate interdependent individuals to monitor government behavior, thereby restraining potential discretionary use of fiscal policy and reducing associated volatility in the rice region. Conversely, monitoring and control mechanisms are less prevalent in the wheat region,

[29] In summary statistics, the sample of this instrument ($L.FisVol$) is 279 (31 provinces*9 years) because our sample is from 1994, so the earliest volatility measure we can get is for 1996 given the 5-year moving window method. Then the 1996 value is used to instrument the value of 1999 and so on. Thus we have the missing year of 1998 where no instrument is available.

where individualism dominates, leading to higher fiscal volatility. Indeed, we find a robust positive correlation between the wheat-rice ratio and fiscal policy volatility across the 31 provinces.[30] Importantly, the historical division between wheat and rice regions is unlikely to be influenced by the current dispersion of MRPK, making the wheat-rice ratio a suitable instrumental variable for our analysis.

Third, we use the initial income inequality of each province as another instrumental variable ($Gini_p$). This variable is defined as the overall Gini coefficient of province p in the year 1995. Following Thomas et al. (2001) and Sundrum (2003), we compute the overall Gini index as a weighted average of the Gini indices of population subgroups (i.e. rural people and urban people) and a covariance term between rural and urban people in each province.[31] According to Woo (2011), struggles over income distribution in highly unequal societies can lead to discretionary spending decisions and more volatile fiscal outcomes. Thus, the provinces with high initial income inequality may suffer greater fiscal policy volatility, whereas the *initial* income inequality (in 1995) is unlikely to be affected by the current MRPK dispersion.[32] As expected, we find a significant and positive relationship between initial income inequality and fiscal policy volatility.[33]

In addition to the IV approach, we adopt the System GMM estimator (Blundell and Bond, 1998) to estimate (7). In addition to the external instruments described above, the level of fiscal policy volatility lagged three times is used as an IV in the first-differenced equations and the first-differenced fiscal policy volatility lagged twice is used as an additional IV in the level equations. The Hansen J test of over-identifying restrictions is adopted to evaluate the overall validity of the set of instruments. In assessing whether our models are correctly specified and consistent, we also check for the presence of second-order autocorrelation in the differenced residuals in all estimations.

Table 2 reports the results. The first-stage IV results show that all three sets of instruments have a significantly positive effect on fiscal policy volatility. The second-stage results confirm the exogenous role of fiscal policy volatility in raising the MRPK dispersion within provinces. To verify the quality of the instruments, we first use the under-identification test based on the Kleibergen-Paap rk LM statistics to check whether

[30] We present the cross-sectional relationship between the wheat-rice ratio and fiscal policy volatility (in 2003) in Online Appendix Figure OB.3.

[31] The income and population data are from the 1996 Provincial Statistical Yearbook published by National Bureau of Statistics of China. Due to the missing data of four provinces (Tibet, Shandong, Hainan, and Jilin), we compute the Gini coefficient for 27 provinces.

[32] Higher inequality may also imply that starting entrepreneurs face more significant financial constraints, which results in a higher degree of capital misallocation (e.g., Midrigan and Xu, 2014). Nonetheless, our sample data only include established firms with annual sales of five million yuan (about \$817,000) and State-Owned Enterprises, and we use the *initial* Gini index (in 1995) in the analysis. Thus, our result is unlikely to be driven by capital misallocation directly resulting from higher inequality.

[33] We show the relationship between initial income inequality and fiscal policy volatility (in 2003) in Online Appendix Figure OB.4.

Table 2: Addressing the reverse causality problem

	Two-stage least square regression			System GMM estimator	
	(1)	(2)	(3)	(4)	(5)
FisVol	0.070***	0.240*	0.157***	0.120***	0.089***
	(0.019)	(0.125)	(0.019)	(0.033)	(0.025)
Control variables	Yes	Yes	Yes	No	Yes
Under-identification test	25.904***	3.228*	25.938***	—	—
Weak-identification test	32.62***	3.56*	35.108***	—	—
AR(2) test	—	—	—	-0.96	-1.42
Hansen J test	—	—	—	27.58	29.16
Observations	279	310	240	310	310
First stage					
L.FisVol	0.526***				
	(0.092)				
WheatRice		0.098*			
		(0.052)			
Gini			3.272***		
			(0.584)		

Note: The dependent variable is $\log(\sigma(MRPK^A))$ at the province and year level; the control variables include: government size, subsidy, financial dependence, inflation, and export; all independent regressors are in natural logarithm unless otherwise stated – see Online Appendix OA for all variable definitions; the under-identification test is based on the Kleibergen-Paap rk LM statistic, with a null hypothesis that the model is under-identified; the weak-identification test is based on the Cragg-Donald Wald F statistic, with a null hypothesis that the first stage regression is weakly identified; AR(2) test is to check for the presence of second-order autocorrelation in the differenced residuals; the Hansen J test of over-identifying restrictions is to evaluate the overall validity of the set of instruments. *** p<0.01, ** p<0.05, * p<0.1.

the excluded instruments are correlated with the endogenous regressors. As shown in Table 2, the null hypothesis that the model is under-identified is rejected at the 1 percent significance level in columns (1) and (3) and at the 10 percent significance level in columns (2). Second, the weak-identification test based on the Cragg-Donald Wald F statistics provides strong evidence for rejecting the null hypothesis that the first stage regression is weakly identified at the 1 percent significance level in columns (1) and (3) and at the 10 percent significance level in columns (2). In addition, the System GMM results in columns (4) and (5) also confirm that the positive impact of fiscal policy volatility on the MRPK dispersion is not driven by reverse causality.[34]

6.3 Further robustness checks

In the baseline model, we have already controlled for a set of factors (related to policy distortions, frictions or market imperfections, and trade openness) that affect the MRPK dispersion in addition to fiscal policy volatility. In this subsection, we further conduct

[34] There is no evidence of second-order serial correlation in the first-differenced residuals, and the Hansen test does not reject the validity of the instruments.

a number of robustness checks to secure our results from potential identification bias originating from omitted variable and mismeasurement problems.

6.3.1 Omitted variable problems

Essentially, fiscal policy volatility represents a sort of uncertainty about conditions affecting firms' future profitability. A natural concern could be that the volatility of fiscal policy may be confounded with other sorts of uncertainty that also affect firms' future profitability. To address this concern, we consider a set of different uncertainty measures such as output volatility, volatility of total factor productivity growth, and institutional and political volatility in the regression model. The results are presented in Table 3. Overall, the results suggest that the documented relationship is not driven by other sorts of uncertainty or omitted variables.

Table 3: Robustness check: the omitted variable problem (type 2 endogeneity)

	(1)	(2)	(3)	(4)	(5)	(6)
FisVol	0.023**	0.012***	0.023**	0.023**	0.023**	0.023**
	(0.009)	(0.002)	(0.011)	(0.010)	(0.010)	(0.010)
GDPVol	0.001					
	(0.009)					
TFPGVol		0.030**				
		(0.013)				
SOE			-0.018			
			(0.016)			
FOR			-0.025***			
			(0.005)			
PolVol1				0.001		0.001
				(0.002)		(0.002)
PolVol2					0.002	0.002
					(0.002)	(0.002)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.462	0.465	0.483	0.463	0.464	0.465
Observations	310	279	307	310	310	310

Note: The dependent variable is $\log(\sigma(MRPK^A))$ at the province and year level; the control variables include: government size, subsidy, financial dependence, inflation, and export; all independent regressors are in natural logarithm unless otherwise stated – see Online Appendix OA for all variable definitions. *** p<0.01, ** p<0.05, * p<0.1.

