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Risk Sharing and Industrial Specialization in China *

By **DU JULAN, HE QING and ZHANG CE***

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Abstract

We investigate how risk sharing shapes industrial specialization across prefecture-level cities in China. By unbundling the mechanisms of risk sharing, we find that *ex ante* risk sharing generates a first-order stimulant effect on the geographical concentration of manufacturing industries, particularly for non-state-owned enterprises and cyclical industries. *Ex post* risk sharing matters only for state-owned enterprises. This result remains robust to instrument variable estimation and controlling for other determinants of industrial specialization. Finally, we show that interregional labor migration (special fiscal transfers) plays an important role in promoting interregional *ex ante* (*ex post*) risk sharing. The study implies that much more risk sharing and efficiency gains from industrial specialization would be achieved if capital markets and credit markets are better developed.

Keywords: risk sharing; industrial specialization; state-owned enterprises; cyclical industry; cultural boundary

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1. Introduction

The importance of production risk insurance in gaining benefits from industrial specialization is widely recognized (Brainard and Cooper, 1968; Ruffin 1974; Helpman and Razin, 1978). Specialization helps achieve higher economic growth but incur a greater variance of output (Saint-Paul, 1992). In the absence of insurance of production risks, the welfare losses due to the latter would outweigh the benefits brought by industrial specialization. If regions and countries can insure their idiosyncratic production risks, they are able to better explore comparative advantage by specializing in their productions (Greenwood and Jovanovic, 1990; Saint-Paul, 1992; Obstfeld, 1994; Acemoglu and Zilibotti, 1997). Consistently, Kalemli-Ozcan et al. (2003) provide evidence that more insurance is associated with higher specialization. Yet, the economic mechanism is yet to be well understood.

Theoretically, there are two ways to smooth regional output fluctuations in a market economy (Kalemli-Ozcan et al., 2003). First, residents in a region can geographically diversify their revenue sources among regions, primarily through capital markets, thereby insuring their income and smoothing their consumption (*ex ante*). Second, in response to income fluctuations (temporary shocks), residents in a region can mainly borrow or lend through credit markets to smooth their consumption (*ex post*) (Asdrubali et al., 1996). No effort has been made to unbundle these two mechanisms of risk sharing. Our main task is to demonstrate empirically the relative importance of *ex ante* vs *ex post* risk sharing in promoting industrial specialization.

This issue is particularly relevant for emerging market economies and developing countries. In advanced economies, the well-developed capital markets and credit markets serve as the primary instruments of *ex ante* and *ex post* risk sharing, respectively. They are both market-based mechanisms so that the government plays a minor role in achieving risk sharing. In contrast, emerging market economies and developing countries are typically characterized with financial repression where financial system is under excessive government control and intervention and highly underdeveloped. Government ownership or control of domestic banks is prevalent. Interest rates are subject to explicit or indirect capping so that banks can provide cheap loans to privileged large companies and governments. Equity markets and bond markets either do not exist or remain small. Excessive government control of and intervention in securities markets are prevalent. Under these circumstances, capital markets and credit markets can hardly benefit non-state-owned enterprises (non-SOEs), especially those small and medium-sized ones and large swathes of urban and rural households. They are thus hardly capable of shouldering heavy responsibilities of achieving *ex ante* and *ex post* risk sharing and supporting industrial specialization. Alternatively, labor migration, especially rural-urban migration, and the resultant remittances play a significant part in diversifying income sources and become an important means of *ex ante* risk sharing (Du et al., 2011; Balli and Rana, 2015). Special fiscal transfers and government aid become a primary means of *ex post* risk sharing in maintaining consumption in the wake of negative shocks. This pattern demonstrates that *ex ante* risk sharing relies primarily on the market-based mechanism, while *ex post* risk sharing on the government-orchestrated mechanism in emerging market economies and developing countries. Thus, the prevalent state-owned or state-controlled companies in these economies may benefit disproportionately from the government-administered *ex post* risk sharing mechanism, whereas their non-state counterparts from the market-based *ex ante* mechanism. Consequently, the geographic concentration of state-owned enterprises (SOEs) and that of non-SOEs could be significantly shaped by the *ex post* and *ex ante* risk sharing mechanism,

respectively.

Using a large data set of China's manufacturing firms for the period 2003−2015, we empirically investigate the impacts of both *ex ante* and *ex post* risk sharing on geographic concentration of manufacturing activities. The case of China provides a unique opportunity among emerging market economies to gauge which risk sharing (*ex ante* vs *ex post)* is more closely related to production specialization. For instance, under repressive financial policies, China's state-dominated banking system channels formal credit to SOEs, while small and median-sized enterprises (SMEs) find it difficult to obtain bank credits (He et al., 2017), which is also typical for developing economies. China still has a dual-economy structure in which rural-urban migration plays an essential part in relieving rural poverty, a feature common to underdeveloped economies. Understanding China could have valuable policy implications for other emerging market economies.

In addition, China is a large country that includes all manufacturing industries[1]. Industrial agglomeration across China's cities differs substantially (Lu and Tao, 2009; He et al., 2017). A large prefecture-level city sample and differentiated industrial patterns facilitate our empirical analysis, and such investigation is carried out by using consistent measures of risk sharing and industrial classification without a concern over measurement errors and estimation biases which are typically encountered in a cross-country analysis. Finally, the variation in the extent of risk sharing among provinces within China is similar to that across countries (Du et al., 2011), and the barrier to risk sharing across provinces is comparable to that across countries[2], making a study in the context of China valuable for both regional and international studies.

Following Kalemli-Ozcan et al. (2003), we define a risk sharing group as a country (China) consisting of numerous regions (Cities), and calculate the income-based and consumption-based measures to proxy the degree of the *ex ante* and *ex post* risk sharing among cities within China. We then calculate an index of industrial specialization for each city within China, and check whether a city's degree of risk sharing with the other cities in China is positively associated with the city's degree of industrial production concentration. The results show that a better risk sharing entails a higher degree of industrial specialization. This effect is more pronounced in regions with a greater extent of income-based risk sharing (*ex ante* risk sharing). In contrast, the role of consumption-based risk sharing (*ex post* risk sharing) is more limited, and exerts no salient effects on the overall industrial specialization. In addition, we find that *ex ante* risk sharing has significant positive effects on regional specialization in cities with economic development zones, and the positive effect is more pronounced in cyclical industries.

Taking advantage of our detailed data, we further examine the industrial specialization of SOEs and non-SOEs, and find that *ex ante* and *ex post* risk sharing enhance the industrial specialization of non-SOEs and SOEs, respectively. This is consistent with our observation that the *ex ante* risk sharing channel is primarily market-based while the *ex post* one is mainly government-administered in China's emerging market economy.

Our results remain robust after controlling for a variety of traditional determinants of industrial specialization. Similar results are obtained by using alternative measures for industrial specialization as well as adopting various regression specifications. To guard the potential endogeneity problems, we search for instrumental variables (IVs) that are likely to be exogenous to industrial specialization. Specifically, we use the number of genealogies in each city and the distance between local dialect and Beijing Mandarin as two alternative instrumental variables for

[1] Most economies are small and have only several sizeable industries.

[2] Some of China's provinces income levels are comparable to member countries of the Organization for Economic Co-operation and Development (OECD).

risk sharing. We also control for other traditional determinants of regional specialization. The positive relations between *ex ante* risk sharing as well as the total risk sharing and industrial specialization still survive.

