Fiscal policy volatility and capital misallocation: Evidence from China

Sai Ding* Wei Jiang† Shengyu Li‡ Shangjin Wei§

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Abstract

Can a demand-side macroeconomic shock be a driver of capital misallocation in China? Using cross-province data, we find a positive effect of fiscal policy volatility on the dispersion of risk-adjusted marginal revenue product of capital (MRPK), and the changes of fiscal policy volatility account for 8.9% to 27.4% of the observed reduction in capital misallocation during 1998-2007. Factors relating to capital adjustment costs, financial frictions and policy distortions are found to play an important role in shaping the nexus between fiscal policy volatility and the static measure of capital misallocation, as reflected by the vast heterogeneity among provinces and industries. The impact of fiscal policy volatility on capital misallocation can transmit to the dispersion of marginal revenue products of other factor inputs.

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*Economics, Adam Smith Business School, University of Glasgow, Gilbert Scott Building, Glasgow, UK, G12 8QQ. Email: sai.ding@glasgow.ac.uk.

†School of International Business, Southwestern University of Finance and Economics, Sichuan, P. R. China, 611130. Email: weijiang923@gmail.com.

‡Durham University Business School, Mill Hill Lane, Durham, UK, DH1 3LB. Email: shengyu.li@durham.ac.uk.

§Columbia Business School, Columbia University, Uris Hall, 3022 Broadway, New York, USA, NY 10027. Email: shangjin.wei@columbia.edu.

1 Introduction

Variation in marginal products across firms (within even narrowly defined industries) is widely viewed as evidence of frictions that prevent the efficient allocation of resources in the economy (Asker et al., 2014). A growing literature has shown the qualitative significance and quantitative importance of resource misallocation in both developed and developing countries (Banerjee and Duflo, 2005; Hsieh and Klenow, 2009). Thus identifying potential driving forces of resource misallocation is of paramount importance to induce the process of resource reallocation to more productive use and to improve aggregate efficiency and welfare within industries, countries and over time.

Inspired by the work of Asker et al. (2014) which examines the mechanism associated with the firm-specific productivity shock, we focus on the role of a specific demand-side volatility at the aggregate level, i.e. whether and how fiscal policy volatility affects the dispersion of marginal revenue product of capital (MRPK). According to Collard-Wexler (2013), firms and industries face considerable uncertainty about future demand for their products, thus shocks from the demand side may affect the organization of production. In terms of fiscal policy, on the one hand, government spending or taxation is commonly used as a short-term government instrument to influence the aggregate demand in the economy. It may affect firms' demand directly through government purchase and indirectly through government provision of basic infrastructure and other public goods and services that influence the demand or sales of firms' products[1]. On the other hand, Leduc and Liu (2016) regard the uncertainty shocks as aggregate demand shocks, i.e. an increase in uncertainty can generate the observed demand-like macroeconomic effects (such as a rise in unemployment and a fall in inflation) through interactions between an option-value channel stemming from search frictions and an aggregate demand channel associated with nominal rigidities. Such shocks can generate significant uncertainty faced by firms when making investment or production decisions and lead to resource misallocation. To the best of our knowledge, we are the first to examine the role of fiscal policy volatility, a particular type of policy distortion that influences firms' demand, in shaping the dispersion of MRPK in China, whereas most existing literature focuses on the effects of ownership and financial frictions.

China appears to be an ideal laboratory for this exercise because on the one hand, the problem of resource (such as capital) misallocation is found to be prevalent in

[1] Figure C1 in Appendix C shows that the share of 'Economic construction expenditure' in total government expenditure ranges from 38.7% to 26.6% in China during 1998-2006, which is the most important component of fiscal expenditure and directly relates to the manufacturing sector.

China which has generated significant welfare losses (Hsieh and Klenow, 2009; Brandt et al., 2013; Wu, 2015). According to Hsieh and Klenow (2009), China could benefit 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 US. On the other hand, China has quite high fiscal volatility compared with other countries. Using the Penn World Table data, we conduct a cross-country comparison of fiscal policy volatility over the period of 1980-2013 and find that China ranks the 80^{th} among 135 developed and developing countries in a list ranging from the lowest to highest volatility[2]. Besides, China is argued to be one of the most fiscally decentralized countries in the world and its fiscal system, despite various waves of reforms, remains unsatisfactory, which is often viewed as a source of concern/obstacle for its future development. For instance, there are problems of mismatch between local governments' expenditure tasks and revenue assignments, low fiscal transparency and rising regional fiscal disparity. Thus, we explore the impact of fiscal volatility on capital misallocation within Chinese provinces in order to shed light on whether the present fiscal system gives rise to distortions in resource allocation, thus impairing China's growth potential. This exercise is also useful to understand the effect of China's incremental fiscal reforms and to draw relevant policy implications.

Another three contributions of our paper are as follows. First, we propose a risk-adjusted MRPK dispersion as a new measure of capital misallocation. In the standard literature of asset pricing, returns should be proportional to assets' risks, i.e. if risks are different, so do the returns. If we understand the returns as prices of capital, then firms may face different prices simply because of different risks even without any distortion or friction. In other words, if the dispersion of MRPK is purely driven by the dispersion of firms' risks, then it is socially efficient and the former should not be interpreted as capital misallocation. Assuming that risks are sector- and time-specific, we isolate this risk component from the observed MRPK dispersion, and use the risk-adjusted MRPK dispersion to represent the distortion component, i.e. capital misallocation. Despite the recently rising literature to address the measurement error and other concerns of misallocation measures (see, for instance, Bartelsman et al., 2013; Foster et al., 2016; Morrow and Dhingra, 2018), we are the first to bring in the insights from the asset pricing literature and to disentangle risks from the standard measure of misallocation.

Second, despite the substantial evidence on the negative effect of policy volatility

[2] Fiscal policy volatility is defined as the standard deviation of unforcastable changes in government expenditure, i.e. the portion of discretionary fiscal policy that is not explained by the state of business cycles.

on long-run economic growth, there is not much consensus on specific channels. For instance, the past literature emphasizing irreversible investment claims that higher volatility can result in 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 make a contribution to the literature by offering a new mechanism for the negative link between policy volatility and economic growth: a resource misallocation channel, i.e. policy shocks can make the existing allocation of resources less optimal, thereby generating efficiency losses and hindering economic growth.

Third, fiscal policy volatility is found to affect the dispersion of marginal products of other factor inputs (such as labour and intermediate inputs), which generates the implications for the overall resource allocation efficiency. Unlike the existing literature which relies on the presence of adjustment costs in these markets to rationalize the link, we propose a new transmission mechanism where the misallocation of capital, due to fiscal policy volatility, can influence firm's quality choices of other inputs, and thus leading to the dispersion of marginal revenue products of these inputs.

Using cross-province data, we find that fiscal policy volatility has a significant positive impact on the risk-adjusted MRPK dispersion and the changes of fiscal policy volatility account for 8.9% to 27.4% of the observed changes in capital misallocation during 1998-2007 in the baseline model. This result is robust when potential endogeneity and mismeasurement problems are controlled for. Capital adjustment costs, financial frictions and policy distortions are all found to play a role in shaping the nexus between fiscal policy volatility and the static measure of capital misallocation. For instance, the effect is more prominent for inland provinces, and provinces with less financial development and with high government intervention and state ownership. The capital allocation efficiency of some industries is more likely to be adversely affected by the demand-side shock, for instance, those are more dependent on external finance, those with higher sunkenness of capital investment, and those are more reliant on purchases from governments and state-owned enterprises (SOEs). The effect is mainly through budgetary expenditure of provincial governments and there is evidence of spillover effect from neighbouring provinces.

The structure of the paper is as follows. Section 2 discusses the relevant literature. Section 3 describes the empirical methodology. Section 4 presents the data, sample and some interesting stylized facts. Section 5 discusses our empirical results of both the baseline model and of various robustness checks. Section 6 focuses on various economic channels through which fiscal policy volatility affects capital misallocation. Section 7 addresses the transmission mechanism from capital misallocation to other factors markets with both evidence and theory. Section 8 discusses some possible explanations for fiscal policy volatility in the context of China's incremental fiscal reforms. Section 9 concludes the paper.

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), i.e. aggregate productivity can be low because inputs are misallocated across heterogeneous production units[3]. Market imperfections, technological constraints and policy distortions are commonly identified as potential candidates for explaining the dispersion of TFP or of 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) challenges the conventional hypothesis that competition reduces misallocation by decreasing dispersion in markups, but argues that in the presence of financial constraints, capital wedges of firms can be amplified by competition because the reduced markups driven by competition lower the scope for internally-financed capital accumulation and therefore impeding the process of convergence to the firm's optimal capital level.

The misallocation literature acknowledges the role of factor adjustment costs, a form of technological constraints, in driving the dispersion of marginal revenue prod-

[3]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).

ucts. For instance, Asker et al. (2014) find that adjustment costs in capital, coupled with TFPR 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 is more pervasive in developing countries. Wu (2015) claims that if Chinese firms had faced a lower level of adjustment 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 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 during the period of 1985-2007. 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 was due to misallocation of capital between the state and non-state sectors induced by government policies.

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. 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. For instance, 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 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 nexus 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 etc) 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 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 Empirical methodology

3.1 Our measure of capital misallocation

Misallocation of factors of production across firms is commonly identified by the observed dispersion in marginal products. For instance, Hsieh and Klenow (2009) show that under certain assumptions about technology and demand, revenue productivity should be equated across firms in the absence of distortions, and they recover a measure of firm-level distortions based on the extent to which revenue productivity differs across firms. Asker et al. (2014) regard capital as a dynamic input, when coupled with adjustment costs and productivity volatility, MRPK dispersion can be viewed as a static measure of capital misallocation, i.e. a capital stock determined in some previous period may no longer be optimal after a productivity shock hits. There is also a rising literature addressing the difficulty of interpreting the dispersion measures due to the presence of measurement error, variable mark-ups, increasing return to scale and so on (Bartelsman et al., 2013; Foster et al., 2016; Morrow and Dhingra, 2018).

However, the literature ignores the role of risks in affecting marginal products and their dispersion. In the literature of asset pricing, assets are priced by reference to their exposure to fundamental sources of macroeconomic risks, i.e. one central task of absolute asset pricing is to understand and measure the sources of aggregate or macroeconomic risk that drive asset prices (Cochrane, 2009). Thus, expected returns vary across time and across assets in ways that are linked to macroeconomic risks. In other words, the observed dispersion of marginal products may reflect risk differences of firms rather than distortions. This issue is particularly important when we examine a particular type of macroeconomic risk, fiscal policy volatility, in driving capital misallocation. We therefore propose a risk-adjusted MRPK dispersion as a new measure of capital misallocation in order to partial out the risk factors that influence MRPK dispersion.

We first follow the method of Asker et al. (2014) to compute the MRPK. We start from a Cobb-Douglas production function of a profit-maximizing firm:

$$Q_{it} = A_{it} K_{it}^{\alpha_K} L_{it}^{\alpha_L} M_{it}^{\alpha_M}, \tag{1}$$

where Q_{it} is output of firm i at time t, and K_{it}, L_{it}, and M_{it} are the capital input, labour input and materials respectively. Assuming the demand curve for firm's product with constant elasticity, $Q_{it} = B_{it} P_{it}^{-\eta}$, we can get the following revenue-based production function

$$S_{it} = \Omega_{it} K_{it}^{\beta_K} L_{it}^{\beta_L} M_{it}^{\beta_M}, \tag{2}$$

where S_{it} is total sales revenue of firm i at time t, $\Omega_{it} = A_{it}^{1-(1/\eta)} B_{it}^{1/\eta}$, and $\beta_X = \alpha_X[1-(1-\eta)]$ for $X \in (K, L, M)$. In a perfect world without frictions, 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, i.e.

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

Taking natural logarithms, we can have

$$MRPK_{it} = \log(\beta_K) + \log(S_{it}) - \log(K_{it}) = \log(\beta_K) + s_{it} - k_{it}, \tag{4}$$

where s_{it} is the natural logarithm of firm's sales revenue; k_{it} is the natural logarithm of firm's capital input, which is computed using the perpetual inventory method following Brandt et al. (2012); and β_K is the output elasticity of capital, which is estimated using the Olley and Pakes (1996) approach which alleviates both the selection bias and simultaneity bias between input choices and productivity shocks when estimating production functions[4].

Assuming risks are industry- and time-specific, we regress the computed MRPK on the interaction between industry fixed effect (at 4-digit level) and year fixed effect:

$$MRPK_{it} = Industry * Year + e_{it}, \tag{5}$$

and the residual term, e_{it}, is our risk-adjusted MRPK (i.e., $MRPK^{RA}$). Then our measure of within-province capital misallocation is the dispersion (or standard deviation) of $MRPK^{RA}$ of manufacturing firms in province p at year t, i.e. $\sigma(MRPK_{p,t}^{RA})$. The economic intuition of equation (5) is as follows. We assume that the commonly observed MRPK dispersion comprises of two components, i.e. the risk component

[4]See details of production function estimation using Chinese firm-level data in Ding et al. (2016).

and the distortion component. Given the absence of firm-specific risk indicator in our dataset, we hypothesize that risks are at the industry and year level, and are thus captured by the interaction term ($Industry * Year$). Then the dispersion of the residual (e_{it}), the risk-adjusted MRPK, is assumed to capture the distortion component reflecting capital misallocation. In addition to risks, this correction also allows us to isolate all other industry-and time-specific features (such as production technology and market competition) and potential measurement error at the industry and year level when measuring the within-province capital misallocation. In principle, the risk component could be firm-specific. However, the aggregate demand shock induced by discretionary fiscal policy may affect the systematic risk of all firms so that it may not necessarily change the dispersion of the risks across firms. Thus, the time-series and cross-sectional difference of fiscal policy volatility can only affect the dispersion of the distortion component of MRPK, which is our definition of capital misallocation.

As robustness checks, we apply some other approaches to estimate the output elasticity of capital, including the Levinsohn and Petrin (2003) approach, which use intermediate inputs to proxy unobserved productivity in order to address Olley and Pakes (1996)'s problem of lumpy investment; the Wooldridge (2009) approach, which is a unified method allowing for the possibility that the first stage of Olley and Pakes (1996) or Levinsohn and Petrin (2003) approach actually contains identifying information for parameters on the variable inputs; the system GMM estimator, where fixed effects are allowed to take into account firms' (unmeasured) productivity advantages that persist over time; and the Ackerberg et al. (2015) approach, which extends the Olley and Pakes (1996) method and resolves the potential lack of identification by using a two-step estimation method that does not attempt to identify any production parameters in the first stage.