First, according to Fatás and Mihov (2013), any misspecification of first-stage regression computing fiscal policy volatility in (1) may make a component of output fluctuations enter the residuals. Thus, there is concern that the positive relationship between fiscal policy volatility and the MRPK dispersion might be driven by the effect of output volatility on the MRPK dispersion. In column (1) of Table 3, we include the output volatility ($GDPVol_{p,t}$) as a control variable, which is defined as the natural logarithm of the volatility of the cyclical component of provincial GDP in year t using the filter of Hodrick and Prescott (1997).[35] The positive effect of fiscal policy volatility on capital misallocation remains intact when output volatility is included, suggesting that fiscal policy volatility is not simply a proxy for output volatility.

Second, Asker et al. (2014) find that in the presence of capital adjustment costs, higher productivity volatility (i.e. revenue-based total factor productivity shock) leads to higher cross-sectional MRPK dispersion. We therefore include the volatility of total factor productivity growth ($TFPGVol_{p,t}$) as a control variable in column (2) of Table 3, which is defined as the natural logarithm of volatility of TFP growth of all manufacturing firms in province p in year t.[36] This variable represents the overall volatility of firm profitability in addition to the fiscal policy volatility. We find that the volatility of TFP growth indeed has a significant and positive impact on MRPK dispersion, and more importantly, the effect of fiscal policy volatility on MRPK dispersion remains robust. Notably, by comparing the estimated coefficients in this column, the elasticity of MRPK dispersion in relation to fiscal policy volatility is approximately 40% (=0.012/0.030) of that observed in relation to total factor productivity volatility, which is computed using the approach outlined by Asker et al. (2014). This suggests that the impact of uncertainty from fiscal policy is comparable to the impact of the overall uncertainty from total factor productivity.

Third, policy distortions originating from institutions can lead to resource misallocation. Using the same dataset as ours, Hsieh and Klenow (2009) claim that SOEs account for 39% of China's TFPR dispersion. We thus include two ownership variables, $SOE_{p,t}$ and $FOR_{p,t}$, defined as the natural logarithm of SOE and foreign-owned shares of total value added in manufacturing industries in province p in the year t, respectively. The result is presented in column (3) of Table 3. Foreign ownership has a significantly negative effect on the MRPK dispersion, whereas the impact of state ownership is positive (although insignificant). Presumably, this is because private firms face fewer policy distortions and are less reliant on government expenditure. Importantly, the impact of fiscal policy volatility is not affected by the inclusion of such ownership variables.

Finally, political uncertainty is argued to affect the capital allocation and economic

[35]The Hodrick and Prescott (1997) filter is a detrending method aiming at obtaining a smooth component from the trend, which is commonly used in the business cycle literature. In our case, the provincial real GDP is decomposed into a trend component and a cyclical component (denoted as $c_{p,t}$). Using the 5-year rolling window method, the output volatility in province p in year t ($GDPVol_{p,t}$) is the volatility of the cyclical component of GDP, i.e. the standard deviation over $c_{p,t-2}, c_{p,t-1}, c_{p,t}, c_{p,t+1}, c_{p,t+2}$.

[36]We first compute the TFP of each firm by estimating industrial production functions using the Olley and Pakes (1996) approach, then the TFP growth is the log difference of TFP of firm i in province p in the year t, i.e. $TFPG_{i,p,t}$. The volatility of TFP growth is the standard deviation of $TFPG_{i,p,t}$.

performance in China. Li and Zhou (2005) find that the probability of promotion (termination) of provincial leaders increases (decreases) with their economic performance. An et al. (2016) claim that political turnover leads to lower corporate investment and higher volatility of the corporate investment. Based on the tenure information of provincial leaders, we construct two political uncertainty measures. $PolVol1_{p,t}$ is the length of service of the governor of province p in year t and $PolVol2_{p,t}$ is the length of service of the party secretary of province p in year t. In columns (4)-(6) of Table 3, political uncertainty does not have a significant impact on MRPK dispersion, whereas our result the relationship between fiscal policy volatility and MRPK dispersion remains robust.

6.3.2 Mismeasurement problems

We conduct various robustness checks on the potential mismeasurement problems of our two key variables: fiscal policy volatility and the MRPK dispersion. Table 4 reports the effect of fiscal policy volatility on MRPK dispersion when alternative methods are used to construct the fiscal policy volatility measure. The detailed description is explained in Section 4.1 as well as in the footnote below the result table.

Table 4: Robustness check: the mismeasurement problem of fiscal policy volatility

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FisVol	0.020*	0.020*	0.021***	0.017**	0.025***	0.023**	0.016*	0.025**
	(0.011)	(0.011)	(0.008)	(0.008)	(0.008)	(0.009)	(0.007)	(0.011)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.431	0.432	0.435	0.432	0.441	0.436	0.518	0.532
Observations	310	310	310	310	310	310	124	93

Note: The dependent variable is $\log(\sigma(MRPK^A))$ at the province and year level; the control variables include: government size, subsidy, financial dependence, inflation, and export; all independent regressors are in natural logarithm unless otherwise stated – see Online Appendix OA for variable definitions. The independent variables are the same across different specifications; the difference is how they are computed. Specifically, column (1) includes CPI as a control variable in (1); column (2) includes both CPI and time trend as control variables in (1); column (3) includes CPI, time trend and a further lagged dependent variable ($\Delta \log G_{p,t-2}$) in (1); column (4) adopts the IV method, where lagged provincial GDP growth ($\Delta \log Y_{p,t-1}$) is used to instrument current GDP growth; column (5) uses the non-parametric regression method, locally weighted average estimator, to compute fiscal policy volatility; column (6) uses another non-parametric regression method, local constant estimator, to compute fiscal policy volatility; column (7) adopts the 3-year non-overlapping time interval approach to compute the fiscal policy volatility; column (8) adopts the 4-year non-overlapping time interval approach to compute the fiscal policy volatility. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

In Table 5, we also examine the result using the raw (un-adjusted) MRPK (i.e., from (5) as opposed to the counterpart of the residual of (6) which is used in the baseline result) to compute the MRPK dispersion. In this check, we adopt four alternative approaches to estimate the firm-level revenue production function and compute the output elasticity of capital as a component of (5), including the Levinsohn and Petrin (2003) approach, the Wooldridge (2009) approach, the system GMM estimator, and the Ackerberg et al. (2015) approach.