Finally, we show that the interregional labor migration and special fiscal transfers play an important role in promoting inter-city *ex ante* and *ex post* risk sharing, respectively, which verifies that the *ex ante* and *ex post* risk sharing channels are primarily market-based and government-controlled ones, respectively, in China.

Our study makes several contributions to the literature on risk sharing and industrial specialization. First, this study is the first one to explicitly examine the effects of *ex ante* and *ex post* risk sharing on industrial specialization separately. Previous studies on risk sharing typically focus on examining the effects of risk sharing on economic activities or identifying the effects via different channels of risk sharing separately. For instance, several studies show that a full risk sharing leads to significant welfare gains (Backus et al., 1992; Obstfeld, 1994; Asdrubali et al., 1996; Lewis, 1996; Crucini, 1999). Kalemli-ozcan et al. (2003) find that the extent of risk sharing is positively related to industrial specialization. Hevia and Servén (2018) relates the degree of risk sharing to macro variables, and finds that higher risk sharing improves the gain from globalization. Asdrubali et al. (1996) identify the channels through capital market, federal government and credit market, and further estimate the components effect of risk sharing in achieving their current degree of risk sharing. Du et al. (2011) and Du et al. (2010) have documented different channels of risk sharing in China and the role of financial markets in achieving risk sharing. Asdrubali et al. (2018) investigate how government consumption smooths out macroeconomic shocks.

Our study complements and extends the literature by unbundling how *ex ante* and *ex post* risk sharing help shape the patterns of industrial specialization. Kalemli-ozcan et al. (2003) has suggested the effects of *ex ante* and *ex post* risk sharing on industrial specialization. However, they use a measure of income insurance (*ex ante*) and, alternatively, a measure of overall consumption insurance (the whole risk sharing) in the empirical analysis. The difference in the impacts between *ex ante* and *ex post* risk sharing on industrial specialization remains unexplored.

Second, this study further links *ex ante* risk sharing and *ex post* risk sharing to both market-based risk sharing channels and the government-administered risk sharing channels. The market force and government intervention interact solidly throughout the reform of China, providing an excellent setting for examining how *ex ante* and *ex post* risk sharing affect economic activities.

In China's emerging market economy, the conventional primary market-based risk sharing mechanisms, namely, capital markets and credit markets, do not play a significant role in attaining risk sharing. This mainly reflects the underdevelopment of capital markets in China, and the SOE-oriented banking system that has not benefited much non-SOE businesses and households. It is mainly migrant labor's remittances and intergovernmental special transfers constitute the primary channels of *ex ante* and *ex post* risk sharing, respectively. In general, they are relatively primitive forms of risk sharing. Consequently, the *ex ante* risk sharing hinges on market forces, while the *ex post* risk sharing relies on the government's actions. Consequently, the extent of both *ex ante* and *ex post* risk sharing achieved is still limited, which deters industrial specialization and economic growth and results in substantial efficiency losses. This demonstrates an additional negative effect of an underdeveloped financial system which is often ignored in the literature.

Third, a large body of literature has examined the determinants of industrial specialization (Harrigan, 1999; Davis and Weinstein, 1999; Harrigan and Zakrajsek, 2000; van Riet et al., 2004). Besides the traditional determinants, such as production factor endowment, technology and

knowledge, economic development, researchers have turned their attention to other determinants. New economic geography (Krugman, 1991) points out the role of economic liberalization in sharpening specialization, and a number of studies investigate the relationship between (financial and trade) openness and specialization (Imbs, 2004; Masten et al., 2008). Brülhart and Trionfetti (2001) focus on how the discriminatory public procurement affects the location of industries. Recently, various studies sought to explore the policy and institutional factors in the distribution of the industrial firms (Duranton and Puga, 2004; Johansson and Olaberría, 2014; Chor, 2010; Nunn and Trefler, 2013; He et al., 2017; Fan et al., 2021). Our study contributes to the literature by focusing on the mechanism of how risk sharing affects industrial specialization, and how risk sharing functions along with government intervention. We show that the market-based *ex ante* risk sharing contributes to the industrial specialization of non-SOEs, while the government-administered *ex post* risk sharing shapes the industrial specialization of SOEs. China's experience has general implications for other economies, especially emerging market economies and developing countries.

The rest of the paper is organized as follows. Section 2 develops our hypotheses. We describe the dataset, variable measures and summary statistics for key variables in Section 3. Section 4 investigates the impact of risk sharing as well as other factors on city-level industrial specialization. Robustness and sensitivity analyses are carried out in Section 5. Section 6 investigates the channels of *ex ante* and *ex post* risk sharing in China. Section 7 concludes.

2. Theory and hypotheses

The extent of risk sharing is expected to help shape the degree of industrial specialization. Production factors such as capital and labor can be allocated to different industries. Individuals and firms in each region face uncertainty in production in each sector. If they specialize in only one industry, once a negative production shock occurs[3], their incomes will be negatively affected so that they will not be able to meet their consumption needs. Thus, regions specializing in a small number of industries face production risks that may cause huge losses to their regional economy and considerable harm to social welfare (Kemp and Liviatan, 1973). If a perfect insurance market does exist, all regions can achieve perfect risk sharing with the help of such means as capital markets and fiscal transfers, and regions can achieve specialization in production to promote their economic growth (Obstfeld, 1994; Kalemli-Ozcan et al., 2003).

Consider a Chinese city, Daqing, which has the world's fourth most productive oilfield. It is a natural choice for the city to specialize in petroleum industry and related sectors. However, owing to its high dependence on petroleum industry which has contributed 50~55% of its GDP, Daqing finds itself being periodically affected by oil price fluctuations. For example, crude oil prices experienced a sharp slump in the period 2014−2015 when Brent crude price fell from 108.18 in January 2014 to 35.74 in December 2015. The oil price shock generated a tremendous impact on Daqing city, leading to a decline in its GDP growth rate from 7% in 2013 to 4.5% in 2014 and -2.3% in 2015. Approximately 2.7 million people who lived in Daqing city suffered significant economic losses. If residents had received revenues from investments or other income sources in other regions or received more government transfers or grants, their personal income would have been much less affected by the fall of GDP in Daqing city.

[3] The shock can be either region-specific or industry-specific.

When interregional risk sharing is weak, individuals and firms in each region would have to share production risks internally through industrial diversification. They engage in different industries and products, and a relatively self-contained local economy may enable the region to better withstand production shocks. Consequently, resources are allocated to both the more productive sectors in which the region has comparative advantage and the less productive sectors that the region is not good at, which results in production efficiency losses. In contrast, when interregional risk sharing is strong, firms are able to endure elevated production shocks and exploit the benefits of industrial specialization. We have:

Hypothesis 1: Industrial production is likely to be more specialized in regions with a higher degree of risk sharing.

The previous studies suggested two mechanisms for insuring regional production risks (Asdrubali et al., 1996; Sørensen and Yosha, 1998; Kalemli-Ozcan et al., 2003). First, *ex ante* risk sharing. Residents in a region can geographically diversify their revenue sources across regions, thereby insuring income risks. Second, *ex post* risk sharing. In response to income fluctuations (transitory production shocks), residents in a region can borrow and lend or receive transfers or grants to smooth their consumption (*ex post* risk sharing).