3.2 Our measure of fiscal policy volatility

It is important to distinguish fiscal volatility from adaptability to sudden changes of economic conditions such as counter-cyclical fiscal response to macroeconomic shocks (Woo, 2011). Following some 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 on output. This regression-based measure of fiscal volatility aims at capturing the portion of discretionary fiscal policy that is not explained by the state of the business cycle. Specifically, we run the following regression for 31 provinces over the period of 1994-

2013[5]:

$$\Delta \log G_{p,t} = \alpha_p + \beta_p \Delta \log Y_{p,t} + \gamma_p \Delta \log G_{p,t-1} + \theta_p X_{p,t} + \varepsilon_{p,t}, \tag{6}$$

where $G_{p,t}$ is the real government expenditure (including both budgetary and extra-budgetary expenditure[6]) in province p at year t; $Y_{p,t}$ is the real GDP in province p at year t[7]; $\Delta \log G_{p,t-1}$ is the lagged dependent variable; and $X_{p,t}$ includes a number of control variables such as CPI, time trend (t), and a further lagged dependent variable ($\Delta \log G_{p,t-2}$). According to Fatás and Mihov (2003), fiscal policy consists of three components: (i) automatic stabilizers; (ii) discretionary 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. The intuition of equation (6) is to capture the second component using the output growth ($\Delta \log Y_{p,t}$), so that the residual term, $\varepsilon_{p,t}$, is to capture the third component reflecting the policy decisions exogenous to the state of the economy. Thus, our measure of fiscal policy volatility is the volatility of the residual, $\sigma(\varepsilon_{p,t})$[8].

The baseline model is estimated using OLS without any control variable. As robustness tests, we include various control variables to mitigate the problem of omitted variables, and adopt the instrumental variable (IV) approach to tackle the possible reserve causality from government expenditure to output, where lagged provincial GDP growth ($\Delta \log Y_{p,t-1}$) is used to instrument current GDP growth. We also apply two non-parametric regression methods, locally weighted average estimator and local constant estimator, to compute fiscal policy volatility, which do not require the specification of a function to fit a model to all of the data in the sample[9]. Lastly, instead of using the moving window method to compute fiscal volatility, we adopt the 3-year or 4-year non-overlapping time interval approach in order to focus on the long-run effect

[5]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. See detailed discussion in Section 8.1.

[6]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.

[7]All nominal variables such as government expenditure and GDP are adjusted using provincial GDP deflator where 1978 is set as the base year.

[8]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 at year t, i.e. $\sigma(\varepsilon_{p,t-2}, \varepsilon_{p,t-1}, \varepsilon_{p,t}, \varepsilon_{p,t+1}, \varepsilon_{p,t+2})$.

[9]The locally weighted average estimator fits the model to localized subsets of the data to build up a function that describes the deterministic part of the variation in the data, point by point. The polynomial is fitted using weighted least squares, giving more weight to points near the point whose response is being estimated and less weight to points further away. Local constant estimator is a similar but simpler approach by taking an average of the points without using a weighting function.

of fiscal policy volatility on resource misallocation.

We choose to use government expenditure to measure fiscal policy volatility for at least 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 for our research because the latter does not represent an overall picture of fiscal revenue in China, i.e. a large part of local government's revenue comes from various administrative fees and land sales.

3.3 Model specification

To examine the link between fiscal policy volatility and capital misallocation, we estimate the following baseline equation using the fixed effect model:

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

where $\sigma(MRPK_{p,t}^{RA})$ is the risk-adjusted MRPK dispersion of province p at year t, $FisVol_{p,t}$ is the natural logarithm of our fiscal policy volatility measure of province p at year t; $Z_{p,t}$ is a number of control variables, including three groups of factors capturing policy distortions, frictions or market imperfections, and trade openness. First, we use government size ($GovSize_{p,t}$) to measure the extent of government intervention in the process of resource allocation, which is defined as the natural logarithm of total government expenditure as a share of GDP in province p at year t. Government intervention may represent a 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). We hypothesize that government size has a positive impact on the dispersion of risk-adjusted MRPK.

Second, government subsidy ($Subsidy_{p,t}$) is included as an additional measure of policy distortion, defined as the natural logarithm of total subsidized income divided by total sales income of all manufacturing firms in province p at 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. We expect a positive effect of government subsidy on the risk-adjusted MRPK dispersion.

Third, we include a financial dependence variable ($FD_{p,t}$) as a proxy for capital market imperfections due to financial frictions in China, which is defined as the natural logarithm of total bank loans as a share of GDP in province p at 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). We therefore keep an open view on the relationship between financial dependence and the risk-adjusted MRPK dispersion.

Fourth, inflation ($Inflation_{p,t}$) is included as a measure of informational friction faced by producers and consumers, defined as the growth rate of natural logarithm of Consumer Price Index (CPI) in province p at year t. According to Friedman (1977), low or stabilizing inflation improves the informational content of the price system and therefore favours a more efficient allocation of resources. For instance, price stability allows investment to be more effectively channeled towards more profitable uses because good investment opportunities are more easily identified. On the other hand, the macroeconomic uncertainty induced by high inflation is argued to shorten agents' horizon, disrupt the organization of markets and generate resource misallocation (Tommasi, 1999). Thus, it is important to control for the role of inflation when examining the determinants of resource allocation efficiency in China.

Lastly, we use the share of exports in provincial GDP at year t ($Export_{p,t}$) as a proxy for trade openness to examine whether the Melitz-type mechanism works in China. We hypothesize that there is a negative effect of exports on MRPK dispersion, i.e. the benefits of exposure to foreign competition/markets enjoyed by the more productive domestic firms should drive the least efficient domestic producers out of business, thereby reducing the risk-adjusted MRPK dispersion.

The error term in equation (7) comprises three components: (i) ς_p is the province-specific fixed effect, capturing geographic factors that influence capital misallocation such as transportation costs and so on; (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, controlling for other unspecified factors.

4 Data

4.1 Data and sample

We adopt a number of datasets for this research. First, the computation of MRPK dispersion and some other variables (such as government subsidy, ownership and volatility of TFP growth) 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) 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[10].

Second, the data used to compute our fiscal policy volatility measure and other provincial-level control variables are from various issues of China Statistics Yearbook and the 'China Compendium of Statistics 1949-2009' compiled by NBS. The final sample consists of a panel of 31 provinces with annual data for the period 1998-2007. However, due to the use of moving window method for the construction of fiscal policy volatility, the original sample for this calculation is 1996-2009. All nominal variables are deflated using provincial GDP deflator[11] to convert to real values (at 1978 constant price).

Lastly, some historical and political datasets are used to construct instrumental variables (such as wheat-rice ratio and port opening time) and omitted variables (such as political volatility) in order to tackle the problem of endogeneity. Some industry-level data (such as industry-specific financial dependence and capital resalability index)

[10]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.

[11]Provincial CPI is used as an alternative price deflator as a robustness check, as 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.

is obtained from the US Bureau of the Census. Some firm-level information from World Bank Investment Climate dataset is used to calculate the industry-specific reliance on government demand. The summary statistics of all variables are provided in Appendix A and detailed variable definitions are provided in Appendix B.

4.2 Stylized facts

Figure 1 and Figure 2 compare the distribution of risk-adjusted MRPK with that of standard MRPK of Chinese manufacturing firms for years 1998 and 2007. It is interesting to find that the risk-adjusted MRPK has a smaller dispersion than the MRPK in both years. This is in line with our assumption that the standard MRPK dispersion compounds the risk component and the distortion component, and exaggerates the degree of capital misallocation.

[Figures 1 and 2 about here.]

Figure 3 illustrates the time evolution of risk-adjusted MRPK dispersion of Chinese firms over the sample period. It is interesting to observe a trend of both rising central tendency in Chinese industry's $MRPK^{RA}$ distribution and a lower degree of dispersion over time, i.e. there is a truncation from the lower end of the MRPK distribution as indicated by the much thinner left tail of $MRPK^{RA}$ distribution in 2007 than that in 1998 and 2003. Despite a significant amount of welfare loss due to resource misalloaction 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 combination of increase in the mean or median of $MRPK^{RA}$ distribution and a corresponding decrease in its dispersion.

[Figure 3 about here.]

Figure 4 shows the regional disparity of risk-adjusted MRPK distribution in China. We find that manufacturing firms in the Eastern (coastal) region not only have higher central tendency of $MRPK^{RA}$ distribution, but also lower degree of dispersion than firms in the Central and Western (inland) regions. This indicates that the capital allocation efficiency is much higher in coastal provinces than in inner provinces. One possible explanation is that firms in Central and Western regions may face higher capital adjustment costs due to the lack of transport infrastructure and obstacles to factor mobility and/or more financial frictions due to the lack of financial development in inland provinces.

[Figure 4 about here.]

Figure 5 presents the evolution of our fiscal policy volatility measure for different regions[12] over the period of 1998-2007. There is a decreasing trend of fiscal policy volatility in all regions over the sample period, reflecting the positive outcome of various fiscal reforms which is discussed in Section 8. Regional disparity does exist, where Eastern region has the lowest volatility whereas the Western region has the highest.

[Figure 5 about here.]

Lastly, Figure 6 shows the simple correlation between fiscal policy volatility and risk-adjusted MRPK dispersion across 31 provinces in China. We observe a positive relationship, i.e. provinces with lower fiscal policy volatility turn out to have lower dispersion of $MRPK^{RA}$. Hence, it is interesting to examine whether and how a demand shock, as measured by fiscal policy volatility, influences the capital allocation efficiency of manufacturing firms within different provinces in China.

[Figure 6 about here.]

5 Empirical findings

5.1 Baseline results

Table 1 presents the baseline results of equation (7). We find that fiscal policy volatility has a significant and positive effect on the risk-adjusted MRPK dispersion in all estimations, indicating that shocks generated from distortionary government policies such as fiscal policy volatility are one of the key drivers of our static measure of resource misallocation within Chinese provinces. The marginal effect ranges from 0.07 in column (1) to 0.02 in column (8), i.e. a 10 percentage point fall in fiscal policy volatility is associated with a 0.2% to 0.7% drop in the risk-adjusted MRPK dispersion, which accounts for 8.9% to 27.4% of the observed changes in capital misallocation

[12] Fiscal policy volatility of different regions (i.e. Eastern, Central and Western) is the mean value of fiscal policy volatility of all provinces in each region in each year.

during 1998-2007[13]. The coefficients of both government size and government subsidy are significantly positive in columns (2) and (3), reflecting the fact that government intervention may generate distortions in the allocation of capital across manufacturing firms. The effect of financial dependence on $MRPK^{RA}$ 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 $MRPK^{RA}$ dispersion in column (5). Considering the fact that the average inflation rate was very low during the sample period, i.e. merely 1.2% per annum, the result implies that moderate inflation or relative price stability is conducive to efficient resource allocation in China. Lastly, we find a negative effect of exports on $MRPK^{RA}$ dispersion in column (6), suggesting the beneficial effect of trade liberalization in terms of inducing inter-firm reallocations and improving aggregate efficiency. In columns (7) and (8), we include all variables in a single regression and find that the results of fiscal policy volatility remain robust. One interesting finding is that when year fixed effects are added in column (8), most control variables become insignificant except inflation, perhaps because the year fixed effects have absorbed some influences of other control variables.

[Table 1 about here.]

5.2 Robustness checks

A large number of robustness tests are conducted to tackle the potential identification bias originated from the endogeneity problem (including both reverse causality and omitted variables) and the mismeasurement problem.

5.2.1 Reverse causality problem

Despite the largely exogenous nature of our fiscal volatility measure induced by macroeconomic policy, it is plausible to argue that provinces with high $MRPK^{RA}$ dispersion are more likely to use discretionary fiscal policy to support least efficient firms. To tackle this potential endogeneity bias induced by reverse causality, we adopt both the two-stage instrumental variable (IV) approach and the System GMM estimation method.

Three sets of instrumental variables are used in the two-stage IV analysis. The

[13] It is the contribution of changes in fiscal policy volatility to the changes in observed risk-adjusted MRPK dispersion between 1998 and 2007.

first instrument originates from the historical and cultural difference between China's wheat and rice regions[14], which is defined as the natural logarithm of the ratio between wheat output and rice output in province p at year t ($WheatRice_{p,t}$). According to Talhelm et al. (2014), a history of farming rice makes cultures more interdependent, because farming rice requires a significant amount of water so that societies have to cooperate intensively during planting and harvesting. On the other hand, farming wheat makes cultures more independent as societies do not have to depend on each other in terms of irrigation or labour and become more individualistic. Since paddy rice makes cooperation more valuable in the whole society, we hypothesize that individuals may have more incentives to monitor government behaviour, which possibly leads to a lower fiscal policy volatility, in the rice region than in the wheat region. The cross-sectional correlation between fiscal policy volatility (in 2003) and the wheat-rice ratio is shown in Figure 7, where a positive relationship can be observed across 31 provinces.

[Figure 7 about here.]

Second, inspired by Dong et al. (2012), we use the natural logarithm of capital city's port opening time period (until 2007) in each province ($PortOpen_p$) as an instrument[15]. The intuition is that the longer is the history of port opening to international business/trade, the earlier the exposure of that province/region to western culture and economic and political institution is. Such foreign influence may provide people with more incentives to monitor the behaviour of local governments, curb discretionary fiscal policy and reduce the corresponding volatility. The relationship can be seen from Figure 6, where a negative correlation between fiscal policy volatility (in 2003) and port opening time of each province's capital city is found among Chinese provinces.

[Figure 8 about here.]

Third, we use the lagged value of fiscal policy volatility ($L.FisVol_{p,t}$) as another instrument, which is lagged by three year period in order to reduce reverse causality[16]. A number of diagnostic tests are conducted to verify the quality of the three sets of instruments.

[14] In China, the Yangtza River splits the wheat-growing north from the rice-growing south since thousands of years ago.

[15] For instance, the dates of port opening of Shanghai and Shenyang (the capital city of Liaoning province) were November 1843 and April 1908, then their corresponding time periods of port opening until 2007 are 164 and 99 years respectively.

[16] 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 one missing year of 1998 where no instrument is available.