Table 5: Robustness check: the mismeasurement problem of MRPK dispersion

	Levinsohn and Petrin	Wooldridge	System GMM	Ackerberg et al.
	(1)	(2)	(3)	(4)
FisVol	0.023**	0.023**	0.025**	0.022*
	(0.010)	(0.010)	(0.010)	(0.013)
Control variables	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
R^2	0.462	0.462	0.479	0.404
Obs	310	310	310	310

Note: The dependent variable is $\log(\sigma(MRPK))$, which is the MRPK dispersion in logarithm computed from raw (un-adjusted) MRPK in defined (5) as opposed to the adjusted counterpart in (6), at the province and year level; the control variables include: government size, subsidy, financial dependence, inflation, and export; all independent regressors are in natural logarithm unless otherwise stated – see Online Appendix OA for variable definitions. The dependent and independent variables are the same across different specifications; the difference is how the dependent variable are computed. Specifically, we adopt four alternative approaches to estimate the firm-level revenue production function and compute the output elasticity of capital as a component of (5), including the Levinsohn and Petrin (2003) approach, the Wooldridge (2009) approach, the system GMM estimator, and the Ackerberg et al. (2015) approach. *** p<0.01, ** p<0.05, * p<0.1.

Overall, we find that the impact of fiscal policy volatility on the static measure of capital misallocation remains robust despite the use of alternative measures of fiscal policy volatility and the dispersion of MRPK.

7 Mechanisms making fiscal policy volatility matter

After establishing the relationship between fiscal policy volatility and capital misallocation, a natural question is what makes fiscal policy volatility matter. Answering this question is meaningful in providing government policymakers with alternative policy tools to reduce the impact on the allocative efficiency of capital even when the volatility of fiscal policy could not be lowered. For this purpose, we analyze how types of government expenditure, capital adjustment costs, and government dependence shape the relationship between fiscal policy volatility and the dispersion of marginal revenue product of capital.

Table 6: Role of volatility: budgetary versus extrabudgetarty expenditure

	(1)	(2)	(3)	(4)	(5)	(6)
FisVolB	0.048***	0.034***			0.048***	0.033**
	(0.007)	(0.012)			(0.008)	(0.012)
FisVolEB			0.003	0.024	-0.003	0.014
			(0.016)	(0.016)	(0.018)	(0.018)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes
R^2	0.347	0.481	0.285	0.457	0.347	0.484
Observations	310	310	310	310	310	310

Note: The dependent variable is $\log(\sigma(MRPK^A))$ at the province and year level; the control variables include: government size, subsidy, financial dependence, inflation, and export; all independent regressors are in natural logarithm unless otherwise stated – see Online Appendix OA for all variable definitions. *** p<0.01, ** p<0.05, * p<0.1.

7.1 Budgetary versus extrabudgetary expenditure

We start by investigating how the relationship is driven by the nature of fiscal policy. To this end, we distinguish two types of (provincial) government expenditure: budgetary expenditure and extrabudgetary expenditure.[37] The government's investment in infrastructure is mainly included in budgetary expenditure, while extrabudgetary expenditure covers city maintenance and administrative costs. The former expenditure is more relevant in determining manufacturing firms' profitability and thus its volatility is more important in influencing capital allocation in the manufacturing sector.

In the data, there is a declining trend of extrabudgetary expenditure as a result of fiscal reforms aiming at increasing fiscal transparency. Using the method of variance decomposition, we decompose the overall fiscal policy volatility into different components: volatility due to budgetary expenditure ($FisVolB$), volatility due to extrabudgetary expenditure ($FisVolEB$), and a covariance term between budgetary and extrabudgetary expenditure ($FisVolCov$). Noticeably, both budgetary and extrabudgetary expenditures are volatile in Chinese provinces. They contribute about 60% and 52% to the overall fiscal policy volatility, respectively. The contribution of the covariance term is -12%, indicating the overall substitution between the two types of government expenditure.[38]

Interestingly, despite sizable volatility in both types of expenditure, fiscal policy volatility resulting from budgetary expenditure is the main driver of the documented

[37]Budgetary expenditure is proposed by the administrative branch of the government and approved by the National People's Congress. Extrabudgetary expenditure is directly controlled by local governments, government agencies, and government institutions, which does not need to be approved by the higher level of government. Despite the difference, the existence of both is anticipated by firms.

[38]We present these patterns in Appendix Table A1.

capital misallocation. In contrast, the volatility from the extra-budgetary expenditure turns out to have an insignificant impact. The results are reported in Table 6. The results are consistent with the nature of the two different types of government expenditure. Budgetary expenditure involves infrastructure development and fixed asset investment and has a direct impact on the market conditions faced by manufacturing firms. As a result, its volatility is more prominent on the MRPK dispersion than the impact of extrabudgetary expenditure, which is mainly used for maintenance, administrative, and operative services. This exercise can serve as a placebo test showing that the documented impact on the MRPK dispersion is indeed driven by fiscal policy volatility that directly affects firms' profitability rather than other factors that are confounded with fiscal policy. This novel finding also generates important policy implications: the elimination of extra-budgetary government expenditure alone may not be sufficient to curb the fiscal policy volatility, as the latter arises from the budgetary government expenditure. Our results call for further policy reforms to reduce the discretionary use of budgetary funds.

7.2 Capital adjustment costs and government dependence

In theory, firms face adjustment costs that are inherent in changing the amount of input used, and their response to shocks is not instantaneous. Specifically, regarding capital adjustment costs, altering the level of capital services, whether it is the capital stock or its rate of utilization, incurs net adjustment costs as it disrupts the routine of an unchanged workforce, leading to reassignment and restructuring of tasks (Hamermesh and Pfann, 1996). For instance, gross costs arise when the delivery of new equipment takes time, constraining production as the new equipment may divert other inputs away from production. Dixit and Pindyck (1994) highlight that uncertainty about future shocks makes firms hesitant to invest in new capital, resulting in substantial adjustment costs associated with changing the stock due to the irreversibility of many investment projects. Furthermore, Hamermesh and Pfann (1996) suggest that adjustment costs can arise from direct or indirect effects of government policies.

The existing literature emphasizes the role of capital adjustment costs in shaping the relationship between the profitability volatility and MRPK dispersion – without adjustment costs, the volatility would not affect the MRPK dispersion (Asker et al., 2014). We explore the role of capital adjustment costs by examining the differential impacts of fiscal policy volatility across regions and their association with capital adjustment costs. Table 7 reports the results. Columns (1) and (2) distinguish the effects between Eastern (coastal) and Central/Western (inland) provinces. We find that fiscal policy volatility significantly affects MRPK dispersion only in Central and Western provinces, where high capital adjustment costs are argued to exist. Firms in these inland regions face more investment frictions, such as severe capital market imperfections and obstacles to factor mobility resulting from the lack of transport infrastructure, which may hinder their instantaneous and costless adjustment of capital stock to the optimal level (Wu, 2015).

Table 7: Capital adjustment costs and government dependence (province level evidence)

	Capital adjustment costs		Government dependence			
	(1)	(2)	(3)	(4)	(5)	(6)
	East	Centre/West	Low Gov Size	High Gov Size	Low SOE	High SOE
FisVol	0.007	0.027**	0.008	0.035*	0.014	0.033*
	(0.015)	(0.012)	(0.009)	(0.017)	(0.010)	(0.019)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.617	0.425	0.709	0.378	0.633	0.416
Observations	130	180	150	160	160	150

Note: The dependent variable is $\log(\sigma(MRPK^A))$ at the province and year level; the control variables include: government size, subsidy, financial dependence, inflation, and export; all independent regressors are in natural logarithm unless otherwise stated – see Online Appendix OA for all variable definitions. *** p<0.01, ** p<0.05, * p<0.1.