One way to achieve *ex ante* risk sharing is the geographic diversification of income sources through interregional movements of production factors. By investing in capital markets and keeping stakes in corporations operating in various regions, a region can insure against idiosyncratic shocks and thus can better exploit the advantages of industrial specialization (Greenwood and Jovanovic, 1990; Saint-Paul, 1992; Kalemli-Ozcan et al., 2003; Basile and Girardi, 2010). In addition, the interregional labor flow and the associated cross-region remittances would diversify the geographic sources of labor income and contribute to risk sharing. Provided the importance of industrialization and urbanization and the underdeveloped capital markets in emerging market economies, this labor movement and remittances mechanism is expected to be particularly important for China and other developing countries. For instance, the remittances of migrant laborers are found to play an important part in enhancing income risk sharing in China (Du et al., 2011). Moreover, some types of fiscal flows such as taxes and social security are usually regarded as *ex ante* channels.

Ex post risk sharing takes many forms. Residents of a region can borrow or lend in interregional credit markets in the wake of a shock to dampen income fluctuations and smooth their consumption (Kalemli-Ozcan et al., 2003). Some types of fiscal flows such as government subsidies and fiscal transfers can serve as a vehicle for consumption smoothing. For example, financial aid from various government-related agencies can help weather income shocks generated by natural disasters (Du et al., 2011).

It is noteworthy that in most emerging market economies and developing countries, like China, state-controlled banks are prevalent so that the government can influence credit allocation, and channel loans or subsidies to its favored industries and enterprises. In this sense, *ex post* risk sharing channels are largely put under the control of the government. In contrast, *ex ante* risk sharing channels, such as capital markets and migration, largely rely on market-based activities.

Along with China's market-oriented reforms, income sources for Chinese households have been increasingly diversified. Incomes from interregional capital and labor flows are expected to grow in importance in household income structure, which is likely to promote *ex ante* risk sharing. Meanwhile, bank credit still favors the state sector. Household credit is rather limited. National and subnational fiscal expenditures are biased toward promoting economic growth instead of supporting residents' livelihood. Thus, the banking sector and government expenditure are

likely to play a minor role in enhancing individuals' risk sharing. We expect that *ex ante* risk sharing channels play a much larger part than *ex post* ones. Meanwhile, given the non-state sector accounts for the majority of employment, industrial output, and GDP in China, *ex ante* risk sharing is anticipated to be more influential in shaping industrial specialization than *ex post* risk sharing when we look at the whole economy[4]. Hence, we have:

Hypothesis 2: *Ex ante* risk sharing matters more for industrial specialization than *ex post* risk sharing.

Although China has achieved a remarkable economic growth fueled by non-SOEs, the commanding heights of the national economy, i.e., those strategically important sectors, are still under government control and SOEs play an important part. The spatial industrial distribution of SOEs is determined primarily by the industrial plan of the central and local governments with various strategic considerations. Local governments have incentives to design and implement industrial policies for SOEs, and require SOEs to specialize in certain industries (Catin et al., 2005), to achieve high economic growth by exploiting the benefits of specialization. By holding a substantial share of productive capacity in the form of SOEs and enjoying considerable discretion over the allocation of various resources, the local government can adopt industry-specific policies to guide their productions[5]. Thus, SOEs in general may have a higher degree of specialization, but at the same time are more likely to be fragile to production shocks. Nevertheless, the spatial industrial distribution of SOEs is largely independent of the impact of market-based *ex ante* risk sharing mechanisms because the government-administered *ex post* risk sharing mechanisms provide a strong backing to SOEs in the face of production shocks.

Once production shocks occur, the government would give priority to subsidizing and bailing out the SOEs, and the state-controlled banking system would offer credit to SOEs to help them cope with the shock[6]. Hence, the government-orchestrated *ex post* risk sharing mechanisms are likely to provide insurance safety net for SOEs and enhance the industrial specialization of SOEs.

In contrast, the non-state sector is less likely to benefit from the government safety net as an *ex post* risk sharing channel because the bank loans and fiscal subsidy primarily go to SOEs (Eckaus, 2006). Then, the *ex ante* risk sharing working mainly through interregional capital and labor movements would be particularly relevant for the industrial specialization of non-SOEs.

Thus, we expect *ex post* risk sharing to be more relevant to specialization in the state-owned sector, while *ex ante* risk sharing is more important to the industrial specialization in the non-state sector.

Hypothesis 3: The positive effect of *ex ante* (*ex post*) risk sharing on industrial specialization is larger (smaller) in the non-state sector than in the state sector.

Note that industries also differ in their sensitivities to business cycles. The production of cyclical industries would typically magnify GDP fluctuations, whereas the output of non-cyclical industries is less subject to GDP fluctuations and would dampen GDP volatility. Typically, producer goods and durable consumption goods industries are more cyclical than non-durable consumption goods industries (Petersen and

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[4] From 1978 to 2017, the private sector contributes more than 50% of tax revenue, 60% of the GDP, 70% of the innovation, 80% of the urban employment and 90% of enterprises according to Xi Jinping's speech at Private Enterprise Symposium in December 1st, 2018.

[5] Though government competition brings other cities' experience, they usually copy it blindly, which lead to similar industrial structure (Young, 2000; Bai et al., 2004)

[6] In addition to government subsidies from special transfers, SOEs also enjoy privileged access to bank loans directed by both central and local governments (Eckaus, 2006).

Strongin, 1996). For example, food production is considered as a non-cyclical industry because the demand for food will not vary much with GDP fluctuations. Equipment manufacturing is regarded as a cyclical industry, and the demand for equipment would show a larger volatility than does GDP. Besides, cyclical industries are often capital intensive, and tend to have high levels of operation leverage[7], which in turn increases their production risks. Since cyclical industries are subject more to production shocks generated by cyclical fluctuations, and exhibit a higher volatility facing a production shock, *ex post* risk sharing mechanisms, e.g. interregional credit or government subsidies and fiscal transfers, are likely to incur higher costs than *ex ante* risk sharing mechanisms[8]. As a result, a better risk sharing, particular the *ex ante* one, is likely to be effective in promoting the industrial specialization of the cyclical sectors.

Even though *ex ante* risk sharing is likely to have larger impacts on the specialization of cyclical industries, some cyclical industries consist of mainly heavy industries, which are often industries with strategic importance and thus are subject extensively to the influences of government industrial policies and intervention. If our hypothesis that the government-administered *ex post* risk sharing mechanisms provide a strong backing to SOEs in the face of production shocks is correct, we should expect that *ex ante* risk sharing is more important to the cyclical industrial specialization of the non-state sector.

Hypothesis 4: The positive effects of risk sharing on industrial specialization are more salient in cyclical industries than in non-cyclical industries. *Ex ante* (*Ex post*) risk sharing particularly promotes non-SOE (SOE) industrial specialization in cyclical industries.

Specialization benefits from the dispersion of production risk, but under different institutional environments, the effectiveness of the risk sharing mechanism is different (Kalemli-Ozcan et al., 2003). The market force and local protectionism are two driving forces for market fragmentation and integration (Brandt et al., 2014). The market force tends to push forward industrial specialization by allocating resources to different industries in different geographic locations according to various endowments. Nevertheless, local protectionism is different. Under local protectionism, cities are committed to achieving a comprehensive industrial structure and a maximum self-sufficiency economy (Young, 2000; Bai et al., 2014). Moreover, they help maintain the comparative advantages of local companies through favorable loan and fiscal support, even administrative intervention. Therefore, local protectionism propels the local economy to move toward a similar and comprehensive industrial structure across the country.