Lastly, we adopt the system GMM estimator (Blundell and Bond, 1998) to estimate equation (7), which can also take into account possible mismeasurement problems of regressors. In addition to the external instruments described above, levels of fiscal policy volatility lagged three times are used as instruments in the first-differenced equations and first-differenced fiscal policy volatility lagged twice are used as additional instruments 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 are also checking for the presence of second-order autocorrelation in the differenced residuals in all estimations.

Table 2 reports the results of these endogeneity tests. The first-stage IV results show that all three sets of instruments have a significant effect on fiscal policy volatility, where the relationship is positive for the wheat-rice ratio and lagged fiscal policy volatility but negative for the port opening time, which is consistent with our hypotheses. The second-stage results confirm the exogenous role of fiscal policy volatility in raising the the risk-adjusted 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 the excluded instruments are correlated with the endogeneous regressors. As shown in Table 2, the null hypothesis that the model is under-identified is rejected at the 10 percent significance level in columns (2) and (5) and at the 1 percent significance level in other columns. Second, the weak-identification test based on the Cragg-Donald Wald F statistics provide strong evidence for rejecting the null hypothesis that the first stage regression is weakly identified at the 10 percent significance level in columns (2) and (5) and at the 1 percent significance level in other columns. The System GMM estimation in columns (6) and (7) further confirms our baseline results of a positive impact of fiscal policy volatility on the risk-adjusted MRPK dispersion which is not driven by reverse causality. There is no evidence of second-order serial correlation in the first-differenced residuals, and the Hansen test does not reject the validity of instruments.

[Table 2 about here.]

5.2.2 Omitted variable problem

To check for the possibility of another type of endogeneity problem due to omitted variables in driving the link between fiscal policy volatility and the risk-adjusted MRPK dispersion, we include various measures including output volatility, TFP growth volatility, institutions, and political volatility in Table 3.

[Table 3 about here.]

First, according to Fatás and Mihov (2013), any misspecification of first-stage regression computing fiscal policy volatility in equation (5) may make a component of output fluctuations enter the residuals. Thus, there is concern that the positive relationship between fiscal policy volatility and $MRPK^{RA}$ dispersion might be driven by the effect of output volatility on $MRPK^{RA}$ dispersion. In columns (1) and (2), we include the output volatility ($GDPVol_{p,t}$) as a control variable, which is defined as the natural logarithm of volatility of the cyclical component of provincial GDP at year t using the filter of Hodrick and Prescott (1997)[17]. 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. The effect of output volatility itself is insignificant.

Second, Asker et al. (2014) find that in the presence of capital adjustment costs, higher productivity volatility (i.e. TFPR shock) leads to higher cross-sectional MRPK dispersion. We therefore include the volatility of TFP growth ($TFPGVol_{p,t}$) as a control variable in columns (3) and (4), which is defined as the natural logarithm of volatility of TFP growth of all manufacturing firms in province p at year t[18]. We find that the volatility of TFP growth has a significant and positive impact on $MRPK^{RA}$ dispersion, as predicted by Asker et al. (2014). And the positive effect of fiscal policy volatility dispersion on $MRPK^{RA}$ dispersion remains robust.

Third, policy distortions originated from institutions can lead to resource misallocation. For instance, 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 (or foreign) share of total value added in manufacturing industries in province p at the year t in columns (5) and (6). Compared with the default group of private ownership, we find that state ownership has a significantly positive impact on $MRPK^{RA}$ dispersion in column (5), whereas foreign ownership has a significantly negative effect in both columns. The impact of fiscal policy volatility on $MRPK^{RA}$ dispersion is not affected by including such ownership information.

[17]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 ($\tau_{p,t}$) and a cyclical component ($c_{p,t}$). Using the 5-year rolling window method, the output volatility in province p at year t ($GDPVol_{p,t}$) is the volatility of the cyclical component of GDP, i.e. $\sigma(c_{p,t-2}, c_{p,t-1}, c_{p,t}, c_{p,t+1}, c_{p,t+2})$.

[18]We first compute the TFP of each firm in the NBS dataset using the Olley and Pakes (1996) approach; then the TFP growth is the log difference of TFP of firm i in province p at the year t, i.e. $TFPG_{i,p,t}$ and the volatility of TFP growth is $\sigma(TFPG_{i,p,t})$.

Lastly, political uncertainty is argued to affect capital allocation and economic performance in China. For instance, 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 corporate investment. Based on the tenure information of provincial leaders, we construct two political volatility measures, where $PolVol1_{p,t}$ is the length of service of governor of province p at year t and $PolVol2_{p,t}$ is the length of service of party secretary of province p at year t. In columns (7)-(9), we find that political volatility does not have a significant impact on $MRPK^{RA}$ dispersion, whereas our main result of a positive link between fiscal policy volatility and $MRPK^{RA}$ dispersion remains robust.

5.2.3 Mismeasurement problem

We conduct various robustness checks on the potential mismeasurement problem of our two key variables: fiscal policy volatility and the risk-adjusted MRPK dispersion.

Table 4 reports the effect of fiscal policy volatility on $MRPK^{RA}$ dispersion when alternative methods are used to construct fiscal policy volatility. In column (1), we include CPI as a control variable in the first-stage equation to compute fiscal policy volatility (equation (5)). In column (2), both CPI and time trend (t) are included as control variables in equation (5). In column (3), we include CPI, time trend (t) and a further lagged dependent variable ($\Delta \log G_{p,t-2}$) in equation (5). In column (4), we adopt the 2-stage IV approach to estiamte equation (5), where lagged provincial GDP growth ($\Delta \log Y_{p,t-1}$) is used to instrument current GDP growth. In column (5), we opt for the non-parametric regression method, locally weighted average estimator, to compute fiscal policy volatility; and in column (6), another non-parametric regression method, local constant estimator, is used to compute fiscal policy volatility. In column (7), we choose the 3-year non-overlapping time interval approach, i.e. 1996-1998, 1999-2001, 2001-2004, and 2005-2007, to compute the fiscal policy volatility for each period. The corresponding $\sigma(MRPK^{RA})$ is from year 1998, 2001, 2004 and 2007. Lastly, in column (8), we adopt the 4-year non-overlapping time interval approach, i.e. 1996-1999, 2000-2003, and 2004-2007, to compute the fiscal policy volatility for each period. The corresponding $\sigma(MRPK^{RA})$ is from year 1999, 2003 and 2007.

[Table 4 about here.]

In Table 5, we adopt four alternative approaches to estimate the output elasticity of capital and $MRPK^{RA}$ dispersion, including the Levinsohn and Petrin (2003) approach, the Wooldridge (2009) approach, the system GMM estimator, and the Ackerberg et al. (2015) approach. 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 $MRPK^{RA}$ dispersion.

[Table 5 about here.]

6 Possible economic channels

6.1 Budgetary versus extrabudgetary expenditure

We now investigate the possible channels through which fiscal policy volatility affects the risk-adjusted MRPK dispersion. For instance, whether the effect is driven by budgetary expenditure or extrabudgetary expenditure of provincial governments? Table C.1 in Appendix presents some further descriptive statistics of this exercise. The first three columns show that the share of budgetary expenditure in total government expenditure increases from 1998 to 2007 in all provinces, indicating the declining role of extrabudgetary expenditure as a result of fiscal reforms aiming at increasing fiscal transparency. Using the method of variance decomposition, we decompose the fiscal policy volatility into three components: volatility due to budgetary expenditure ($FisVolB$), volatility due to extrabudgetary expenditure ($FisVolEB$), and a covariance term between budgetary and extrabudgetary expenditure ($FisVolCov$). Columns (4)-(6) present the share of three components in total fiscal policy volatility in each province, where both budgetary and extrabudgetary expenditure are found to play a key role in driving fiscal policy volatility in Chinese provinces whose contributions are 60% and 52% respectively. The contribution of the covariance term is -12%, indicating the complementary relationship between the two types of government expenditure, i.e. the use of extrabudgetary expenditure may reduce the need to excessively adjust the budgetary expenditure especially when binding constraints are tight, thus alleviating the overall fiscal policy volatility.

Table 6 reports the effect of three components of fiscal policy volatility on $MRPK^{RA}$ dispersion. We find that fiscal policy volatility resulted from budgetary expenditure ($FisVolB$) is the main driver of capital misallocation, whereas neither the volatility from the extrabudgetary expenditure ($FisVolEB$) nor the covariance term ($FisVolCov$) turn out to have significant impact. This maybe due to the fact that government's investment in fixed assets is mainly included in the budgetary expenditure, which has direct impact on capital misalloaction among manufacturing firms. On the other hand, extrabudgetary expenditure covers mainly expenditure for city maintenance or other administrative and operative expenditure, which has limited impact on capital allocation in the manufacturing sector.

[Table 6 about here.]

6.2 Province heterogeneity and spillover effects

Table 7 reports the province heterogeneity effects in order to further shed light on the role of adjustment costs, financial frictions and policy distortions in shaping the nexus between fiscal policy volatility and the risk-adjusted MRPK dispersion. Columns (1) and (2) distinguish the effects between coastal and inland provinces. The positive and significant impact of fiscal policy volatility on $MRPK^{RA}$ dispersion is only found for Central and Western provinces where the capital adjustment costs are argued to be high. In Columns (3) and (4), we distinguish provinces in terms of the extent of financial dependence[19], and find that the positive effect of fiscal policy volatility is only found in provinces with low financial dependence, which also turn out to be those inland provinces where capital market imperfections are most severe. In columns (5)-(8), we find that the positive link between fiscal policy volatility and $MRPK^{RA}$ dispersion is only significant for provinces with high level of government intervention[20] or high share of SOE in economic output[21], indicating that policy distortion induced by government intervention or state ownership is an important channel through which fiscal policy volatility affects capital misallocation.

[Table 7 about here.]

We next examine whether there is any spillover effect from neighbouring provinces, i.e. whether the risk-adjusted MRPK dispersion of each province is affected by fiscal volatility originated from adjacent provinces? We define the fiscal volatility from neighbouring provinces ($FisVol-Neighbour$) as the natural logarithm of the average fiscal policy volatility of all neighbouring provinces of province p at year t. In Table

[19]We define $High\ FD$ or $Low\ FD$ as a dummy variable which is equal to one if the average financial dependence (FD) of province p is higher or lower than the median value of FD, and zero otherwise.

[20]We define $High\ GovSize$ or $low\ GovSize$ as 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.

[21]We define $High\ SOE$ or $low\ SOE$ as 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.

8, we find strong evidence of spillover effect from adjoining provinces as indicated by the positive and significant coefficient of neighbouring provinces' fiscal volatility in all models, where columns (1) and (2) apply the panel data fixed effects model, columns (3) and (4) use the fixed effects Spatial Durbin Model, and columns (5) and (6) adopt the random effects Spatial Durbin Model. The significance of the Spatial rho statistic suggests the presence of spatial autocorrelation and proves the validity of the use of spatial models. The significance of Hausman specification test favours the fixed effects Spatial Durbin model. Our main result of a positive link between fiscal policy volatility and $MRPK^{RA}$ dispersion remains robust. Our results show that despite the presence of local protectionism at the province level, capital allocation efficiency of each province can be affected by demand shocks from other nearby provinces.

[Table 8 about here.]

6.3 Industry heterogeneity effects

We also examine the heterogeneous effects among different industries. In Table 9, we find that among all 29 2-digit manufacturing industries, the impact of fiscal policy volatility is significantly positive for 18 industries but insignificant for the other 11 industries[22], implying widespread heterogeneous responses to fiscal policy shock at the industry level.

[Table 9 about here.]

We then explore possible sources of industry heterogeneity in Table 10. First, we adopt Rajan and Zingales (1998)'s measure of industry's dependence on external finance (IFD), where the sum of firms' use of external finance over the 1980's is divided by the sum of capital expenditure over the 1980's for 425 4-digit US manufacturing industries[23]. Using the Difference-in-Difference (DID) method and controlling for both industry-year effects and province-year effects, we find that the coefficient of interaction term between the industry-level financial dependence and fiscal policy volatility is significantly positive in column (1), suggesting that the capital allocation efficiency of industrial sectors that are relatively more dependent on external finance are more likely to be adversely influenced by fiscal policy volatility. One possible explanation

[22] For this industry-level analysis, we compute the MRPK dispersion among firms in each of 29 industries in each province.

[23] We convert the SIC industry codes to corresponding GB (2002) industry level when merging it to the Chinese dataset.

is that since external funds are much more expensive than internal funds, industries that are heavily dependent on external finance may face higher capital adjustment costs than those rely more on internal finance, and thus exacerbating the impact of demand-side shock on capital misallocation.

Second, another industry-specific factor which might affect capital adjustment cost is the sunk costs of investment. We use Balasubramanian and Sivadasan (2009)'s capital resalability index ($CapRes$), which is defined as the share of used capital investment in total capital investment at each 4-digit US industry[24]. This measure of capital resalability is to capture recoverability of investments, which is an inverse proxy for the extent of sunkenness of capital investments. Three sets of index are used, where $CapRes1$ 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 (2)-(4), we find that the coefficents of interaction terms between fiscal policy volatility and all three capital resalability index are negative and significant, implying that the risk-adjusted MRPK dispersion of industrial sectors with higher sunkenness of capital investment, indicated by lower capital resalability, is more likely to be affected by fiscal policy volatility.

Lastly, using the 2005 World Bank Investment Climate database of more than 12,000 Chinese manufacturing firms, we compute the degree of reliance on governance demand ($GovDem$) for every 2-digit industrial sector in China. 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[25]. In columns (5)-(7), we find a significant and positive interaction term between fiscal policy volatility and government demand, suggesting that industries that are more reliant on government and SOE purchase are more likely to be influenced by fiscal policy volatility when allocating capital.

[Table 10 about here.]

[24] The used capital expenditure data is from the US Bureau of the Census. We convert the SIC industry codes to corresponding GB (2002) industry level when merging it to the Chinese dataset.

[25] 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?'.

7 Alternative channels: labour, intermediate inputs and TFP

7.1 Evidence

In addition to the effect on capital misallocation, we examine whether fiscal policy volatility can affect the allocation efficiency of other inputs such as labour and intermediate material inputs, which leads to the overall resource misallocation. One justification of this exercise is that there exist adjustment costs in other inputs and frictions or distortions in the corresponding markets. On the one hand, labour market frictions such as firing costs are found to generate large aggregate TFP losses (Da-Rocha et al., 2016). Cooper et al. (2017) claim that labour adjustment is costly in China due to its new labour regulations which 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 significant reduction in labour reallocation and thus productivity and output losses. On the other hand, intermediate inputs are subject to adjustment costs as well. For instance, 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.