Nonetheless, even in the presence of capital adjustment costs, the impact of the fiscal policy volatility would be likely muted if firms' performance is less dependent on government expenditure and intervention. To examine this mechanism, we use government size and the presence of SOE to approximate how firms' performance depends on government expenditure and intervention. In columns (3)-(5) of Table 7, we find that the positive link between fiscal policy volatility and MRPK dispersion is only significant for provinces with a high level of government size or high share of SOE in economic output.[39] This province-level evidence suggests that the dependence on government purchase, intervention, and state ownership, presumably due to their easier access to external finance and subsidies (e.g, Hsieh and Klenow, 2009; Bai et al., 2018), is an important channel through which fiscal policy volatility affects capital misallocation.

To put the above mechanisms into work, we utilize the different levels of capital adjustment costs and government dependence across industries to explore the heterogeneous relationship between fiscal policy volatility and the MRPK dispersion among different industries. Among all 29 2-digit manufacturing industries, the impact of fiscal policy volatility is significant for 18 industries but insignificant for the other 11 indus-

[39] We define *High GovSize* or *low GovSize* as a dummy variable that is equal to one if the average government size (*GovSize*) of province p is higher or lower than the median value of *GovSize*, and zero otherwise. Similarly, we define *High SOE* or *low SOE* as a dummy variable that is equal to one if the average SOE share of total value added (*SOE*) of province p is higher or lower than the median value of *SOE*.

tries.[40] The impact is positive in most industries (27 out of 29), ranging from 0.004 to 0.131. This industry-level result shows that the documented relationship in Section 6 is not driven by the different provincial compositions of industries. More importantly, these widespread heterogeneous responses to fiscal policy shock are associated with the characteristics of capital adjustment costs and government dependence at the industry level. We explore the mechanisms at the industrial level in detail as follows.

First, we use a proxy of sunk costs of investment as a measure of industry-specific capital adjustment costs. Specifically, we adopt the capital resalability index ($CapRes$) used in Balasubramanian and Sivadasan (2009). This measure is defined as the share of used capital investment in total capital investment in each 4-digit US industry.[41] We convert the US SIC industry codes to the Chinese industry code when merging them into the Chinese data set. This measure captures the recoverability of investments, which is an inverse proxy for the extent of the sunkenness of capital investments. We hypothesize that industries with higher sunkenness of capital investment are subject to higher capital adjustment costs as the more capital is invested, the longer and more costly it takes to change the amount of the input used. For the robustness purpose, three indices are used: $CapRes1$ refers to the capital resalability index in 1987, $CapRes2$ refers to the capital resalability index in 1992, and $CapRes3$ is the mean average of the capital resalability index in 1987 and 1992. In columns (1)-(3) of Table 8, the coefficients of interaction terms between fiscal policy volatility and all three capital resalability indices are negative and significant. This implies that the MRPK dispersion of industrial sectors with higher sunkenness of capital investment and capital adjustment costs, indicated by lower capital resalability, is more likely to be affected by fiscal policy volatility. This result further suggests that it is not the differential capital adjustment costs alone that drive the documented impact in the baseline regression in Section 6, because otherwise the coefficients of the interaction terms would be insignificant.

As a further check in this vein, we measure how industries rely on external finance as an alternative approximation of how capital adjustment costs vary at the industry level. The view that the costs of external finance generate additional adjustment costs on the stock of capital is widely accepted in the corporate finance literature (Chirinko, 1993; Casalin and Dia, 2014). Compared with internal funds, external funds are much more expensive and are less irreversible once invested to install capital. As a result, industries that are heavily dependent on external finance may face higher capital adjustment costs than those that rely more on internal finance. For this purpose, we adopt Rajan and Zingales (1998)'s measure of industry's dependence on external finance – as Industrial

[40] For this industry-level analysis, we compute the MRPK dispersion among firms in each of 29 industries in each province. The results are reported in Appendix Table A2.

[41] The used capital expenditure data is from the US Bureau of the Census.

Table 8: Capital adjustment costs and government dependence (industry level evidence)

	Capital adjustment costs				Government dependence		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
*FisVol*CapRes*	-0.038***	-0.102***	-0.071***				
	(0.011)	(0.018)	(0.017)				
*FisVol*IFD*				0.002***			
				(0.000)			
*FisVol*GovDem*					0.162***	0.071***	0.066***
					(0.03)	(0.006)	(0.005)
Industry×Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province×Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.039	0.04	0.04	0.04	0.038	0.04	0.04
Observations	74,738	63,142	58,092	57,148	75,174	75,174	75,174

Note: The dependent variable is $\sigma(MRPK^A)$ for each 4-digit industry at the province and year level; only interaction terms are reported because individual terms are absorbed by the industry-year level or province-year level fixed effects; columns (2)-(4) report the results of $CapRes1$, $CapRes2$, and $CapRes3$, respectively; columns (5)-(7) report the results of $GovDem1$, $GovDem2$, and $GovDem3$, respectively; see Online Appendix OA for all variable definition. *** p<0.01, ** p<0.05, * p<0.1.

Financial Dependence (IFD). This measure is constructed as the sum of firms' use of external finance divided by the sum of capital expenditure over the 1980s for 425 4-digit US manufacturing industries. We convert the US SIC industry codes to the corresponding Chinese industry codes and merge them into the Chinese data set. We use the Difference-in-Difference (DID) method and include for both industry-year effects and province-year effects to control for capital misallocation caused directly by external finance reliance.[42] We find that the coefficient of the interaction term between the industry-level dependence on external finance and fiscal policy volatility is significantly positive in column (4) of Table 8. This suggests that the capital allocation efficiency of industrial sectors that are relatively more dependent on external finance suffer more from capital adjustment costs and consequently are more likely to be adversely influenced by fiscal policy volatility.

Second, to approximate industry-specific reliance on government expenditure, we compute the degree of dependence on governance demand ($GovDem$) for every 2-digit industrial sector in China using the 2005 World Bank Investment Climate database of more than 12,000 Chinese manufacturing firms. For the sake of robustness, three measures are used, i.e. $GovDem1$ is the share of government purchase in total sales at each 2-digit industry in 2004; $GovDem2$ is the share of SOE purchase in total sales at each 2-digit industry in 2004; and $GovDem3$ is the share of both government and SOE purchase in total sales at each 2-digit industry in 2004.[43] In columns (5)-(7) of Table 8, we find a

[42] For example, firms relying more on external finance suffer more from the collateral constraint and may have a higher level capital misallocation (e.g., Moll, 2014).

[43] The original questions in the 2005 World Bank survey are "Regarding your products sold in 2004: what percent of your products are sold to the government and what percent of your products are sold to the SOEs?".

significant and positive interaction term between fiscal policy volatility and government demand. This suggests that industries that are more reliant on government and SOE purchases are more likely to be influenced by fiscal policy volatility.

Overall, these results suggest that policies contributing to lower capital adjustment costs and lower reliance of firms on government expenditure can alleviate the capital misallocation caused by fiscal policy volatility.

8 Conclusion

Firms face considerable uncertainty about future conditions affecting their costs, demand, and profitability, which affects their decisions on capital allocation and investment in the presence of capital adjustment costs. We focus on the uncertainty arising from a particular form of policy shock, i.e. the excessive discretionary changes in fiscal policy that do not represent a reaction to economic conditions. We explore whether and how the dispersion of marginal revenue product of capital is influenced by fiscal policy volatility, after controlling for a wide set of driving forces of capital misallocation. Estimating the magnitude of the influence is crucial to understanding the extent to which capital efficiency can be improved by designing less volatile fiscal policy and how the influence is mediated by industrial features.