With the progress of economic reform and opening-up, China set up a list of special economic zones that concentrate the efforts and resources to build a sound infrastructure, create a high-standard business environment and form an efficient administration. Special economic zones are conductive to promoting the power of the market force, which further improves the effectiveness of *ex ante* risk sharing. Meanwhile, *ex post* risk sharing with the help of special transfers and credit resources is very important for the specialization of state-owned enterprises. Thus, we expect the effect of *ex ante* risk sharing on industrial specialization to be more pronounced in the cities with a higher degree of marketization, while *ex post* risk sharing still stimulates SOEs' industrial specialization.

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[7] For instance, capital-intensive industries require a large amount of fixed asset investments, and should have a large scale of production to obtain an adequate investment return. Thus, capital-intensive industries are vulnerable to economic downturn, as they still need to pay fixed costs.

[8] Panjin city in Liaoning province specializes in petroleum industry and related sectors, which are typical cyclical industries. Dominated by large state-owned enterprises, Panjin city relies on the government-orchestrated *ex post* risk sharing mechanisms to maintain its specialization. Around 42.1% of its fiscal revenue in 2018 comes from the intergovernmental transfer system and fiscal subsidies.

In addition, economic shocks can be either persistent or temporary. The *ex ante* mechanism helps people smooth income, and is effective in insuring both permanent and temporary production shocks. Instead, *ex post* risk sharing is less effective in coping with highly persistent shocks, because fiscal transfers and bank credits help smooth consumption in the post-shock period but are helpless in achieving income diversification (Asdrubali et al., 1996; Corsetti et al., 2008). For instance, once production shocks (persistent shocks) affect a region specializing in a specific technology or project, inhabitants would likely suffer income decline and transfer to other industries. Risk sharing through *ex ante* channels would help smooth income, and inhabitants would not need to change their jobs. In areas with high *ex ante* risk sharing, inhabitants would be more likely to stay in their current jobs and gain experiences, for they expect high incomes in the future. As for *ex post* risk sharing, savings and fiscal transfers are not reliable means of risk sharing in the long run. Inhabitants still have a high incentive to switch to other industries. As a result, both risk sharing mechanisms are relevant to industrial specialization decisions, only the *ex ante* mechanism is effective in insuring persistent production shocks. Based on the above discussion, we have:

Hypothesis 5: *Ex ante* risk sharing plays a more salient part for industrial specialization than *ex post* risk sharing in cities with economic development zones or in sectors with high-persistence shocks, while *ex post* risk sharing still stimulates SOEs' industrial specialization.

3 Data, measures and summary statistics

3.1 Measuring risk sharing

The risk sharing group is a country (China) consisting of numerous regions (prefecture-level cities). We measure how much risk in a city within China is shared with other cities in the country by estimating the sensitivity of the city's income and consumption to idiosyncratic (city-specific) GDP fluctuations. Asdrubali et al. (1996) developed a panel regression method by estimating the proportion of idiosyncratic GDP shocks that are insured through various channels. To see how these measures work, we consider the following equations:

$$\Delta\log GDP_{it} - \Delta\log CONS_{it} = v_t + \beta_1 \Delta\log \mathrm{GDP}_{it} + \epsilon_{it} \quad (1)$$

$$\Delta\log GDP_{it} - \Delta\log INC_{it} = v_t + \beta_2 \Delta\log \mathrm{GDP}_{it} + \epsilon_{it} \quad (2)$$

$$\Delta\log INC_{it} - \Delta\log CONS_{it} = v_t + \beta_3 \Delta\log \mathrm{GDP}_{it} + \epsilon_{it} \quad (3)$$

where $\Delta\log GDP_{it}$ is the growth rate of real GDP per capita for city i in year t. $\Delta\log INC_{it}$ is the growth rate of real income per capita for city i in year t. $\Delta\log CONS_{it}$ is the growth rate of real consumption per capita for city i in year t. v_t is the time fixed effect.

The overall degree of risk sharing is reflected in regression Model (1). If there is a perfect risk sharing, consumption does not co-move with GDP, which means the coefficient β_1 is equal to 1. For most cities, the risk cannot be fully shared, and the coefficient lies between 0 and 1.

The extent of risk sharing can be further classified into two components: *ex ante* and *ex post* risk sharing. Equation (2) gauges the degree of income smoothing as *ex ante* risk sharing. Income smoothing is to maintain the stability of household income and minimize the transmission of GDP fluctuations to household income. It is mainly *ex ante* risk sharing because consumers diversify their income sources and asset allocation in advance to reduce income volatility arising from the idiosyncratic GDP shocks. If income smoothing is perfect, the co-movement of income and

GDP would be driven down to zero, which implies $\beta_2 = 1$. An imperfect *ex ante* risk sharing implies $0<\beta_2<1$. Thus, β_2 is a proxy of the extent of *ex ante* risk sharing.

Equation (3) addresses *ex post* risk sharing. It is likely that individual income would fluctuate as a result of various shocks. If *ex post* risk sharing channels such as direct fiscal transfers and grants are provided when individual income is hit after a negative shock, individual consumption would be much less affected. β_3 in Equation (3) captures the consumption smoothing provided by *ex post* risk sharing channels. When β_3=1, the co-movement of individual consumption and individual income would become zero, and perfect *ex post* risk sharing would be achieved. Usually, β_3 ranges from 0 to 1.

According to Asdrubali et al. (1996), Sørensen and Yosha (1998) and Kalemli-Ozcan et al. (2003), *ex ante* risk sharing channels incorporate those stemming from factor income movement and capital market investment return, which are achieved by portfolio diversification and multiple sources of income, while *ex post* risk sharing channels include borrowing and lending which smooth consumption. Specifically, capital market investments and security holdings, and remittances of income are *ex ante* risk sharing channels. Fiscal transfers take place in both *ex ante* and *ex post* risk sharing. Taxes and social security are usually regarded as *ex ante* channels, but direct transfers and grants to individuals are more likely to work after the shock as *ex post* risk sharing channels.

In our risk sharing measurement, it is not difficult to find $\beta_1 = \beta_2 + \beta_3$ through Equations (1) to (3). That is, the extent of total risk sharing is the sum of that of *ex ante* and that of *ex post* risk sharing.

Our analysis is based on prefectural-level cities in China. We exclude from the sample the four province-level municipalities, i.e., Beijing, Chongqing, Shanghai and Tianjin, because they are not comparable to other prefecture-level cities in the sample. Owing to the lack of data for Xizang and Taiwan, our sample contains 209 prefecture-level cities in 26 provinces. Appendix 1 lists the number of prefecture-level cities in each of the 26 provinces in our sample.

To construct the measures of risk sharing, we use GDP, consumption and income data at city level over the period from 2003 to 2015[9]. Since cities in China consist of both urban areas and rural ones, we follow Xu (2008) and Du et al. (2011) to measure the city-level household income as the average of urban household disposable income and rural household net income in each city, and household consumption is measured as the average of urban and rural consumption expenditure per capita in each city[10]. We use consumer price index (CPI) to convert household income and household consumption into real per capita values in 1990 Yuan. Because the price index at the city level is unavailable for most cities, we use the province-level CPI in the calculation. To measure local disposable income and consumption, we first use data

[9] The data for urban household disposable income and rural household net income at the city level is available since 2002. The ASIF Data after 2015 is not yet available for our study period.