Using the similar method as equations (4) and (5), we compute the risk-adjusted marginal revenue product of labour ($MRPL^{RA}$) and the marginal revenue product of intermediate inputs ($MRPM^{RA}$) of manufacturing firms and their corresponding dispersion in province p at year t, i.e. $\sigma(MRPL_{p,t}^{RA})$ and $\sigma(MRPM_{p,t}^{RA})$. Lastly, we compute the overall risk-adjusted TFP dispersion of manufacturing firms in province p at year t, i.e. $\sigma(TFP_{p,t}^{RA})$. Table 11 reports results. We find that the impact of fiscal policy volatility on these three types of dispersion is positive and significant, indicating that fiscal policy volatility can not only generate misallocation in the capital markets, but also lead to dispersion of marginal products in labour and intermedidate input markets and the overall TFP dispersion.

[Table 11 about here.]

7.2 A new mechanism from a theoretical model

We present a simple theoretical model in order to better understand how the dynamic chosen input (capital), when coupled with adjustment cost and demand volatility, can not only shed light on the dispersion of the static marginal revenue product of the dynamic input but also shape the dispersion of the marginal revenue product of the *static* inputs (labour and intermediate material inputs). Unlike the existing literature which relies on the presence of adjustment costs in inputs markets to rationalize the link, we propose a new transmission mechanism. That is, if the quality of inputs (material quality and human capital) are complementary to physical capital and promote the quality of output, then the misallocation of capital induced by the aggregate demand shock (fiscal policy volatility) will influence the quality choices of material and labour inputs and further cause the dispersion of marginal revenue products of these inputs.

The dynamic framework of the model follows from Asker et al. (2014) and the static component is inspired by Kugler and Verhoogen (2012) and Grieco et al. (2017). We start from a Cobb-Douglas production function of a profit-maximizing firm:

$$Q_{it} = e^{\omega_{it}} K_{it}^{\alpha_K} L_{it}^{\alpha_L} M_{it}^{\alpha_M}, \tag{8}$$

where Q_{it} is output of firm i at time t, and ω_{it}, K_{it}, L_{it}, and M_{it} are productivity, capital, labour and material inputs respectively. In particular, $\alpha_K + \alpha_M + \alpha_L = 1$. Assuming the (inverse) demand curve for firm's product with constant elasticity,

$$P_{it} = b_t^{\frac{1}{\eta}} Q_{it}^{-\frac{1}{\eta}} h(g(K_{it}), \nu_{it}, \mu_{it}), \tag{9}$$

where b_t is the aggregate demand (fiscal policy) shock and $\eta > 1$. $h(g(K_{it}), \nu_{it}, \mu_{it})$ is the output quality of firm i, which depends on a measure of capital stock $g(K_{it})$, material input quality ν_{it}, and labour quality (i.e., human capital) μ_{it}. We assume $\frac{\partial g(K)}{\partial K} > 0$. We following Kugler and Verhoogen (2012) to allow for flexible rate of substitution across these variables in the production of output quality:

$$h(g(K_{it}), \nu_{it}, \mu_{it}) = [\gamma_K g(K_{it})^\theta + \gamma_L \mu^\theta + \gamma_M \nu^\theta]^{\frac{1}{\theta}}, \tag{10}$$

where $\gamma_K + \gamma_L + \gamma_M = 1$. When $\theta < 0$ 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 of inputs.

However, the unit prices of labour and material are increasing in their quality:

$$P_L = \mu^{\phi_L}, P_M = \nu^{\phi_M}, \tag{11}$$

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

Given the dynamic state $(b_t, \omega_{it}, K_{it})$, denote the firm's maximized static period profit as $\pi(b_t, \omega_{it}, K_{it})$.

On the dynamic aspect, 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 cost, which consists of a fixed cost and a variable adjustment cost, in addition to I_{it}:

$$C(I_{it}, K_{it}, \omega_{it}, b_t) = I_{it} + C_K^F \mathbf{1}(I_{it} \neq 0)\pi(I_{it}, K_{it}, \omega_{it}, b_t) + C_K^V K_{it} \left(\frac{I_{it}}{K_{it}}\right)^2. \tag{12}$$

Further, we assume productivity and the aggregate demand 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.

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

$$\begin{aligned} V(\omega_{it}, b_t, K_{it}) = &\max_{I_{it}} \pi(\omega_{it}, b_t, K_{it}) - C(I_{it}, K_{it}, \omega_{it}, b_t) + \\ &\beta \int_{\omega_{it+1}, b_t} V(\omega_{it+1}, b_{t+1}, \delta K_{it} + I_{it}) dF(\omega_{it+1}, b_{t+1} | \omega_{it}, b_t). \end{aligned} \tag{13}$$

Appendix D shows that the marginal revenue product of labour in logarithm is

$$MRPL \equiv \log(P_L) = \mu_{it}^{\phi_L} \propto \phi_L \log(g(K_{it})), \tag{14}$$

and similarly, the marginal revenue product of material input in logarithm is

$$MRPM \equiv \log(P_M) = \nu_{it}^{\phi_M} \propto \phi_M \log(g(K_{it})), \tag{15}$$

Asker et al. (2014) suggest that the demand uncertainty and dispersion of static MRPK (and capital) are positively related. Equations (14) and (15) show that if 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. Since firms choose the quantity of static inputs to equalize their marginal revenue products and their prices, this implies that capital misallocation further influences the dispersion of marginal revenue products of labour and intermediate material inputs, as illustrated by Figure 9. This model is closely related to Asker et al. (2014), but we show how the dynamic input, when coupled with adjustment cost and demand volatility, can not only shed light on the dispersion of the static marginal revenue product of the dynamic input but also shapes the dispersion of the marginal revenue product of the static inputs.

[Figure 9 about here.]

8 Possible reasons for fiscal policy volatility in China

8.1 Mismatch between expenditure and revenue of local governments – an outcome of the 1994 fiscal reform

Fiscal system in China has undergone significant changes since 1978. The original Chinese fiscal system was a highly centralized one, where the central government had absolute control over revenue collections and budget appropriation, i.e. 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 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 remittance to the central government. Fiscal decentralization is argued to be conducive to China's economic growth by improving efficiency of resource allocation and boosting investment at the local level (Lin and Liu, 2000). However, one direct outcome of fiscal decentralization is the dramatic decline of 'two ratios', i.e. 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 so as to restrengthen the central government's role in the fiscal system through a tax sharing system, where taxes were assigned to 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 levels of governments, which not only led to distortions that impair the role of central and local governments in providing public goods and services but also generated unnecessary fiscal volatility. For instance, many local governments have to face a huge fiscal gap, and rely heavily on extrabudgetary revenue[26] and/or accumulate large amount of government debt to cope with their increasing fiscal problems. 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).

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 central government in order to relieve local governments' fiscal burden.

8.2 Low fiscal transparency

Fiscal transparency comprises of 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 Chinese government provides scant or no information to the pubic. 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, there is a negative correlation between fiscal

[26]Extrabudgetary revenue is non-tax revenue collected by local governments, central government agencies and government institutions outside the normal budgetary process. According to Fan (2013), local governments providing public services at the local level finance half or more of their expenditures from extrabudgetary revenue.

policy volatility and fiscal transparency index[27] across Chinese provinces as illustrated by Figure 10.

[Figure 10 about here.]

Thus, more recent fiscal reforms focus on improving fiscal transparency. Since 2000, China has legalized and publicized government expenditures through a number of reforms including treasury centralized payment system, government procurement system, revenue and expenditure separate management and so on. Since January 2011, all extrabudgetary funds have been merged into budgetary management in order to eliminate the discretionary use of the former and therefore enhance fiscal transparency.

8.3 Rising regional fiscal disparity

Another important feature of China's fiscal system is the growing fiscal disparities across regions. Rich provinces in the East have abundant fiscal revenue and provide good public services and investment in local infrastructure. By contrast, there is a deterioration in public services provided by provinces in the Central and Western regions due to their serious fiscal problems. This is a joint outcome of both rising income inequality between coastal and inland provinces and the absence of an efficient transfer and supporting system from the central government to ensure minimum standards of service provision across regions. In 1999, a 'Go West' development strategy was launched by the central government in order to direct more fiscal resources to poorer regions in order to reverse the worrying trend of regional inequality. However, the outcome seems rather limited as indicated by the high fiscal volatility in the inland provinces, which has significant impact on their capital allocation efficiency.

9 Conclusion

Firms face considerable uncertainty about future conditions affecting their costs, demand and profitability, which affects their decisions on capital allocation and investment. We focus on the uncertainty arisen from a particular form of policy shock, i.e. the excessive discretionary changes in fiscal policy that do not represent reaction to economic conditions. We find that the aggressiveness of use of fiscal discretionary policy leads to capital misallocation (as proxied by the dispersion of risk-adjusted MRPK)

[27] The information of fiscal transparency index is from the 2005 Chinese governments' performance evaluation website published by the Ministry of Commerce of China.

in manufacturing firms in China, and the effect depends on factors relating to capital adjustment costs, financial frictions and policy distortions. Based on a theoretical model, we discover that the impact of fiscal policy volatility on the static measure of capital misallocation can transmit to the dispersion of marginal revenue products of other factor inputs, thus affecting the overall resource allocation efficiency. This calls for further fiscal reforms in China such as the expenditure-side fiscal reform, increasing fiscal transparency and reducing regional fiscal disparity so as to constrain fiscal policy discretion and reduce the corresponding volatility.

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Table 1: The effect of fiscal policy volatility on the risk-adjusted MRPK dispersion: baseline results

	(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
Contribution	27.4%	21.6%	25.4%	26.6%	18.5%	15.4%	12.0%	8.9%

Notes: the dependent variable is $\sigma(MRPK^{RA})$; see Appendix B for detailed definitions of all variables; Contribution refers to the contribution of changes in fiscal policy volatility to the changes in observed risk-adjusted MRPK dispersion between 1998 and 2007; *** p<0.01, ** p<0.05, * p<0.1.

Table 2: The effect of fiscal policy volatility on the risk-adjusted MRPK dispersion: the reverse causality problem (type 1 endogeneity)

	Two-stage instrumental variable (IV) approach					System GMM estimator	
Second stage	(1)	(2)	(3)	(4)	(5)	(6)	(7)
FisVol	0.070***	0.240*	0.075***	0.022*	0.152*	0.120***	0.089***
	(0.019)	(0.125)	(0.019)	(0.012)	(0.084)	(0.022)	(0.025)
GovSize	0.076*	0.020	0.073*	0.136***	0.092*		-0.014
	(0.043)	(0.065)	(0.043)	(0.027)	(0.054)		(0.049)
Subsidy	0.003	-0.003	0.004	-0.022	-0.022		0.005
	(0.013)	(0.018)	(0.013)	(0.015)	(0.017)		(0.026)
FD	0.025	0.016	0.026	-0.068***	-0.066***		-0.014
	(0.028)	(0.029)	(0.028)	(0.010)	(0.013)		(0.024)
Inflation	0.081*	0.093*	0.080*	-0.002	-0.000		0.002
	(0.043)	(0.053)	(0.043)	(0.002)	(0.002)		(0.004)
Export	-0.006**	0.003	-0.006**	-0.017***	-0.009		-0.009**
	(0.002)	(0.007)	(0.002)	(0.003)	(0.015)		(0.003)
Underidentification test	25.904***	3.228*	70.040***	29.308***	4.898*	—	—
Weak identification test	32.62***	3.56*	47.23***	39.23***	2.39*	—	—
AR(2) test	—	—	—	—	—	-0.96	-1.42
Hansen J test	—	—	1.779	1.984	1.756	27.58	29.16
Obs	279	310	279	270	300	310	310
First stage							
L. (FisVol)	0.526***		0.512***	0.717***			
	(0.092)		(0.056)	(0.085)			
WheatRice		0.098*	0.077**		0.005		
		(0.052)	(0.038)		(0.009)		
PortOpen				-0.002**	-0.003**		
				(0.001)	(0.001)		

Notes: the dependent variable is $\sigma(MRPK^{RA})$; the underidentification 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.see Appendix B for detailed definitions of all variables; *** p<0.01, ** p<0.05, * p<0.1.

Table 3: The effect of fiscal policy volatility on the risk-adjusted MRPK dispersion: the omitted variable problem (type 2 endogeneity)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
FisVol	0.071***	0.023**	0.060***	0.012***	0.042***	0.023**	0.023**	0.023**	0.023**
	(0.010)	(0.009)	(0.012)	(0.002)	(0.013)	(0.011)	(0.010)	(0.010)	(0.010)
GDPVol	0.013	0.001							
	(0.008)	(0.009)							
TFPGVol			0.061***	0.030**					
			(0.019)	(0.013)					
SOE					0.043**	-0.018			
					(0.020)	(0.016)			
FOR					-0.041***	-0.025***			
					(0.010)	(0.005)			
PolVol1							0.001		0.001
							(0.002)		(0.002)
PolVol2								0.002	0.002
								(0.002)	(0.002)
GovSize		-0.081		-0.060		-0.081	-0.083	-0.090	-0.090
		(0.060)		(0.055)		(0.062)	(0.060)	(0.063)	(0.063)
Subsidy		0.003		-0.002		0.007	0.003	0.003	0.003
		(0.014)		(0.015)		(0.014)	(0.014)	(0.014)	(0.014)
FD		0.013		0.035		0.013	0.011	0.017	0.015
		(0.030)		(0.034)		(0.032)	(0.030)	(0.030)	(0.030)
Inflation		-0.004*		-0.003		-0.004*	-0.004*	-0.004*	-0.004*
		(0.002)		(0.002)		(0.002)	(0.002)	(0.002)	(0.002)
Export		-0.011		-0.027*		-0.013	-0.011	-0.013	-0.012
		(0.017)		(0.016)		(0.015)	(0.018)	(0.017)	(0.018)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes	Yes	Yes	Yes
R^2	0.148	0.462	0.179	0.465	0.293	0.483	0.463	0.464	0.465
Obs	310	310	279	279	307	307	310	310	310

Notes: the dependent variable is $\sigma(MRPK^{RA})$; see Appendix B for detailed definitions of all variables; *** p<0.01, ** p<0.05, * p<0.1.