Using several disaggregate data sources, we document that the aggressiveness of the use of fiscal discretionary policy leads to capital misallocation (as proxied by the dispersion of industry- and year-adjusted MRPK) in manufacturing firms in China. The identification of the effect comes from the variation of fiscal transparency and fiscal disparities across regions and over time. After accounting for various factors that can influence MRPK dispersion, we document an elasticity of 0.023 between MRPK dispersion and changes in fiscal policy volatility. This result is robust to a wide range of robustness tests. Considering the overall decrease in fiscal policy volatility in China during the period 1998-2007, our estimate indicates that this decrease contributed to 8.9 percent of the observed improvement in capital dispersion during this period.

Our results have important policy implications. More expenditure-side fiscal reforms aiming at a better match between revenue and expenditure of local governments, measures to improve fiscal transparency, and policies to reduce regional fiscal disparities are crucial for curbing fiscal policy discretion and volatility, which are conducive to the overall enhancement of capital allocative efficiency among manufacturing firms. When the reduction of fiscal policy volatility is difficult to achieve, policies leading to lower capital adjustment costs and lower reliance of firms on government expenditure are important to alleviate the capital misallocation caused by fiscal policy volatility. Our paper has wider global policy implications in respect that the Covid-19 pandemic has caused a significant deterioration in public finances and fiscal resources, especially in many developing countries.

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Appendices

A Appendix Tables

Table A1: Variance decomposition of government expenditure (percentage)

province	BudgetExp share(1998)	BudgetExp share (2007)	BudgetExp share change	FisVolB share	FisVolEB share	FisVolCov share
	(1)	(2)	(3)	(4)	(5)	(6)
Beijing	71.63	92.87	-21.24	45.33	24.48	30.19
Tianjin	80.02	92.01	-11.99	26.65	119.35	-46.01
Hebei	75.53	87.86	-12.33	33.8	58.48	7.72
Shanxi	68.95	88.85	-19.9	65.5	19.13	15.38
Inner Mongolia	87.09	92.9	-5.81	90.2	94.64	-84.85
Liaoning	78.63	88.59	-9.96	15.15	128.81	-43.96
Jilin	80.07	91.63	-11.56	43.91	84.78	-28.69
Heilongjiang	79.39	90.16	-10.77	92.47	77.27	-69.74
Shanghai	79.48	90.11	-10.63	50.54	74.62	-25.17
Jiangsu	61.81	79.92	-18.11	8.91	80.06	11.02
Zhejiang	58.88	74.93	-16.05	51.27	41.58	7.15
Anhui	71.85	91.3	-19.45	59.6	41.51	-1.11
Fujian	65.14	80.04	-14.9	7.74	111.96	-19.7
Jiangxi	71.15	85.86	-14.71	56.53	24.26	19.21
Shandong	68.54	85.82	-17.28	65.04	95.73	-60.77
Henan	69.68	87.48	-17.8	52.17	39.26	8.58
Hubei	75.5	87.51	-12.01	87.06	27.78	-14.83
Hunan	64.83	85.9	-21.07	56.6	43.13	0.26
Guangdong	82.08	83.92	-1.84	110.42	58.1	-68.52
Guangxi	68.14	84.14	-16	88.34	18.77	-7.11
Hainan	78.03	94.19	-16.16	68.6	66.36	-34.96
Sichuan	42.81	77.42	-34.61	11.75	103.38	-15.14
Chongqing	67.87	88.92	-21.05	67.54	21.29	11.17
Guizhou	79.8	91.59	-11.79	89.51	18.13	-7.64
Yunnan	84.39	94.17	-9.78	42.76	26.98	30.26
Tibet	97.88	99.08	-1.2	97.06	1.58	1.36
Shaanxi	79.62	86.14	-6.52	46.18	45.87	7.96
Gansu	82.06	90.21	-8.15	46.62	27.16	26.22
Qinghai	91.11	96.19	-5.08	92.33	19.77	-12.1
Ningxia	85.94	90.83	-4.89	106.59	17.53	-24.11
Xinjiang	77.92	91.72	-13.8	85.35	5.77	8.88
Average	75.03	88.46	-13.43	60.05	52.18	-12.23

Note: Column (1) is the share of budgetary expenditure in total government expenditure in 1998; column (2) is the share of budgetary expenditure in total government expenditure in 2007; column (3) is the change of budgetary expenditure share between 2007 and 1998, i.e. column (1)-column (2); column (4) is the share of budgetary expenditure volatility in total fiscal policy volatility; column (5) is the share of extrabudgetary expenditure volatility in total fiscal policy volatility; column (6) is the share of covariance between budgetary and extrabudgetary expenditure volatility in total fiscal policy volatility.

Table A2: Industry heterogeneity effects

Industry code	Industry name	FisVol	S.E.	Observations
All	All manufacturing sectors	0.059***	0.008	8578
13	Food processing industry	0.115***	0.022	310
14	Food manufacturing industry	0.126***	0.026	310
15	Beverage manufacturing industry	0.091***	0.025	310
16	Tobacco processing industry	0.037	0.064	260
17	Textile industry	0.074***	0.018	306
18	Clothing and other fiber products manufacturing	0.034	0.048	304
19	Leather, fur, down and down products industry	0.079*	0.041	285
20	Timber processing, bamboo, cane, calm fiber and straw products industry	0.131***	0.03	288
21	Furniture manufacturing industry	0.098*	0.05	298
22	Papermaking and paper products industry	0.004	0.036	299
23	Printing and record medium reproduction industry	0.043	0.027	310
24	Educational and sports goods industry	0.105	0.067	240
25	Petroleum processing and coking industry	0.058*	0.034	289
26	Chemical materials and chemical products manufacturing industry	0.057***	0.019	310
27	Pharmaceutical manufacturing industry	0.018	0.018	310
28	Chemical fibers manufacturing industry	0.068	0.076	260
29	Rubber product industry	0.035	0.054	289
30	Plastic products industry	0.034	0.035	305
31	Non-metallic mineral products industry	0.058***	0.017	310
32	Ferrous metal smelting and rolling processing industry	0.062***	0.022	300
33	Non-ferrous metal smelting and rolling processing industry	-0.042	0.026	300
34	Fabricated Metal Products industry	0.118***	0.025	306
35	General machinery manufacturing industry	0.045*	0.026	302
36	Special equipment manufacturing industry	0.051	0.046	307
37	Transportation equipment manufacturing industry	0.097***	0.018	310
39	Electrical machinery and equipment manufacturing	0.037*	0.019	300
40	Communication equipment, computer and other electronic equipment manufacturing industry	0.067**	0.027	283
41	Instrumental, cultural, and office machinery manufacturing industry	0.071***	-0.026	279
42	Artwork and other manufacturing industry	-0.042	0.039	298

Note: The dependent variable is $\sigma(MRPK^A)$ for each 2-digit industry in province p at year t; *** p<0.01, ** p<0.05, * p<0.1.