[10] Urban Household Survey and Rural Household Survey are conducted by the National Bureau of Statistics of China. Statistical criteria for urban rural survey were not united before 2014. After 2013, Rural Household Survey Yearbook has stopped publishing rural household net income data, which is replaced by rural disposable income. Disposable income for urban households is similar to the disposable income measure employed in the previous literature, which is the total income including personal income, operating income, capital income and direct transfers minus operating expenditure, taxes and social security contributions. Net income for rural households excludes operating expenditure, taxes and contributions to the collective, but does not exclude social security contributions and capital expenditure like money lent to the relatives. Consumption expenditure is composed of food, clothes, residence, household equipment, transport and communication, cultural and educational entertainment, health care and other expenditures.

collected from the *Rural Household Survey Yearbook*, and the *Urban Household Survey Yearbook*. These survey yearbooks provide us with data on disposable income and consumption for urban and rural households in each city. The province-level CPI data are obtained from the *Comprehensive Statistical Data and Materials on 60 Years of New China* and China National Bureau of Statistics. Appendix 1 presents the mean values of annual average growth rates of GDP, household income and household consumption in each sample province over the years 2003-15.

3.2 Measuring industrial specialization

Industrial specialization is measured on the basis of the data drawn from *Annual Survey of Industrial Firms* (ASIF) conducted by China's Bureau of Statistics for the period of 2003-2015. ASIF covers all enterprises with annual sales of five million RMB or above in manufacturing industries.[11] For each firm in this dataset, we can access the information on the firm's 2-digit, 3-digit and 4-digit primary industry codes. The industry census data set also allows us to collect information on the firm's address, ownership structure and other financial conditions.

To measure regional specialization, we first extract the names of city and province from each firm's address in the ASIF dataset. We focus on prefecture-level cities, and estimate the industrial specialization index using firms' primary 2-digit industry code[12]. In 2011, China started to use the new Industrial Classification for National Economic Activities (GB/T4754-2011) to replace the old classification system (GB/T4754-2002). To obtain a consistent measure of industry code, we convert the old industry codes to the new classification system. We estimate the city-level industrial specialization index for each sample year and then take the average over the sample period. Following Kalemli-Ozcan et al. (2003), we define the local industrial specialization as

$$Spec^i = \sum_{s=1}^{S} \left(\frac{OUTPUT_i^s}{OUTPUT_i^M} - \frac{1}{J-1} \sum_{j \neq i} \frac{OUTPUT_j^s}{OUTPUT_j^M} \right)^2 \quad (4)$$

where S is the number of industrial sectors and J is the number of cities in the risk sharing group. $OUTPUT_i^s$ is the gross industrial output value of sector s in city i. $OUTPUT_i^M$ is the total industrial output of all manufacturing sectors in city i. This measure takes industrial structure into account and reflects the deviation of the share of an industry in a city's output from that of the national average, which captures the degree of industrial specialization. The patterns of industrial specialization are different across regions, but they must be embodied in the concentration of output value.

3.3 Other variables

We also control for other traditional determinants, which, if omitted, may bias the estimates of the effects of risk sharing on industrial specialization. First, population and population density are included to control for the labor market effect (Kalemli-Ozcan et al., 2003). Imbs and Wacziarg (2003) find that economic development and regional specialization have an "inverted U-shape" relationship. So, GDP per capita and its squared term are added into our regressions. Second, factor endowment is crucial to the formation of industrial specialization (Krugman, 1991;

[11] ASIF also covers enterprises in mining and production and distribution of electricity, gas and water industries. The location choice for these industries is heavily influenced by resource endowments.

[12] In Section 5, we also use firms' primary 3-digit and 4-digit industry codes to estimate specialization. Similar results are obtained.

Ellison and Glaeser, 1999). A high level of factor endowment can reduce costs and attract firms to produce in a specific region. To control for this impact, we compute the share of agricultural sector output in GDP and the ratio of mining sector gross output to total GDP[13] as a proxy of the city's natural resource endowments and fixed asset investment per capita as a proxy of the city's capital resource endowments. Young (2000) suggests that local protectionism in China brings about market segmentation, that is, cities have similar industrial structure. Regarding local protectionism, Bai et al. (2008) show that local governments that have a higher ratio of government expenditure to GDP are more likely subject to financial pressure, and thus are more likely to implement protection policies and obtain fiscal revenues for the public sector's expenditure. Following Bai et al. (2008), we use the ratio of local government expenditure to its GDP to capture the severity of local protectionism. Finally, Rosenthal and Strange (2001) show that knowledge can promote industrial specialization. We use the primary and secondary school enrollments as proxies. We also employ the freight volume to control for the influence of internal trade on industrial specialization. Data on these variables are drawn from *China City Statistics Yearbooks* and China National Bureau of Statistics. Variable definitions and data sources are shown in Appendix 2.

3.4 Summary statistics

Table 1 shows the summary statistics for our key variables. The city-level industrial specialization index is estimated by Equation (4). The mean value of city-level total risk sharing (*RS*) is 0.436, which is consistent with the finding of Du et al. (2011). The mean values of the *ex ante* risk sharing (*Ex ante RS*) and *ex post* risk sharing (*Ex post RS*) are 0.371 and 0.064, estimated using Equations (2) and (3), respectively. It suggests that the *ex ante* channels play a dominant role in risk sharing across prefecture-level cities in China.

Table 1: Summary statistics

Note: This table reports the summary statistics. N, mean, sd, min, p10, p50, p90, max stand for the number of sample observations, mean, standard deviation, minimum, 10-percentile, median, 90-percentile, and maximum, respectively. Variable definitions and data sources are contained in the Appendix

variable	observation	mean	sd	min	p10	p50	p90	max
Industrial Specialization Measurement								
Spec	209	0.140	0.123	0.020	0.041	0.099	0.315	0.784
HHI	209	0.200	0.137	0.065	0.086	0.152	0.392	0.852
Gini	209	0.701	0.108	0.461	0.555	0.689	0.845	0.952
Risk Sharing Measurement								
RS	209	0.436	0.166	0.025	0.252	0.415	0.624	1.099
Ex ante RS	209	0.371	0.168	-0.525	0.212	0.365	0.559	0.953
Ex post RS	209	0.064	0.121	-0.369	-0.042	0.063	0.156	1.067
Risk Sharing Channel Variables								

[13] As China City Statistics Yearbooks do not have the mining sector GDP, we construct the variable using gross output data from the ASIF.

Migration ratio	2717	0.414	0.303	0.141	0.222	0.330	0.667	3.649
Capital market	2717	0.211	0.355	0.000	0.000	0.096	0.527	7.360
General transfer	1449	0.024	0.026	-0.041	-0.004	0.019	0.059	0.177
Special transfer	1449	0.021	0.031	-0.025	0.001	0.015	0.049	0.532
Credit market	2717	2.045	0.987	0.560	1.209	1.762	3.351	10.739
				Control Variables				
POP	209	5.836	0.703	2.955	4.860	5.907	6.639	7.042
POPDEN	209	0.045	0.030	0.004	0.013	0.041	0.083	0.248
GPC	209	0.014	0.011	0.003	0.005	0.010	0.027	0.089
AGR	209	0.128	0.078	0.005	0.037	0.118	0.234	0.434
MIN	209	0.039	0.061	0.000	0.001	0.014	0.115	0.328
FAI	209	0.340	0.614	-1.328	-0.491	0.332	1.215	1.808
EDU	209	0.135	0.035	0.085	0.101	0.132	0.171	0.442
FISCAL	209	0.132	0.045	0.048	0.084	0.123	0.198	0.326
FREIGHT	209	3.989	0.707	1.852	3.031	4.019	4.925	5.862
				Instrumental Variables				
Clanship	209	3.871	1.932	0	0.693	3.932	6.368	8.422
Dialect	209	2.347	0.463	1	2	2	3	3

To gain an insight on the impacts of risk sharing on industrial specialization, we examine the patterns of industrial specialization over different ranges of local risk sharing. In Table 2, we consider the whole, *ex ante* and *ex post* risk sharing separately. For each type of risk sharing, we divide the sample into three subsamples, i.e., the cities with low, intermediate and high levels of risk sharing, and present the descriptive statistics for each subsample. When we look at the whole risk sharing, the mean (median) values of industrial specialization index increases from 0.106 (0.077) to 0.189 (0.136) as the level of risk sharing increases from the low-level group to the high-level one. Similarly, we find a significant increase in both the mean and median values of industrial specialization, i.e., from 0.099 (0.072) to 0.191 (0.141), as the level of the *ex ante* risk sharing increases from the low-level group to the high-level one. In contrast, the level of specialization does not change materially with the level of *ex post* risk sharing, which suggests an insignificant relationship between *ex post* risk sharing and industrial specialization.