Table 4: The effect of fiscal policy volatility on the risk-adjusted MRPK dispersion: 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)
GovSize	-0.085	-0.085	-0.079	-0.086	-0.094	-0.086	0.002	0.045
	(0.061)	(0.061)	(0.061)	(0.061)	(0.057)	(0.061)	(0.084)	(0.108)
Subsidy	0.004	0.005	0.003	0.003	0.004	0.003	0.012	-0.022
	(0.014)	(0.014)	(0.014)	(0.014)	(0.013)	(0.014)	(0.016)	(0.028)
FD	0.016	0.014	0.014	0.008	0.011	0.017	0.089	0.080
	(0.031)	(0.031)	(0.030)	(0.030)	(0.028)	(0.030)	(0.058)	(0.062)
Inflation	-0.003*	-0.003*	-0.003	-0.004*	-0.004**	-0.004**	-0.790*	-0.453**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.417)	(0.209)
Export	-0.015	-0.015	-0.010	-0.017	-0.017	-0.015	-0.055**	-0.006
	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)	(0.024)	(0.033)
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
Obs	310	310	310	310	310	310	124	93

Notes: the dependent variable is $\sigma(MRPK^{RA})$; Column (1) includes CPI as a control variable in equation (5); Column (2) includes both CPI and time trend (t) as control variables in equation (5); Column (3) includes CPI, time trend (t) and a further lagged dependent variable ($\Delta \log G_{p,t-2}$) in equation (5); Column (4) adopts the instrumental variable (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, i.e. 1996-1998, 1999-2001, 2001-2004, and 2005-2007, to compute the fiscal policy volatility for each period. The corresponding $\sigma(MRPK)$ is from year 1998, 2001, 2004 and 2007; Column (8) adopts the 4-year non-overlapping time interval approach, i.e. 1996-1999, 2000-2003, and 2004-2007, to compute the fiscal policy volatility for each period. The corresponding $\sigma(MRPK)$ is from year 1999, 2003 and 2007. See Appendix B for detailed definitions of all variables; *** p<0.01, ** p<0.05, * p<0.1.

Table 5: The effect of fiscal policy volatility on the risk-adjusted MRPK dispersion: the mismeasurement problem of $MRPK^{RA}$ dispersion

	Levinsohn and Petrin (2003)		Wooldridge (2009)		System GMM		Ackerberg et al. (2015)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FisVol	0.031**	0.023**	0.031**	0.023**	0.034**	0.025**	0.029*	0.022*
	(0.014)	(0.010)	(0.014)	(0.010)	(0.014)	(0.010)	(0.015)	(0.013)
GovSize	0.049	-0.082	0.049	-0.082	0.057	-0.079	0.114***	-0.030
	(0.035)	(0.061)	(0.035)	(0.061)	(0.036)	(0.063)	(0.029)	(0.066)
Subsidy	0.009	0.003	0.009	0.003	0.008	0.002	-0.001	-0.007
	(0.013)	(0.014)	(0.013)	(0.014)	(0.013)	(0.014)	(0.017)	(0.017)
FD	0.083*	0.012	0.083*	0.012	0.085*	0.013	0.087	0.034
	(0.047)	(0.030)	(0.047)	(0.030)	(0.049)	(0.032)	(0.055)	(0.043)
Inflation	-0.005**	-0.004*	-0.005**	-0.004*	-0.005***	-0.004*	-0.006**	-0.005*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Export	-0.073***	-0.012	-0.073***	-0.012	-0.076***	-0.012	-0.052***	-0.001
	(0.018)	(0.017)	(0.018)	(0.017)	(0.019)	(0.018)	(0.019)	(0.024)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes	No	Yes
R^2	0.306	0.462	0.306	0.462	0.325	0.479	0.297	0.404
Obs	310	310	310	310	310	310	310	310

Notes: the dependent variable is $\sigma(MRPK^{RA})$; see Appendix B for detailed definitions of all variables; *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Budgetary expenditure versus extrabudgetarty expenditure

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
FisVolB	4.754***	3.427***					4.771***	3.277**
	(0.743)	(1.174)					(0.763)	(1.236)
FisVolEB			0.253	2.432			-0.255	1.432
			(1.664)	(1.596)			(1.781)	(1.788)
FisVolCov					0.036	0.185***	-0.015	0.082
					(0.063)	(0.054)	(0.079)	(0.083)
GovSize	0.108**	-0.039	0.046	-0.097	0.048	-0.099	0.111**	-0.045
	(0.046)	(0.075)	(0.036)	(0.062)	(0.037)	(0.060)	(0.049)	(0.077)
Subsidy	0.013	0.006	0.012	0.003	0.012	0.003	0.014	0.004
	(0.014)	(0.014)	(0.014)	(0.015)	(0.014)	(0.015)	(0.014)	(0.015)
FD	0.070	0.010	0.082*	0.005	0.083*	0.014	0.070	0.009
	(0.047)	(0.033)	(0.048)	(0.027)	(0.049)	(0.030)	(0.048)	(0.029)
Inflation	-0.004***	-0.004**	-0.006***	-0.003*	-0.006***	-0.004*	-0.005**	-0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Export	-0.075***	-0.020	-0.091***	-0.020	-0.091***	-0.019	-0.075***	-0.016
	(0.017)	(0.018)	(0.016)	(0.015)	(0.016)	(0.016)	(0.018)	(0.018)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes	No	Yes
R^2	0.347	0.481	0.285	0.457	0.285	0.455	0.347	0.484
Obs	310	310	310	310	310	310	310	310

Notes: the dependent variable is $\sigma(MRPK^{RA})$; see Appendix B for detailed definitions of all variables; *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Province heterogeneity effects

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	East	Centre & West	High FD	Low FD	Low GovSize	High GovSize	Low SOE	High SOE
FisVol	0.007	0.027**	0.001	0.026**	0.008	0.035*	0.014	0.033*
	(0.015)	(0.012)	(0.018)	(0.011)	(0.009)	(0.017)	(0.010)	(0.019)
GovSize	-0.029	-0.079	-0.038	-0.106	0.042	-0.068	-0.043	-0.076
	(0.070)	(0.104)	(0.079)	(0.111)	(0.084)	(0.084)	(0.065)	(0.094)
Subsidy	-0.019	0.016	0.006	0.018	0.010	0.005	0.012	0.003
	(0.016)	(0.021)	(0.021)	(0.023)	(0.018)	(0.016)	(0.014)	(0.016)
FD	0.006	0.036	0.039	0.035	-0.003	0.035	-0.017	0.044
	(0.047)	(0.045)	(0.051)	(0.065)	(0.040)	(0.047)	(0.041)	(0.056)
Inflation	-0.003	-0.005	0.000	-0.004	-0.007***	-0.001	-0.004	-0.002
	(0.005)	(0.003)	(0.004)	(0.004)	(0.002)	(0.004)	(0.004)	(0.006)
Export	-0.006	-0.012	-0.067	0.008	0.049	-0.017	0.004	-0.015
	(0.036)	(0.021)	(0.047)	(0.027)	(0.031)	(0.023)	(0.029)	(0.031)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.617	0.425	0.628	0.384	0.709	0.378	0.633	0.416
Obs	130	180	150	160	150	160	160	150

Notes: the dependent variable is $\sigma(MRPK^{RA})$; see Appendix B for detailed definitions of all variables; *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Province spillover effects

	(1) FE	(2) FE	(3) SDM-FE	(4) SDM-FE	(5) SDM-RE	(6) SDM-RE
FisVol	0.023**	0.021**	0.018*	0.020**	0.022**	0.022**
	(0.011)	(0.009)	(0.010)	(0.009)	(0.010)	(0.010)
FisVol-Neighbour	0.094***	0.063***	0.070***	0.063***	0.035**	0.035**
	(0.022)	(0.020)	(0.018)	(0.018)	(0.014)	(0.014)
GovSize	0.015	-0.076	-0.015	-0.085*	-0.022	-0.022
	(0.031)	(0.060)	(0.032)	(0.048)	(0.027)	(0.027)
Subsidy	0.010	0.005	0.007	0.006	0.004	0.004
	(0.011)	(0.012)	(0.010)	(0.009)	(0.010)	(0.010)
FD	0.077*	0.021	0.044	0.023	0.004	0.004
	(0.039)	(0.029)	(0.029)	(0.029)	(0.006)	(0.006)
Inflation	-0.001	-0.004*	0.000	-0.003	-0.001	-0.001
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Export	-0.061***	-0.017	-0.039**	-0.024	-0.019	-0.019
	(0.016)	(0.016)	(0.017)	(0.018)	(0.014)	(0.014)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes
Spatial rho statistic			0.367***	-0.009	0.436***	0.436***
			(0.075)	(0.104)	(0.071)	(0.071)
Hausman test					20.43***	9.20
R^2	0.367	0.482	0.070	0.119	0.133	0.133
Observation	310	310	310	310	310	310

Notes: the dependent variable is $\sigma(MRPK^{RA})$; columns (1) and (2) report the results of panel data fixed-effects model; columns (3) and (4) report the results of fixed-effects Spatial Durbin Model; and columns (5) and (6) report the results of random-effects Spatial Durbin Model; Spatial rho statistic is a test for spatial autocorrelation, and the null hypothesis is that there is no spatial autocorrelation; Hausman specification test is used to decide whether the random or fixed effects specification is more appropriate, and the null hypothesis is that is that the preferred model is random effects; see Appendix B for detailed definitions of all variables; *** p<0.01, ** p<0.05, * p<0.1.

Table 9: Industry heterogeneity effects

Industry code	Industry name	FisVol	S.D.	Obs
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

Notes: the dependent variable is $\sigma(MRPK^{RA})$ for each 2-digit industry in province p at year t; *** p<0.01, ** p<0.05, * p<0.1.

Table 10: The source of industry heterogeneity effects

	Financial dependence	Capital resalability			Government demand		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
*FisVol*IFD*	0.002***						
	(0.000)						
*FisVol*CapRes*		-0.038***	-0.102***	-0.071***			
		(0.011)	(0.018)	(0.017)			
*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
Obs	74738	63142	58092	57148	75174	75174	75174

Notes: the dependent variable is $\sigma(MRPK^{RA})$ for each 4-digit industry in province p at year t; 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 Appendix B for detailed definitions of all variables; *** p<0.01, ** p<0.05, * p<0.1.

Table 11: Alternative channels: labour, intermediate inputs and TFP

	MRPL dispersion		MRPM dispersion		TFP dispersion	
FisVol	0.036**	0.028**	0.037**	0.029**	0.031*	0.020*
	(0.015)	(0.011)	(0.014)	(0.011)	(0.015)	(0.011)
GovSize	0.170***	-0.016	0.146***	-0.012	0.265***	-0.034
	(0.045)	(0.074)	(0.043)	(0.071)	(0.040)	(0.084)
Subsidy	-0.003	-0.007	-0.001	-0.005	-0.015	-0.020
	(0.017)	(0.014)	(0.015)	(0.012)	(0.014)	(0.013)
FD	0.048	-0.003	0.077	0.022	0.032	-0.036
	(0.056)	(0.040)	(0.052)	(0.040)	(0.062)	(0.039)
Inflation	-0.014***	-0.000	-0.013***	-0.002	-0.013***	-0.005
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Export	-0.113***	-0.019	-0.094***	-0.009	-0.123***	-0.031
	(0.019)	(0.023)	(0.016)	(0.024)	(0.021)	(0.020)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	Yes	No	Yes
R^2	0.538	0.651	0.525	0.636	0.584	0.706
Obs	310	310	310	310	310	310

Notes: the dependent variables are $\sigma(MRPL^{RA})$, $\sigma(MRPM^{RA})$, and $\sigma(TFP^{RA})$ respectively; see Appendix B for detailed definitions of all variables; *** p<0.01, ** p<0.05, * p<0.1.

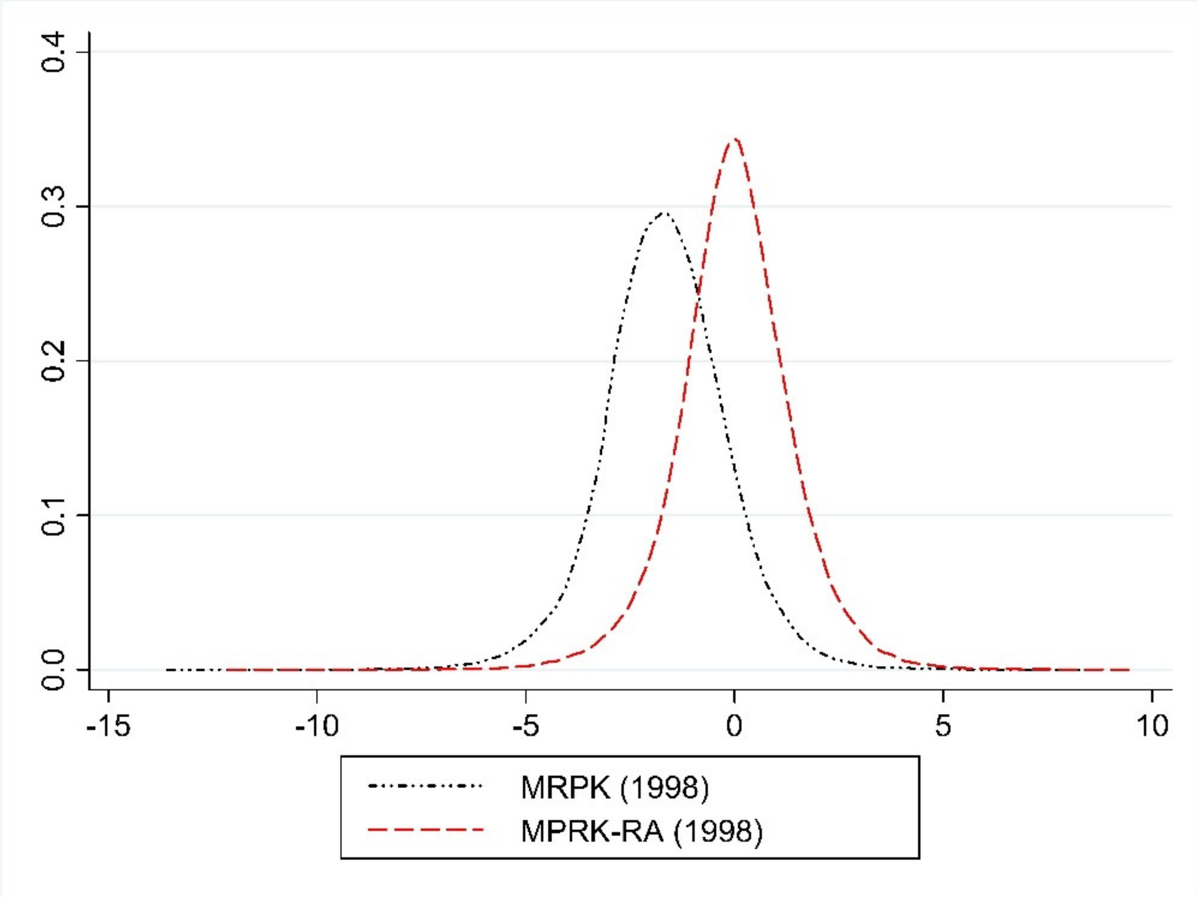

Figure 1: MRPK versus Risk-adjusted MRPK distribution in Chinese manufacturing industry: 1998