Online Appendix

OA Variable definitions and summary statistics

Table OA.1: Definitions of all variables

Variable	Definition
$\sigma(MRPK^A)$:	industry- and year-adjusted MRPK dispersion (standard deviation) across manufacturing firms in province p at year t. We use the natural logarithm of it in all regressions and figures unless otherwise stated.
FisVol:	the fiscal policy volatility measure in province p at year t. We use the natural logarithm of it in all regressions and figures unless otherwise stated.
GovSize:	government size, which is the natural logarithm of total government expenditure as a share of GDP in province p at year t;
Subsidy:	government subsidy, which is the natural logarithm of total subsidized income divided by total sales income of all manufacturing firms in province p at year t.
FD:	financial dependence, which is the natural logarithm of total bank loans as a share of GDP in province p at year t;
Inflation:	inflation rate, which is the growth rate of natural logarithm of Consumer Price Index (CPI) in province p at year t, i.e. $\Delta \log CPI_{p,t} * 100$;
Export:	the natural logarithm of the share of exports in provincial GDP in year t;
GDPGVol:	output volatility, defined as the natural logarithm of volatility of the cyclical component of GDP in province p in year t using the Hodrick and Prescott (1997) filter;
TFPGVol:	TFP growth volatility, which is defined as the natural logarithm of the standard deviation of TFP growth of firms in province p in year t, i.e. $\log(\sigma(TFPG_{i,p,t}))$;
SOE:	the natural logarithm of SOE share of total value added in manufacturing industries in province p in the year t;
FOR:	the natural logarithm of foreign share of total value added in manufacturing industries in province p at the year t;
PolVol1:	political volatility, defined as the length of service of governor of province p in year t;
PolVol2:	political volatility, defined as the length of service of party secretary of province p in year t;
FisVolB :	fiscal policy volatility due to budgetary expenditure in province p in the year t;
FisVolEB:	fiscal policy volatility due to extrabudgetary expenditure in province p in the year t;
FisVolCov:	covariance between budgetary and extrabudgetary expenditure in province p in the year t;
$\sigma(MRPL^A)$:	dispersion of industry- and year-adjusted marginal revenue product of labour (MRPL) of firms in province p in year t. We use the natural logarithm of it in regressions.
$\sigma(MRPM^A)$:	dispersion of industry- and year-adjusted marginal revenue product of materials (MRPM) of firms in province p in year t; We use the natural logarithm of it in regressions.
WheatRice:	an instrumental variable, which is the natural logarithm of the ratio between wheat output and rice output in province p in year t;
Gini:	an instrumental variable, which is the overall Gini coefficient of each province in 1995;
L.FisVol:	an instrumental variable – the lagged fiscal policy volatility by three year periods;
High/Low GovSize:	a dummy variable which is equal to one if the average government size (*GovSize*) of province p is higher or lower than the median value of *GovSize*, and zero otherwise;
High/Low SOE:	a dummy variable which is equal to one if the average SOE share of total value added (*SOE*) of province p is higher or lower than the median value of *SOE*;
IFD:	Rajan and Zingales (1998)'s measure of industry's dependence on external finance;
CapRes1:	Balasubramanian and Sivadasan (2009)'s capital resalability index in 1987, which is defined as the share of used capital investment in total capital investment at each 4-digit US industry;
CapRes2:	Balasubramanian and Sivadasan (2009)'s capital resalability index in 1992;
CapRes3:	the mean average of Balasubramanian and Sivadasan (2009)'s capital resalability index in 1987 and 1992;
GovDem1:	the share of government purchase in total sales at each 2-digit industry in 2004;
GovDem2:	the share of SOE purchase in total sales at each 2-digit industry in 2004;
GovDem3:	the share of government and SOE purchases in total sales at each 2-digit industry in 2004.

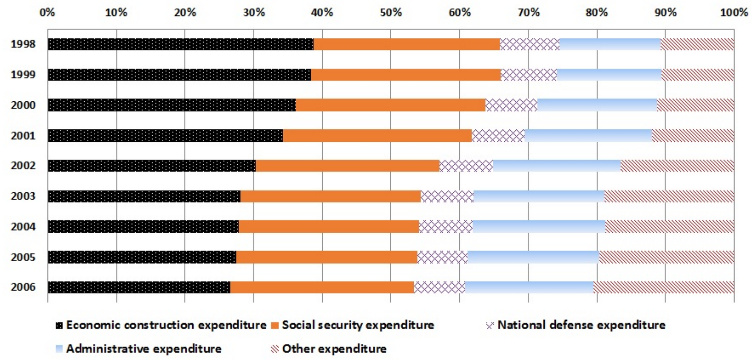
Table OA.2: Summary statistics of all variables

Variable	Observations	Mean	Std. Dev.	Min	Max
$\sigma(MRPK^A)^1$	310	0.294	0.124	0.005	0.840
$FisVol^1$	310	-2.779	0.505	-5.345	-0.538
$GovSize^1$	310	-1.864	0.424	-2.675	-0.159
$Subsidy^1$	310	-4.297	0.643	-5.811	-2.055
FD^1	310	-1.195	3.099	-9.43	0.812
Inflation	310	1.173	2.088	-3.3	6.64
$Export^1$	310	-2.349	0.925	-3.784	-0.072
$GDPVol^1$	310	-4.436	0.553	-6.472	-3.072
$TFPGVol^1$	279	-0.845	0.489	-1.93	0.645
SOE^1	310	-1.436	0.744	-4.159	-0.193
FOR^1	310	-2.03	1.015	-6.512	-0.441
PolVol1	310	3.065	1.789	1	9
PolVol2	310	3.319	2.31	0	13
FisVolB	310	0.004	0.007	0	0.062
FisVolEB	310	0.002	0.003	0	0.026
FisVolCov	310	0.002	0.024	-0.009	0.323
$\sigma(MRPL^A)^1$	310	0.137	0.147	-0.25	0.763
$\sigma(MRPM^A)^1$	310	0.13	0.146	-0.233	0.767
$WheatRice^1$	310	-0.732	3.39	-8.157	6.916
Gini	27	0.328	0.054	0.231	0.437
$L.FisVol^1$	279	-2.734	0.472	-3.917	-0.538
IFD^1	425	0.410	1.887	-1.857	5.472
CapRes1	358	0.098	0.066	0.002	0.534
CapRes2	328	0.083	0.045	0.002	0.238
CapRes3	324	0.093	0.046	0.005	0.346
GovDem1	30	0.023	0.027	0.000	0.136
GovDem2	30	0.238	0.192	0.025	0.845
GovDem3	30	0.261	0.200	0.031	0.875

[1] These variables are in natural logarithm in this table to be consistent with how they are used in the regressions in tables in the paper.
[2] See Online Appendix Table OA.1 for all variable definitions.

OB Additional Figures

Figure OB.1: Components of government expenditure by functions



Note: "Economic construction expenditure" refers to the fiscal expenditure related to economic development, which includes the government's expenditure on state-owned industries, agriculture, forestry, water conservancy, meteorology, construction, railways, transportation, post and telecommunications, domestic commerce, foreign trade, urban public utilities, and so on. "Social security expenditure" refers to the fiscal expenditure on social, cultural, and educational purposes, including spending on scientific and health sectors. "National defense expenditure" consists of direct defense expenditure and indirect defense expenditure in the state budget. "Administrative expenditure" refers to the administrative costs of various levels of government agencies. "Other expenditure" refers to any fiscal expenditure that is not listed above. The 2007 data is not available due to the change in the definition of fiscal functions.