Table 2 Descriptive statistics for industrial specialization sorted by the risk sharing index

Note: This table provides the descriptive statistics for the industrial specialization index (*Spec*). *Spec* is sorted by the risk sharing index *Risk sharing* (*RS*), *Ex ante RS* and *Ex post RS*. Mean, median, standard deviation, 10-percentile, 90-percentile are reported in the table. P1 contains one-third of the sample observations, which have the lowest value of the risk sharing index. P3 contains the one-third of the sample observations, which have the highest value of the risk sharing index.

	Risk sharing			*Ex ante* Risk sharing			*Ex post* Risk sharing		
	P1	P2	P3	P1	P2	P3	P1	P2	P3
mean	0.106	0.126	0.189	0.099	0.130	0.191	0.151	0.120	0.148
median	0.077	0.100	0.136	0.072	0.104	0.141	0.100	0.089	0.095
s.d.	0.085	0.104	0.157	0.083	0.101	0.157	0.144	0.095	0.126
[10%,90%]	[0.039,0.195]	[0.038,0.294]	[0.060,0.432]	[0.038,0.180]	[0.042,0.260]	[0.063,0.432]	[0.047,0.324]	[0.041,0.260]	[0.039,0.347]

In Figures 1-3, we display the scatterplots based on simple regressions of the city-level industrial specialization index on the total, *ex ante*, and *ex post* measures of risk sharing, respectively. The solid regression-fitted lines for both whole and *ex ante* risk sharing have clear positive slopes, but the line turns slightly negative for the *ex post* risk sharing. These results provide further evidence that there are positive relations between industrial specialization and the whole and *ex ante* risk sharing.

Figures 1-3: Industrial specialization and the measures of risk sharing

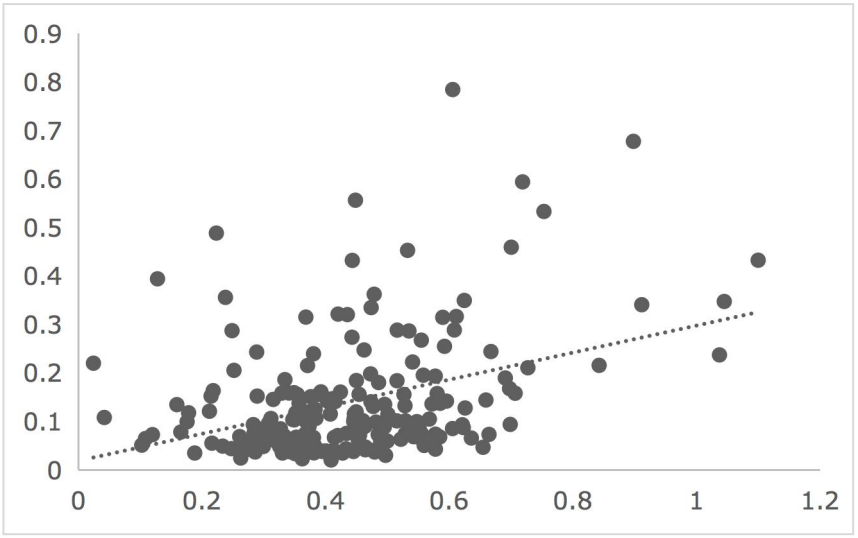

Figure 1: Specialization vs the whole risk sharing

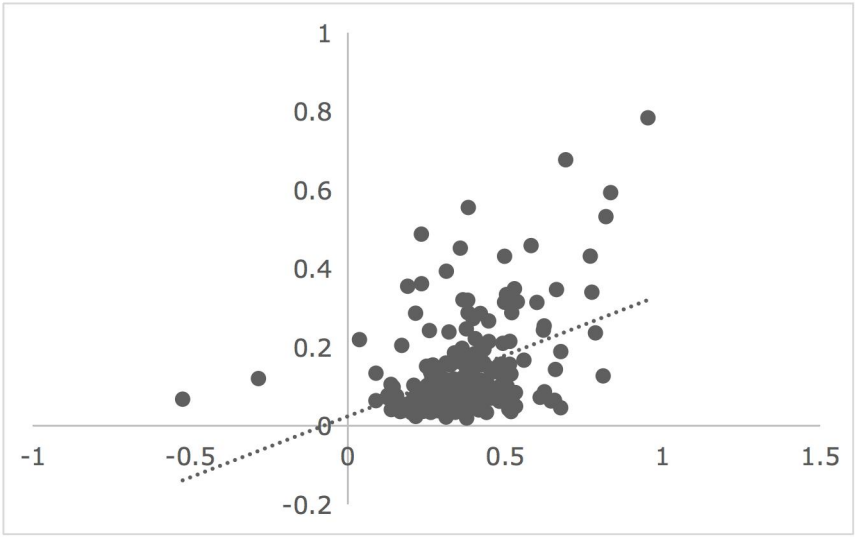

Figure 2: Specialization vs the *Ex ante* risk sharing

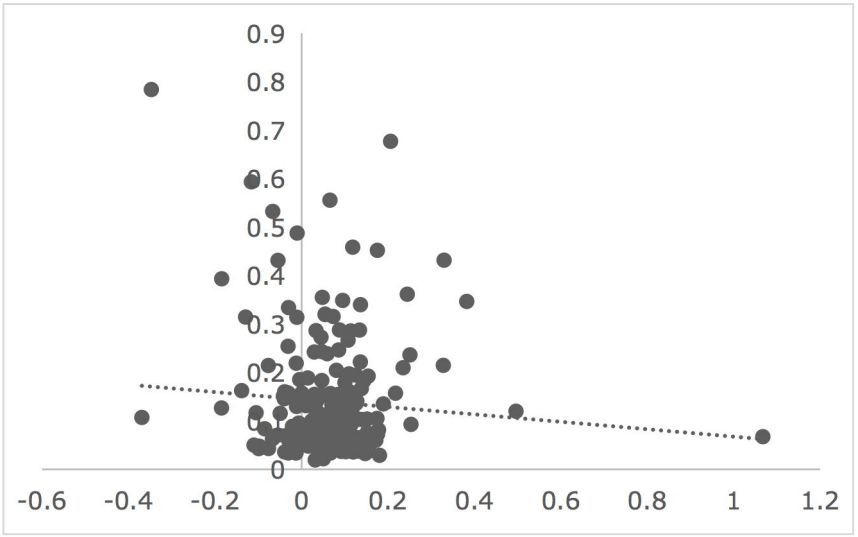

Figure 3: Specialization vs the *Ex post* risk sharing

4. Empirical results

4.1 Baseline results

We explore the relationship between risk sharing and industrial specialization using cross-sectional regressions. In all regressions, the dependent variable is the city-level industrial specialization index defined in Equation (4). Following Kalemli-Ozcan et al. (2003), we conduct all regressions using city-by-city manufacturing gross output as weights to limit the influence of some small-size cities with highly specialized industrial structure[14].