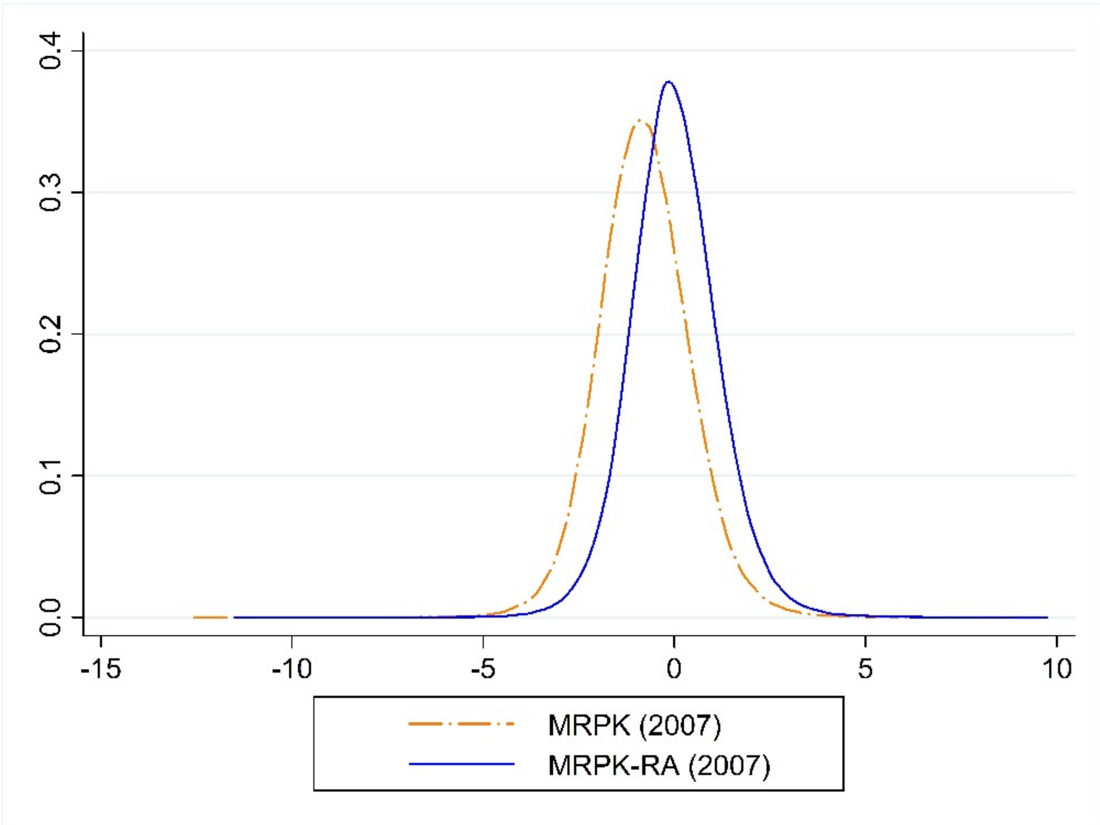

Figure 2: MRPK versus Risk-adjusted MRPK distribution in Chinese manufacturing industry: 2007

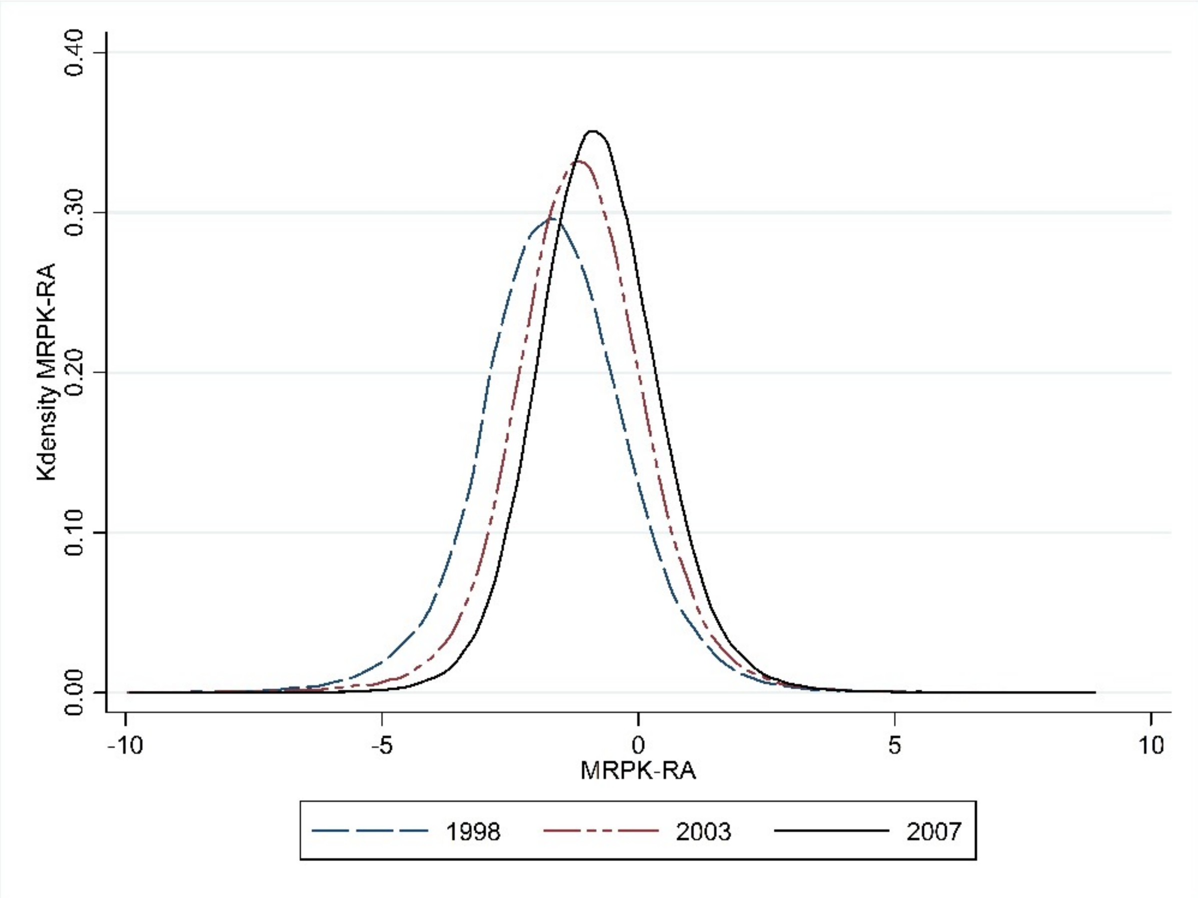

Figure 3: Risk-adjusted MRPK distribution in Chinese manufacturing industry: by year

Notes: The distribution is based on all manufacturing firms in China for each year in the NBS dataset.

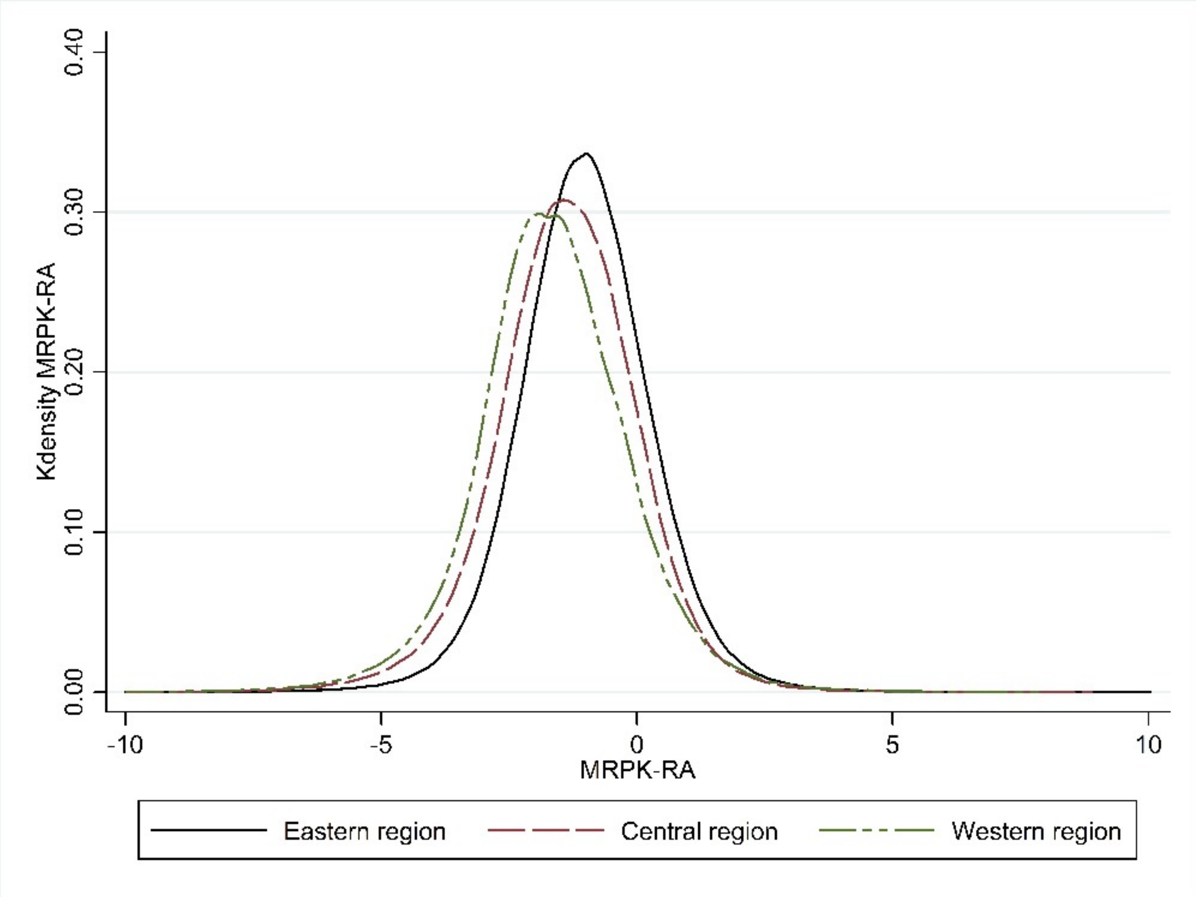

Figure 4: Risk-adjusted MRPK distribution in Chinese manufacturing industry: by region

Notes: The distribution is based on manufacturing firms in different regions in China in the NBS dataset. Eastern region includes Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Shandong, Guangzhou, Fujian and Hainan (11 provinces); Middle region includes Shanxi, Inner Mongolia, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan and Guangxi (10 provinces); and Western region includes Sichuan, Chongqing, Guizhou, Tibet, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia and Xinjiang (10 provinces).

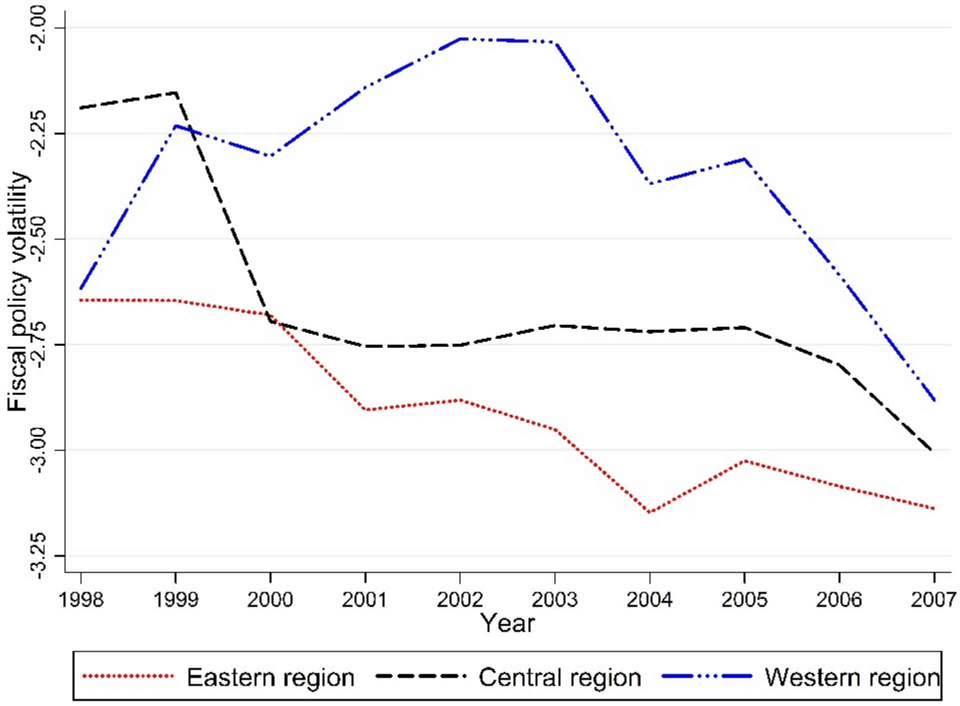

Figure 5: Fiscal policy volatility evolution in China: 1998-2007

Notes: region classification is the same as that in Figure 4.