Figure OB.2: Fiscal policy volatility and government information transparency

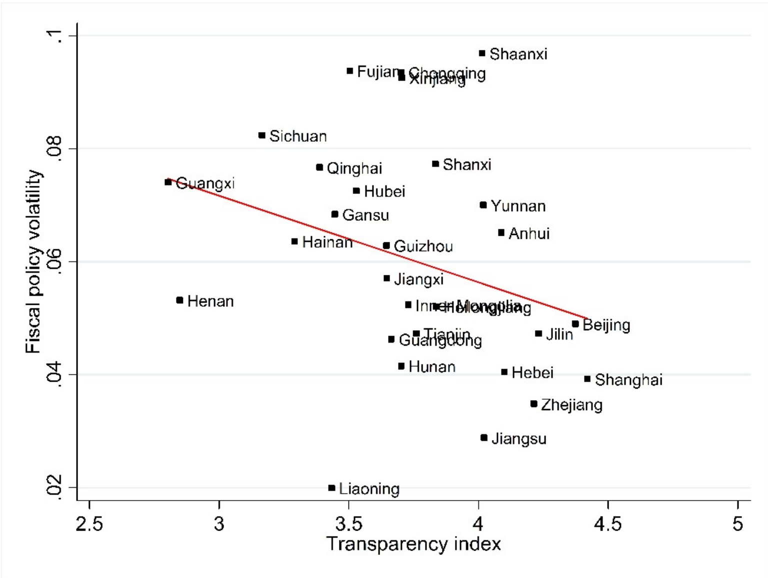
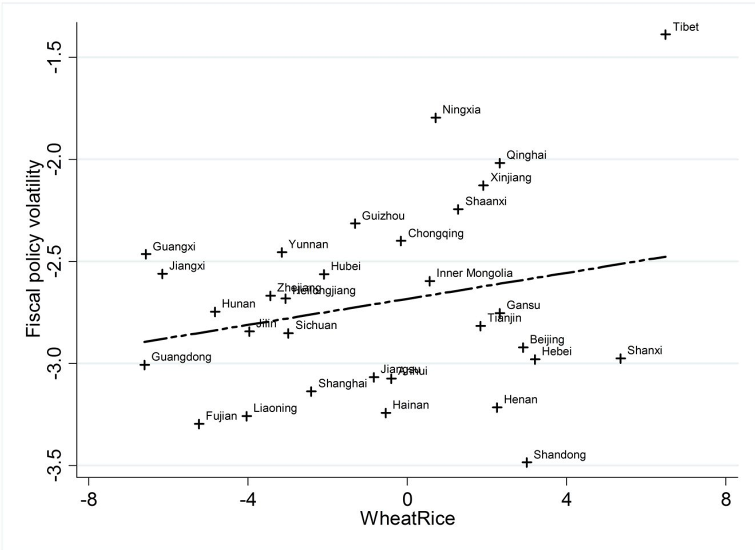
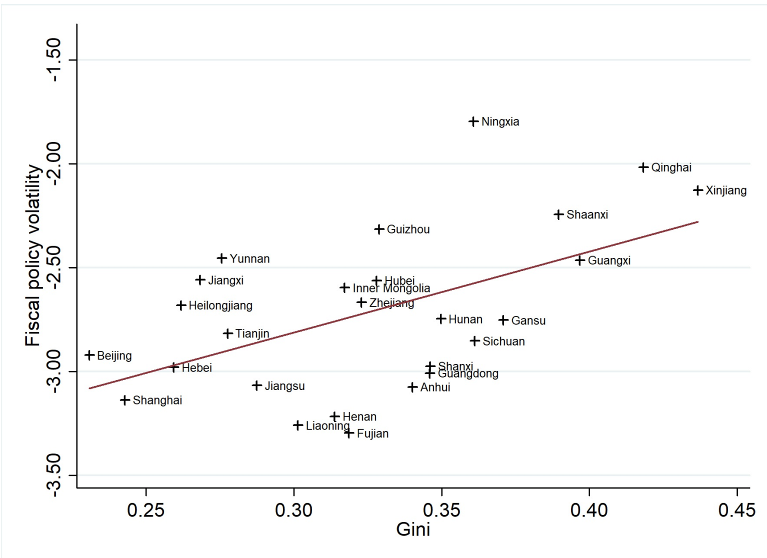


Figure OB.3: Fiscal policy volatility and wheat-rice ratio



Notes: Fiscal policy volatility is in natural logarithm.

Figure OB.4: Correlation between fiscal policy volatility and Gini coefficient



Notes: Fiscal policy volatility is in natural logarithm.

OC Impact on the dispersion of marginal products of labour and intermediate material inputs

In supplement to the main results regarding capital misallocation, this section examines the effects of fiscal policy volatility on affecting the allocation efficiency of labour and intermediate material inputs.

Empirical results. Using the similar method as in the main results, we compute the industry- and year-adjusted marginal revenue product of labour ($MRPL^A$) and the marginal revenue product of intermediate inputs ($MRPM^A$) of manufacturing firms and their corresponding dispersion in province p at year t, i.e. $\sigma(MRPL^A_{p,t})$ and $\sigma(MRPM^A_{p,t})$. Table OC.1 shows that the impact of fiscal policy volatility on these two types of dispersion is positive and significant. This result shows that fiscal policy volatility can not only generate misallocation in the capital markets but also lead to dispersion of marginal products in labour and intermediate inputs.

Table OC.1: Impact on the dispersion of marginal products of other inputs

	MRPL dispersion		MRPM dispersion	
FisVol	0.036**	0.028**	0.037**	0.029**
	(0.015)	(0.011)	(0.014)	(0.011)
Control variables	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes
R^2	0.538	0.651	0.525	0.636
Obs	310	310	310	310

Note: The dependent variables are $\log(\sigma(MRPL^A))$ and $\log(\sigma(MRPM^A))$ at the province and year level; the control variables include: government size, subsidy, financial dependence, inflation, and export; all independent regressors are in natural logarithm unless otherwise stated – see Online Appendix OA for all variable definitions. *** p<0.01, ** p<0.05, * p<0.1.

What makes fiscal policy volatility matter for the dispersion of these marginal products? We discuss the possible mechanisms as follows.

Mechanism treating labour and materials as dynamic inputs. We start with a mechanism similar to what is characterized in Asker et al. (2014). If there exist adjustment costs (rising from frictions or distortions) in the corresponding markets of labour and material inputs, then the input decisions made before a profitability shock may no longer be optimal after a shock hits. Cooper et al. (2017) claim that labour adjustment is costly in China due to its new labour regulations which are intended to protect workers' employment conditions such as job security and wage levels. Using a model of dynamic labour demand, they find that job protection measures such as increases in severance payments could lead to a significant reduction in labour reallocation and thus productivity and output losses. Similarly, intermediate material inputs may be subject to adjustment costs as well. Downstream firms need to sign contracts with upstream providers of intermediate inputs, and frequent switches among providers can be expensive. Nunn (2007) finds that a large proportion of intermediate inputs are relationship-specific, which indicates an intermediate level of market thickness and relationship-specificity.