In Table 3, the first three columns report regression estimates when we include only one of the three risk sharing measures in each regression separately. The whole and *ex ante* risk sharing indices produce positive and statistically significant effects on industrial specialization. Nonetheless, the estimated coefficient of the *ex post* risk sharing index is negative but statistically insignificant. These results support the hypotheses that the degree of risk sharing, in particular, *ex ante* risk sharing, is important for the geographic concentration of industrial production. This implies that risk sharing does matter for industrial specialization and the *ex ante* risk sharing channels are the primary force in shaping this pattern in China. The variation in the *ex post* risk sharing is rather weak in accounting for the inter-city variations in industrial specialization.

Next, we control for an array of other possible determinants of industrial specialization. The estimated coefficients of the whole and *ex ante* risk sharing are still positive and statistically significant at the 1% confidence level, but the magnitude of the estimated coefficients is small. According to these estimates, a one standard deviation increases in the overall risk sharing index increases industrial specialization by 0.201, and a one standard deviation increase in the *ex ante* risk sharing index leads to an increase of industrial specialization by 0.224. Taking an extreme case, we find that moving from the scenario without risk sharing to the scenario of perfect risk sharing would increase the industrial specialization index by 0.149, about 1.06 times of the sample mean.

Turning to control variables, we find a negative and statistically significant impact on industrial specialization of city size as measured by the logarithm of population, which is consistent with the previous findings. The population density has a significantly negative impact on industrial specialization. Theoretically, industries with high transportation costs are inclined to concentrate in areas with high population densities, because the close-to-market location reduces transportation costs. However, population agglomeration also produces congestion costs that impede the concentration of industries in populous areas with low transportation costs. Our result lends partial support to the observation that industrial production seems to be concentrated in sparsely populated regions due to high congestion costs.

Next, the estimated coefficients of GDP per capita (GPC) are positive and statistically significant, while those of GDP per capita squared (GPC2) are negative and sometimes statistically significant. In contrast to the findings of Imbs and Wacziarg (2003), our results seem to lend support to an "inverted U-shaped" relationship between economic development level and local industrial specialization. We interpret this result as the consequence of the evolution of the market-oriented economic reforms in China. In the central planning period, every city had a full array of industries and a low level of industrial specialization. In the reform era, cities began to spin off the less competitive industries, devote resources to their core industries, and exhibit a positive correlation between industrial specialization and economic development. When economic development reaches a certain level, demand for new types of goods is generated, which is beyond what the old industrial structure can provide. Then, factors such as transportation costs and locating to the market start to work,

[14] Kalemli-Ozcan et al. (2003) and Asdrubali et al. (1996) use manufacturing GDP and population, respectively. We use manufacturing gross output as weights. The results using population as weights are nearly the same. As population is included as a control variable, we do not use the population weights in our main results.

causing a fall in specialization (Imbs and Wacziarg, 2003). The share of mining sector output in GDP (MIN) has little impact on industrial specialization. The fixed asset investment per capita (FAI) and the share of the primary sector in GDP (AGR) have a negative and significant effect on industrial specialization. In addition, the estimated coefficient of the ratio of primary and secondary school enrollments to population (EDU) is positive and statistically insignificant. Finally, local protectionism (FISCAL) and freight volume (FREIGHT) have an insignificant impact on industrial specialization, which implies that the government policy and internal trade have little impact on industrial specialization.

Table 3 Basic regression results

Note: The basic regression results are provided in Columns (1)-(3), in which the dependent variable is the city-level industrial specialization index. Regressions in Columns (4)-(6) include more control variables. Robust t-statistics are in parentheses, and *,**,*** stand for statistical significance at the 10%, 5%, and 1% level, respectively.

		Spec			Spec	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
RS	0.279***			0.149***		
	(4.464)			(2.651)		
Ex ante RS		0.312***			0.164***	
		(3.858)			(3.343)	
Ex post RS			-0.077			-0.014
			(-0.718)			(-0.159)
POP				-0.065***	-0.061***	-0.071***
				(-2.876)	(-2.660)	(-3.040)
POPDEN				-0.903***	-0.881***	-1.081***
				(-3.362)	(-3.653)	(-3.835)
GPC				8.160**	7.903**	6.433**
				(2.537)	(2.442)	(2.024)
GPC2				-84.957*	-78.712*	-58.283
				(-1.822)	(-1.850)	(-1.312)
AGR				-0.377***	-0.356***	-0.381***
				(-2.652)	(-2.604)	(-2.743)
MIN				0.046	0.055	0.091
				(0.327)	(0.374)	(0.537)
FAI				-0.093***	-0.091***	-0.083***
				(-3.030)	(-2.977)	(-2.661)
EDU				0.384	0.290	0.371
				(0.968)	(0.764)	(0.894)
FISCAL				0.070	0.104	0.001
				(0.300)	(0.465)	(0.002)
FREIGHT				-0.002	-0.003	-0.004
				(-0.094)	(-0.169)	(-0.221)
Constant	0.020	0.025	0.147***	0.435**	0.420**	0.576***
	(0.766)	(0.890)	(12.003)	(2.340)	(2.599)	(3.470)
Observations	209	209	209	209	209	209
R-squared	0.142	0.183	0.006	0.404	0.409	0.372

The lack of significant effects of *ex post* risk sharing on industrial specialization could be a consequence of several factors. First, the extent of *ex post* risk sharing is much smaller than that of *ex ante* risk sharing. The *ex post* risk sharing channels such as special fiscal

transfers and government subsidy are still rather weak in helping households weather negative income shocks, probably because local governments have limited fiscal capacity to provide fiscal subsidies and local government expenditure is typically biased toward infrastructure investment in most cities in China. Second, under financial repression, the state-controlled banking system offers very limited amounts of household credit (other than mortgage loans for property purchases), which are unlikely to provide effective risk sharing *ex post*. Furthermore, the corporate credit market is highly government-oriented, i.e., SOEs have privileged access to bank loans, whereas non-SOEs are typically disadvantaged. The government-controlled banking system distorts the allocation of resources, lowers the extent of *ex post* risk sharing achieved, and impedes industrial specialization.

When we look around the world, the relative strength of *ex ante* vis-à-vis *ex post* risk sharing varies from country to country and changes from time to time. For example, in the United States, the contribution of credit markets (*ex post* channel) to consumption smoothing fell from 45% to 19%, while that of capital markets (*ex ante* channel) increased from 34% to 48% from 1970 to 1990 (Asdrubali et al., 1996). *Ex post* channels contributed more than 40% to risk sharing in the European Community and OECD countries from 1966 to 1990 (Sørensen and Yosha, 1998). Cross-country analysis shows that *ex post* risk sharing takes place more generally, because cross-country portfolio holdings, as a major form of *ex ante* risk sharing, faces substantial obstacles. When we examine a specific country, the patterns are much more varied. Among developed countries, United States, Italy, United Kingdom and Canada rely more on *ex ante* channels, while in Japan and Spain risk sharing is achieved mainly through *ex post* channels (Kalemli-Ozcan et al., 2003). The case of China will help us understand and further explore the *ex ante* vs *ex post* risk sharing channels in emerging economies and developing countries.