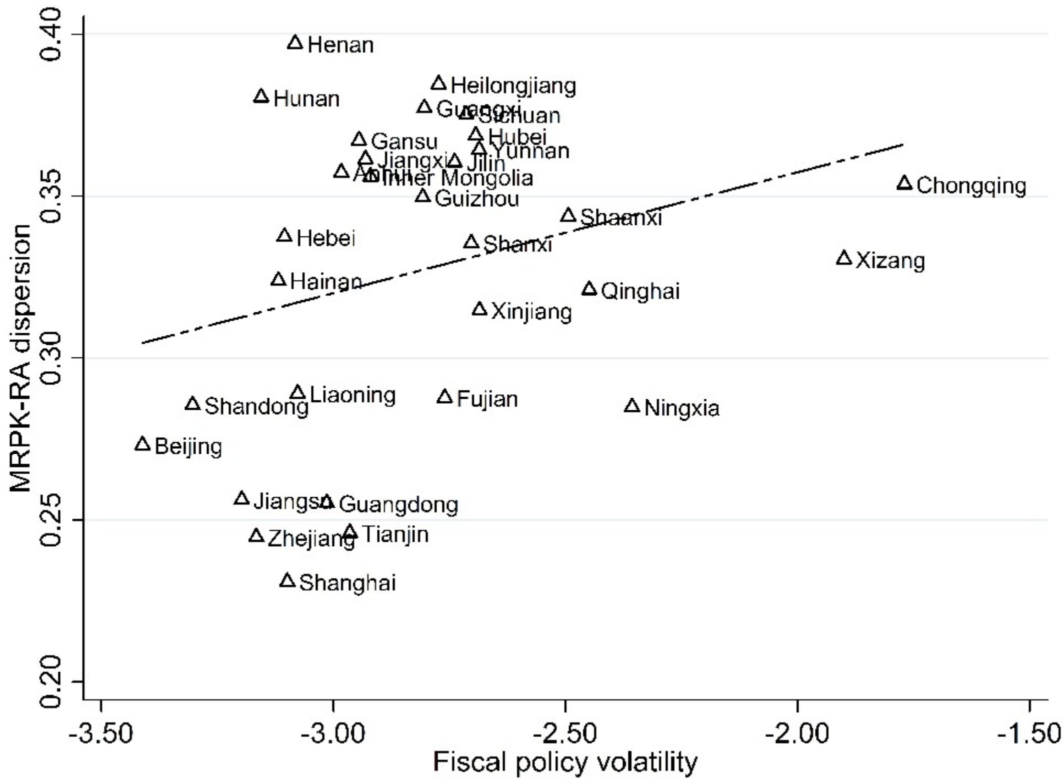

Figure 6: Correlation between risk-adjusted MRPK dispersion and fiscal policy volatility across Chinese provinces

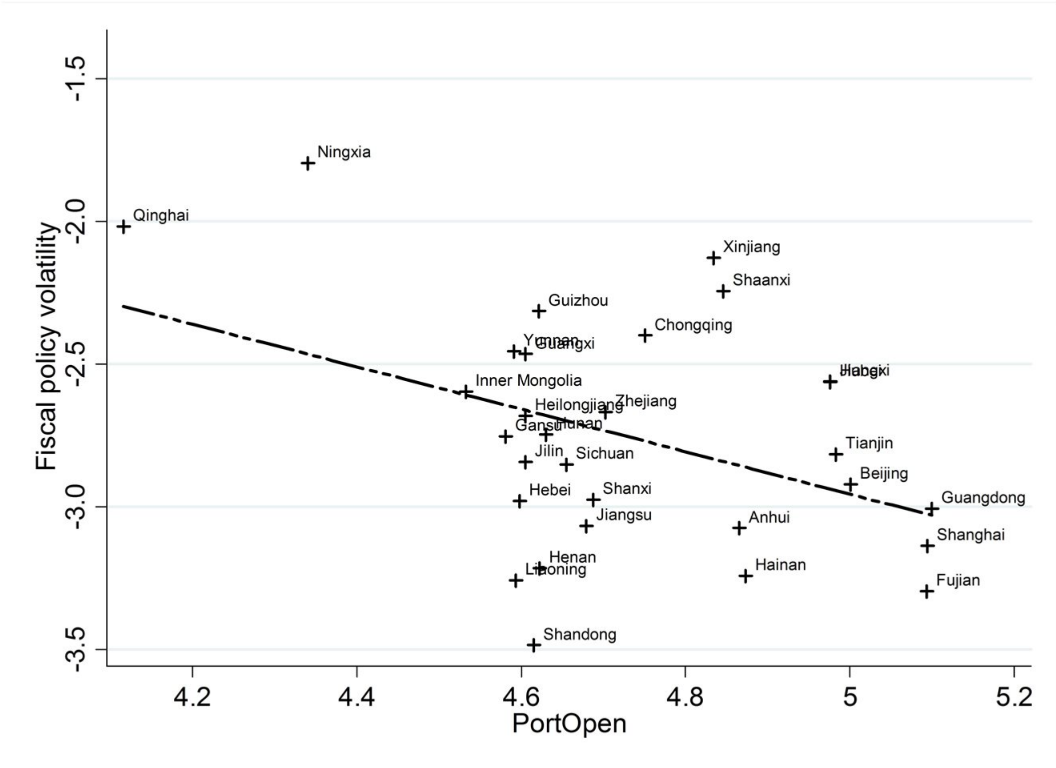

Figure 7: Correlation between fiscal policy volatility and wheat-rice ratio across Chinese provinces

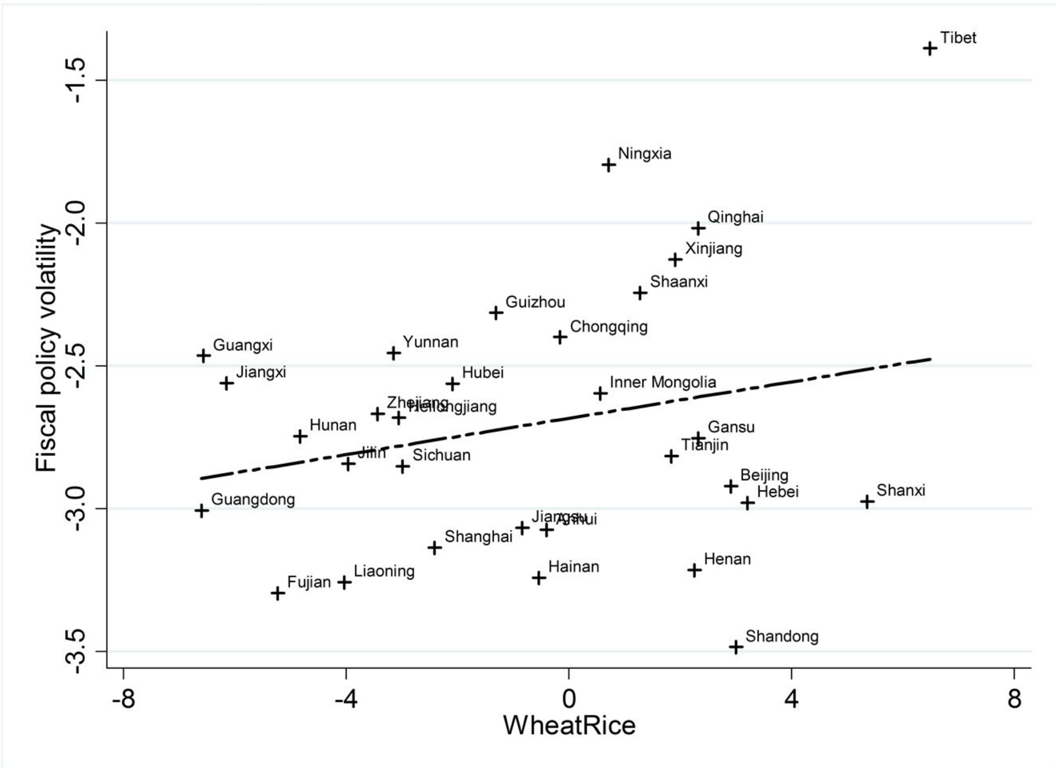

Figure 8: Correlation between fiscal policy volatility and port opening time across Chinese provinces

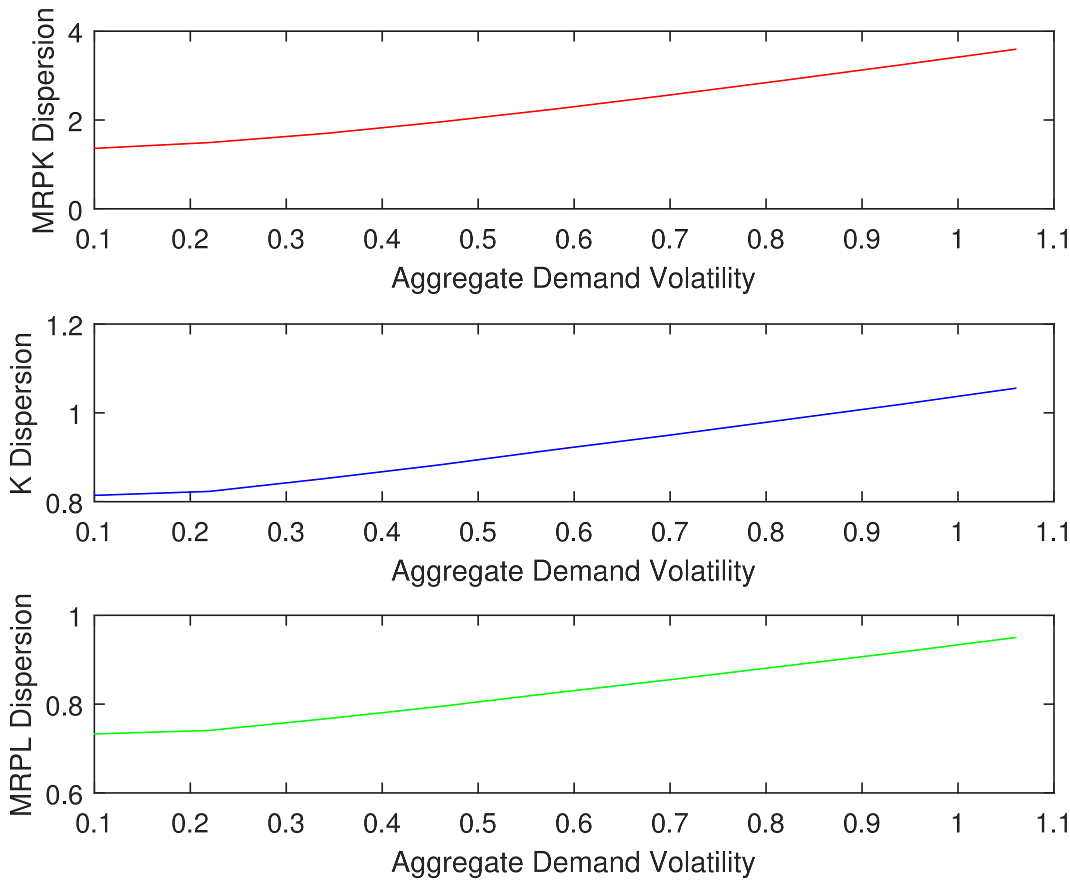

Figure 9: Relation between the dispersion of MRPK, capital and MRPL and aggregate demand volatility

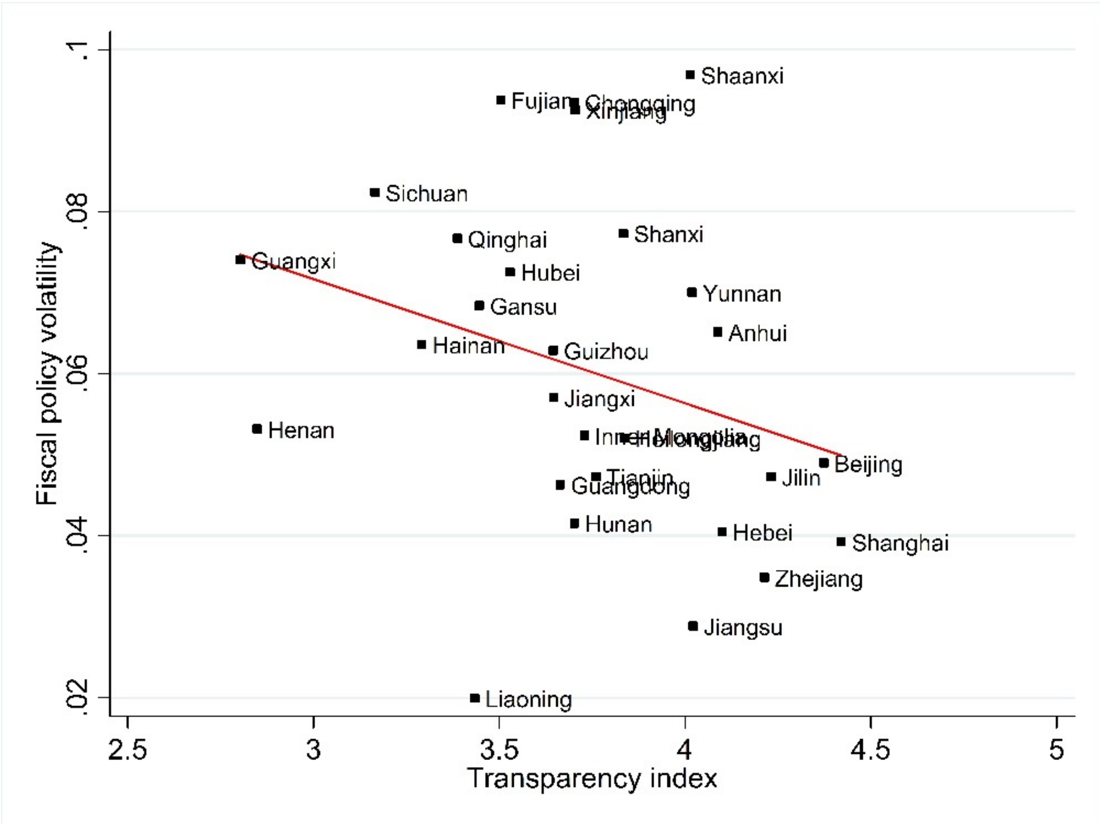

Figure 10: Correlation between fiscal policy volatility and government information transparency across Chinese provinces

Appendix

A Summary statistics

Table A.1: Summary statistics of all variables

Variable	Observation	Mean	Std. Dev.	Min	Max
$\sigma(MRPK)$	310	0.326	0.116	0.06	0.839
$\sigma(MRPK^{RA})$	310	0.294	0.124	0.005	0.840
FisVol	310	-2.779	0.505	-5.345	-0.538
GovSize	310	-1.864	0.424	-2.675	-0.159
Subsidy	310	-4.297	0.643	-5.811	-2.055
FD	310	-1.195	3.099	-9.43	0.812
Inflation	310	1.173	2.088	-3.3	6.64
Export	310	-2.349	0.925	-3.784	-0.072
GDPVol	310	-4.436	0.553	-6.472	-3.072
TFPGVol	279	-0.845	0.489	-1.93	0.645
SOE	310	-1.436	0.744	-4.159	-0.193
FOR	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
FisVol-Neighbour	310	-4.726	0.600	-6.612	-3.256
$\sigma(MRPL^{RA})$	310	0.137	0.147	-0.25	0.763
$\sigma(MRPM^{RA})$	310	0.13	0.146	-0.233	0.767
$\sigma(TFP^{RA})$	310	0.849	0.190	0.333	1.675
$\sigma(MRPK^{RA}_{LP})$	310	0.321	0.118	0.045	0.842
$\sigma(MRPK^{RA}_{Wooldrige})$	310	0.324	0.116	0.063	0.841
$\sigma(MRPK^{RA}_{GMM})$	310	0.463	0.098	0.242	0.908
$\sigma(MRPK^{RA}_{Ackerberg})$	310	0.373	0.117	0.08	0.838
WheatRice	310	-0.732	3.39	-8.157	6.916
PortOpen	30	4.726	0.222	4.116	5.1
L.FisVol	279	-2.734	0.472	-3.917	-0.538
IFD	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

Notes: see Appendix B for detailed definitions of all variables.