Mechanism treating labour and materials as static inputs. Nonetheless, even without adjustment costs of labour and material inputs, it is still possible that fiscal policy volatility has an impact on the dispersion of the marginal products of labour and material inputs via the distorted choice of capital. This is because, if the quality of inputs (human capital and material quality) are complementary to physical capital in promoting the quality of output, then the misallocation of capital induced by fiscal policy volatility will influence the quality choices of material and labour inputs and consequently cause the dispersion of marginal revenue products of these inputs. Thus, the dynamic chosen input (capital), when coupled with its adjustment costs, can not only shed light on the relationship between fiscal policy volatility and dispersion of the marginal revenue product of the dynamic input but also shape the relationship between the volatility and the dispersion of the marginal revenue products of *static* inputs (labour and intermediate material inputs).

We describe a stylized model to demonstrate the mechanism. Specifically, we adopt the dynamic framework from Asker et al. (2014) and the static model from Kugler and Verhoogen (2012) and Grieco et al. (forthcoming). We use the same Cobb-Douglas production function of a profit-maximizing firm as in Section 4. We denote the productivity of the production function as ω_{it}.

We depart by assuming that the product quality can be influenced by the quality levels of material and labour inputs and a portion of capital. That is, there exists a product quality production function using a portion of capital stock $g(K_{it})$, material input quality ν_{it}, and labour quality (i.e., human capital) μ_{it}. $g(K_{it})$ is a function (e.g., a portion) of capital stock. We assume $\frac{\partial g(K)}{\partial K} > 0$, meaning that the more capital used in producing product quality, the higher product quality. We following Kugler and Verhoogen (2012) to allow for flexible rate of substitution across these variables in the production of product quality levels:

$$h(g(K_{it}), \nu_{it}, \mu_{it}) = [\gamma_K g(K_{it})^\theta + \gamma_L \mu^\theta + \gamma_M \nu^\theta]^{\frac{1}{\theta}}, \tag{OC.1}$$

where γ_K, γ_L, and γ_M are constant. If $\theta < 0$, then the quality of material and labour inputs is complementary to capital shock in the output quality production. The implication is that firms with higher capital are self-selected to choose higher-quality inputs. However, the unit prices of labour and material are increasing in their quality:

$$P_L = \mu^{\phi_L}, P_M = \nu^{\phi_M}, \tag{OC.2}$$

where $0 < \phi_L < 1$, and $0 < \phi_M < 1$.

Fiscal policy (e.g., government purchase) enters the demand function as a demand shifter. Specifically, the (inverse) demand curve for the firm's product is:

$$P_{it} = b_t^{\frac{1}{\eta}} Q_{it}^{-\frac{1}{\eta}} h(g(K_{it}), \nu_{it}, \mu_{it}), \tag{OC.3}$$

where b_t is the fiscal policy shock that shifts the demand and $\eta > 1$ is the demand elasticity.[44] In addition to the demand shifter, the product quality, $h(g(K_{it}), \nu_{it}, \mu_{it})$, also shifts demand.

[44] Fiscal policy may also have impact on reducing the firm's production costs (e.g., cheaper material costs due to improved transportation facility provided by government). Such impact plays a similar role in shaping the static profit of the firm. We focus on the demand impact for the simplification purpose.

Given the dynamic state $(b_t, \omega_{it}, K_{it})$, we denote the firm's maximized static period profit as $\pi(b_t, \omega_{it}, K_{it})$. There is no adjustment cost (or friction) of the static inputs (labour and materials), while there exist adjustment costs for capital. Specifically, capital movement is assumed as $K_{it+1} = (1-\delta)K_{it} + I_{it}$, where δ is the depreciation rate and I_{it} is the investment. The investment is associated with adjustment costs, which consist of a fixed cost and a variable adjustment cost, in addition to I_{it}:

$$C(I_{it}, K_{it}, \omega_{it}, b_t) = I_{it} + C_K^F \mathbf{1}(I_{it} \neq 0)\pi(I_{it}, K_{it}, \omega_{it}, b_t) + C_K^V K_{it} \left(\frac{I_{it}}{K_{it}}\right)^2. \quad \text{(OC.4)}$$

Further, we assume productivity and the fiscal policy evolve according to $\omega_{it} = \psi_0 + \psi_1 \omega_{it-1} + \sigma_\omega \epsilon_{it}$ and $b_t = \phi_0 + \phi_1 b_{t-1} + \sigma_b \upsilon_t$, respectively, where ϵ_{it} and υ_{it} are from the standard normal distribution. Thus, σ_ω and σ_b measure the size of volatility of productivity and fiscal policy, respectively.

Finally, the value function of a firm can be expressed as the following Bellman equation:

$$\begin{aligned} V(\omega_{it}, b_t, K_{it}) = &\max_{I_{it}} \pi(\omega_{it}, b_t, K_{it}) - C(I_{it}, K_{it}, \omega_{it}, b_t) + \\ &\beta \int_{\omega_{it+1}, b_t} V(\omega_{it+1}, b_{t+1}, \delta K_{it} + I_{it}) dF(\omega_{it+1}, b_{t+1} | \omega_{it}, b_t). \end{aligned} \quad \text{(OC.5)}$$

Thus, with static profit maximisation, the marginal revenue product of labour is equal to the price of labour. Put the relationship in natural logarithm, we have:

$$MRPL = \log(P_L) = \phi_L \log(\mu_{it}) \propto \phi_L \log(g(K_{it})), \quad \text{(OC.6)}$$

and similarly, the marginal revenue product of material input (in natural logarithm) is also positively related to capital stock:

$$MRPM = \log(P_M) = \phi_M \log(\nu_{it}) \propto \phi_M \log(g(K_{it})). \quad \text{(OC.7)}$$

Therefore, the dispersion of MRPL and MRPM are positively related to the dispersion of capital.

We simulate the model and present the association between the key dispersion and fiscal policy volatility in Figure OC.1. Asker et al. (2014) suggest that the volatility and dispersion of MRPK are positively related in the presence of capital adjustment costs. This is replicated in the top graph of Figure OC.1. In our model, we further show that the dispersion of capital is also positively related to fiscal policy volatility, as shown in the second graph of Figure OC.1. Equations (OC.6) and (OC.7) show that if the quality of inputs coupled with capital can promote the quality of output, then capital will influence the quality choices and hence the prices of inputs. Because firms choose the quantity of static inputs to equalize their marginal revenue products and their prices, capital misallocation can influence the dispersion of marginal revenue products of labour and intermediate material inputs. This is reflected in the last two graphs of Figure OC.1.

In brief, this stylized model shows how the dynamic input, when coupled with adjustment cost and fiscal policy volatility, can not only shed light on the dispersion of the marginal revenue product of the dynamic input but also shapes the dispersion of the marginal revenue products of the static inputs. In our context, fiscal policy volatility leads to misallocation of capital, and this consequently induces the firm to choose distorted levels of quality in labour and material inputs. That is, if there was no misallocation of capital, the firm would choose other levels of input quality. In this sense, the documented impact in Table OC.1 reflects the misallocation in labour and material inputs caused by fiscal policy volatility.

Figure OC.1: Simulated relationship between fiscal policy volatility and key dispersion