B Variable definitions

$\sigma(MRPK)$: MRPK dispersion in province p at year t, where the output elasticity of capital is computed using the Olley and Pakes (1996) approach;
$\sigma(MRPK^{RA})$: risk-adjusted MRPK dispersion in province p at year t, where the output elasticity of capital is computed using the Olley and Pakes (1996) approach;
FisVol: the natural logarithm of the fiscal policy volatility measure in province p at year t, i.e. $\log \sigma(\varepsilon_{p,t-2}, \varepsilon_{p,t-1}, \varepsilon_{p,t}, \varepsilon_{p,t+1}, \varepsilon_{p,t+2})$;
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 share of exports in provincial GDP at year t;
GDPGVol: output volatility, which is defined as the natural logarithm of volatility of the cyclical component of GDP in province p at year t using the Hodrick and Prescott (1997) filter, i.e. $\sigma(c_{p,t-2}, c_{p,t-1}, c_{p,t}, c_{p,t+1}, c_{p,t+2})$;
TFPGVol: TFP growth volatility, which is defined as the natural logarithm of the volatility of TFP growth of all manufacturing firms in province p at year t, i.e. $\sigma(TFPG_{i,p,t})$;
SOE: the natural logarithm of SOE share of total value added in manufacturing industries in province p at 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, which is defined as the length of service of governor of province p at year t;
PolVol2: political volatility, which is defined as the length of service of party secretary of province p at year t;
FisVolB : fiscal policy volatility due to budgetary expenditure in province p at the year t;
FisVolEB: fiscal policy volatility due to extrabudgetary expenditure in province p at the year t;
FisVolCov: fiscal policy volatility due to the covariance term between budgetary and extrabudgetary expenditure in province p at the year t;

FisVol-Neighbour: the natural logarithm of the average fiscal policy volatility of neighbouring provinces of province p at year t;

$\sigma(MRPL^{RA})$: the dispersion of risk-adjusted marginal revenue product of labour (MRPL) of manufacturing firms in province p at year t;

$\sigma(MRPM^{RA})$: the dispersion of risk-adjusted marginal revenue product of intermediate inputs (MRPM) of manufacturing firms in province p at year t;

$\sigma(TFP^{RA})$: the dispersion of risk-adjusted TFP of manufacturing firms in province p at year t;

$\sigma(MRPK_{LP}^{RA})$: risk-adjusted MRPK dispersion in province p at year t, where the output elasticity of capital is computed using the Levinsohn and Petrin (2003) approach;

$\sigma(MRPK_{Wooldrige}^{RA})$: risk-adjusted MRPK dispersion in province p at year t, where the output elasticity of capital is computed using the Wooldridge (2009) approach;

$\sigma(MRPK_{GMM}^{RA})$: risk-adjusted MRPK dispersion in province p at year t, where the output elasticity of capital is computed using the System GMM approach;

$\sigma(MRPK_{Ackerberg}^{RA})$: risk-adjusted MRPK dispersion in province p at year t, where the output elasticity of capital is computed using the Ackerberg et al. (2015) approach;

WheatRice: an instrumental variable, which is the natural logarithm of the ratio between wheat output and rice output in province p at year t;

PortOpen: an instrumental variable, which is the natural logarithm of capital city's port opening time (until 2007) in each province;

L.FisVol: an instrumental variable, which is the lagged fiscal policy volatility by three year periods;

High FD or low FD: a dummy variable which is equal to one if the average financial dependence (FD) of province p is higher or lower than the median value of FD, and zero otherwise;

High GovSize or 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 SOE or 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, which is defined as the sum of firms' use of external finance over the 1980's divided by the sum of capital expenditure over the 1980's for 425 4-digit US manufacturing industries;

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 both government and SOE purchase in total sales at each 2-digit industry in 2004.

C Further descriptive statistics

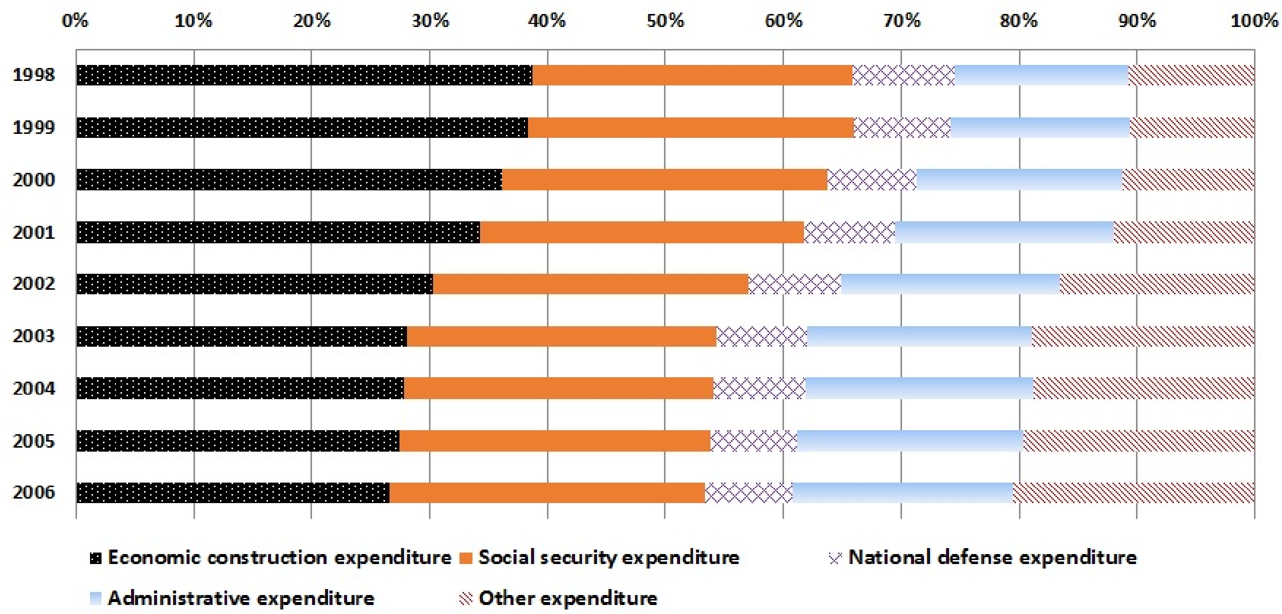

Figure C1: Components of government expenditure by functions: 1998-2006

Notes: 'Economic construction expenditure' refers to the fiscal expenditure related to economic development, which includes 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 of definition of fiscal functions.

Table C.1: Variance decomposition of government expenditure: budgetary expenditure versus extrabudgetary expenditure (%)

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

Notes: 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.

D Detailed derivation of the theoretical model

This section provides a full description with detailed derivation of the theoretical model in Section 7.2. We start from a Cobb-Douglas production function of a profit-maximizing firm:

$$Q_{it} = e^{\omega_{it}} K_{it}^{\alpha_K} L_{it}^{\alpha_L} M_{it}^{\alpha_M}, \tag{D.1}$$

where Q_{it} is output of firm i at time t, and ω_{it}, K_{it}, L_{it}, and M_{it} are productivity, capital, labour and material inputs respectively. In particular, $\alpha_K + \alpha_M + \alpha_L = 1$. Assuming the (inverse) demand curve for firm's product with constant elasticity,

$$P_{it} = b_t^{\frac{1}{\eta}} Q_{it}^{-\frac{1}{\eta}} h(g(K_{it}), \nu_{it}, \mu_{it}), \tag{D.2}$$

where b_t is the aggregate demand (fiscal policy) shock and $\eta > 1$. $h(g(K_{it}), \nu_{it}, \mu_{it})$ is the output quality of firm i, which depends on a measure of capital stock $g(K_{it})$, material input quality ν_{it}, and labour quality (i.e., human capital) μ_{it}. We assume $\frac{\partial g(K)}{\partial K} > 0$. We following Kugler and Verhoogen (2012) to allow for flexible rate of substitution across these variables in the production of output quality:

$$h(g(K_{it}), \nu_{it}, \mu_{it}) = [\gamma_K g(K_{it})^\theta + \gamma_L \mu^\theta + \gamma_M \nu^\theta]^{\frac{1}{\theta}}, \tag{D.3}$$

where $\gamma_K + \gamma_L + \gamma_M = 1$. When $\theta < 0$ 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 of inputs. However, the unit prices of labour and material are increasing in their quality:

$$P_L = \mu^{\phi_L}, P_M = \nu^{\phi_M}, \tag{D.4}$$

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

Given the dynamic state $(b_t, \omega_{it}, K_{it})$, the firm's static decision is to maximize the period profit:

$$\pi(b_t, \omega_{it}, K_{it}) = \max_{M,L,\mu,\nu} b_t^{\frac{1}{\eta}} Q_{it}^{1-1/\eta} h(g(K_{it}), \nu_{it}, \mu_{it}) - MP_M - LP_L, \tag{D.5}$$

It is straightforward to show the following:

$$\mu_{it} = \left[\frac{\beta_L \gamma_K}{1 - \beta_L \phi_L - \beta_M \phi_M} \frac{\phi_L}{\gamma_L}\right]^{\frac{1}{\theta}} g(K_{it}), \tag{D.6}$$

and

$$\nu_{it} = \Big[\frac{\beta_M \gamma_K}{1-\beta_L\phi_L-\beta_M\phi_M}\frac{\phi_M}{\gamma_M}\Big]^{\frac{1}{\theta}} g(K_{it}). \tag{D.7}$$

Thus,

$$h_{it} = \Big[\frac{\gamma_K}{1-\beta_L\phi_L-\beta_M\phi_M}\Big]^{\frac{1}{\theta}} g(K_{it}), \tag{D.8}$$

where $\beta_X = \alpha_X(1-1/\eta)$ and $X = K, L, M$.

Consequently, we have maximized period profit as (after combining all constants terms), we have

$$\pi(b_t, \omega_{it}, K_{it}) = \Psi\Omega_{it}^{\frac{1}{\beta_K+1/\eta}} K_{it}^{\frac{\beta_K}{\beta_K+1/\eta}} g(K_{it})^{\frac{1-\beta_L\phi_L-\beta_M\phi_M}{\beta_K+1/\eta}}, \tag{D.9}$$

where Ψ is the combined constant and $\Omega_{it} = e^{(1-1/\eta)\omega_{it}+b_t/\eta}$. Note that the dynamic input, capital, contributes to the profit in two folds: $K_{it}^{\frac{\beta_K}{\beta_K+1/\eta}}$ is from the output quantity production side while $g(K_{it})^{\frac{1-\beta_L\phi_L-\beta_M\phi_M}{\beta_K+1/\eta}}$ is from the output quality production side, and both of them are increasing in K_{it}.

On the dynamic aspect, 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 cost, which consists of a fixed cost and a variable adjustment cost, in addition to I_{it}:

$$C(I_{it}, K_{it}, \omega_{it}, b_t) = I_{it} + C_K^F \mathbf{1}(I_{it} \neq 0)\pi(I_{it}, K_{it}, \omega_{it}, b_t) + C_K^V K_{it}\left(\frac{I_{it}}{K_{it}}\right)^2. \tag{D.10}$$

Further, we assume the following evolution processes:

$$\omega_{it} = \psi_0 + \psi_1\omega_{it-1} + \sigma_\omega \epsilon_{it}, \tag{D.11}$$

and

$$b_t = \phi_0 + \phi_1 b_{t-1} + \sigma_b \upsilon_t, \tag{D.12}$$

where ϵ_{it} and υ_{it} are from the standard normal distribution.

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

$$\begin{aligned} V(\omega_{it}, b_t, K_{it}) = &\max_{I_{it}} \pi(\omega_{it}, b_t, K_{it}) - C(I_{it}, K_{it}, \omega_{it}, b_t) + \\ &\beta \int_{\omega_{it+1}, b_t} V(\omega_{it+1}, b_{t+1}, \delta K_{it} + I_{it}) dF(\omega_{it+1}, b_{t+1}|\omega_{it}, b_t). \end{aligned} \tag{D.13}$$

From (D.6) and (D.7), we know

$$P_L = \mu_{it}^{\phi_L} = \left[\frac{\beta_L \gamma_K}{1 - \beta_L \phi_L - \beta_M \phi_M} \frac{\phi_L}{\gamma_L}\right]^{\frac{\phi_L}{\theta}} (g(K_{it}))^{\phi_L}, \tag{D.14}$$

and

$$P_M = \nu_{it}^{\phi_M} = \left[\frac{\beta_M \gamma_K}{1 - \beta_L \phi_L - \beta_M \phi_M} \frac{\phi_L}{\gamma_L}\right]^{\frac{\phi_M}{\theta}} (g(K_{it}))^{\phi_M}. \tag{D.15}$$

Thus, the marginal revenue product of labour in logarithm is

$$MRPL \equiv \log(P_L) = \mu_{it}^{\phi_L} \propto \phi_L \log(g(K_{it})), \tag{D.16}$$

and similarly, the marginal revenue product of material input in logarithm is

$$MRPM \equiv \log(P_M) = \nu_{it}^{\phi_M} \propto \phi_M \log(g(K_{it})). \tag{D.17}$$