4.2 Industrial specialization of SOEs and non-SOEs

The impacts of risk sharing on industrial concentration may well differ between SOEs and non-SOEs. SOEs are typically subject more to the influences of governments' industrial policy and industrial development planning than do non-SOEs. Thus, the industrial distribution of SOEs may be less affected by *ex ante* risk sharing. To examine the differential effects of risk sharing arrangements on SOEs and non-SOEs, we first re-estimate the level of industrial specialization according to Equation (4) for SOEs and non-SOEs separately. Panel A of Table 4 shows that the mean and median levels of industrial specialization of SOEs across cities are statistically significantly higher than those of non-SOEs with the magnitude of the former being around 3-4 times as large as that of the latter. This suggests that local governments may pay attention to the need for industrial concentration to improve economic efficiency in their industrial planning, and the clustering of SOEs in certain sectors could be a result of this planning policy. In contrast, the market forces such as risk sharing remain weak so that the extent of industrial specialization of non-SOEs remains far below that of SOEs.

Panel B presents the regression results of the effects of risk sharing on SOE and non-SOE industrial specialization. In Columns (1)−(3), the whole, *ex ante* and *ex post* risk sharing all produce positive effects on industrial specialization of SOEs, and those of the whole and *ex post* risk sharing measures are statistically significant. In Columns (4)−(6), the whole and *ex ante* risk sharing measures produce positive and significant effects on the industrial specialization of non-SOEs, while the *ex post* risk sharing has negative but insignificant effects on specialization. This result is consistent with the pattern of the findings from the whole sample analysis in Table 3 since non-SOEs dominate the sample in terms of firm number. Moreover, the magnitude of the estimated coefficients of the two risk sharing measures is higher than that in Table 3. Consistent with our hypothesis, these results show that risk sharing affects the industrial specialization of both SOEs and non-SOEs, while *ex*

ante and *ex post* risk sharing are the primary channels for non-SOE and SOE industrial specialization, respectively.

Table 4 SOEs vs Non-SOEs

Note: The basic descriptive statistics are displayed in Panel A. Besides the mean and median values, we provide comparison tests. The mean comparison test is a simple t test, and the null hypothesis is that the mean difference is zero. The median comparison test is Wilcoxon rank-sum test, and the null hypothesis is that the median difference is zero. Superscript * stands for statistical significance at the 5% level. In Panel B, the dependent variable for Columns (1)-(3) is the industrial specialization index calculated for state-owned enterprises, while the dependent variable for Columns (4)-(6) is the industrial specialization index calculated for non-state-owned enterprises. In Panel B, control variables are included but not reported, which include variables POP, POPDEN, GPC, GPC2, AGR, MIN, FAI, EDU, FISCAL, FREIGHT and a constant term. Robust t-statistics are reported in parentheses. Superscripts *,**,*** stand for statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A Descriptive statistics

	SOE	Non-SOE	dif
Mean	0.456	0.138	0.318*
Median	0.441	0.098	0.343*

Panel B SOEs and Non-SOEs

		SOE			Non-SOE	
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
RS	0.119*			0.160***		
	(1.711)			(2.934)		
Ex ante RS		0.016			0.181***	
		(0.262)			(3.591)	
Ex post RS			0.159**			-0.023
			(2.110)			(-0.253)
Constant	1.066***	1.163***	1.178***	0.374**	0.354**	0.526***
	(6.694)	(6.810)	(7.863)	(1.995)	(2.186)	(3.148)
Observations	209	209	209	209	209	209
R-squared	0.338	0.328	0.340	0.411	0.420	0.374

Two features of SOE industrial specialization are noteworthy. First, as mentioned above, SOEs exhibit a significantly higher degree of industrial specialization than non-SOEs. As a matter of fact, the distribution of SOEs across industries is directly influenced and even to some extent controlled by governments at various levels. The governments typically take into consideration the endowment of resources and production factors and regional comparative advantage in industrial planning. The governments promote industrial concentration through government-orchestrated resource allocations, especially in some key industries which are believed to be the commanding heights of the national economy as well as the local economy. With government efforts, coupled with market-oriented economic reforms, SOEs exhibit an increasing concentration, especially in sectors of strategic importance. In the Fourth Plenary Session of the Fifteenth Central Committee of the Communist Party of China (1999), the policy was set for the reform of SOEs: SOEs should concentrate on industries that are vital to the maintenance of national security, natural monopoly industries, important public goods industries and high-tech industries, and exit from other industries. This reform policy could contribute to the pattern of elevated industrial specialization of SOEs.

Second, *ex post* risk sharing plays a striking role in shaping SOE industrial specialization, while *ex ante* risk sharing casts significant effects on non-SOE specialization. Comparatively speaking, the government has direct control or influence over *ex post* risk

sharing channels. SOEs are the primary beneficiaries of the income flow generated by these *ex post* risk sharing channels. Once idiosyncratic risks severely affect business operation of an industry, fiscal subsidies and favorable loan policy from local governments will help SOEs get out of trouble. The SOE sector and consumers working in this sector would find their income less subject to industry-specific shocks. For the non-SOE sector, firms and consumers working in the sector do not have favorable access to the government's fiscal subsidies such as special transfers and state-controlled credit markets. Thus, they would rely primarily on *ex ante* risk sharing schemes to shield idiosyncratic risks.

4.3 Cyclical and non-cyclical industries

Industries also differ in their correlations with economic fluctuations. The outputs of cyclical industries are highly positively correlated with and would magnify GDP fluctuations. For instance, capital goods and durable consumer goods industries such as the steel industry and automobile industry thrive disproportionately when the economy booms, and they will decline disproportionately when the economy slumps. Non-cyclical industries produce or distribute goods and services people always need. Non-durable goods, mainly nondurable consumer goods, such as food, water and gas, are less likely influenced by economic boom or downturn.

In a city, cyclical industries more likely suffer from local production shocks. The effect of risk sharing arrangement on industrial specialization is expected to be more pronounced in cyclical industries than in non-cyclical industries. We re-estimate the level of industrial specialization by considering the two types of industries, i.e., cyclical and non-cyclical industries[15]. In particular, we modify the specialization measure to examine the role of risk sharing in cyclical and noncyclical industries separately. From the descriptive statistics in Panel A of Table 5, the extent of specialization for cyclical industries looks slightly smaller than that for non-cyclical industries, but there are no statistically significant differences between the two.

Table 5 Cyclical vs non-cyclical industries

Note: Basic descriptive statistics are displayed in Panel A. Besides mean and median statistics, we provide comparison tests. Mean comparison tests are a simple t test, and the null hypothesis is the mean difference is zero. Median comparison test is Wilcoxon rank-sum test, and the null hypothesis is the median difference is zero. * stands for statistical significance at the 5% level. In Panel B, the dependent variable for columns (1)-(3) is the cyclical industry specialization index. The dependent variable for columns (4)-(6) is non-cyclical industry specialization index. In Panel C, the dependent variable for columns (1)-(3) is the specialization index calculated for stated-owned enterprises in cyclical industries. The dependent variable for columns (4)-(6) is the specialization index calculated for non-stated-owned enterprises in cyclical industries. In Panels B and C, control variables are included but not reported, including variables POP, POPDEN, GPC, GPC2, AGR, MIN, FAI, EDU, FISCAL, FREIGHT and a constant term. Robust t-statistics are reported in parentheses, and *,**,*** stand for statistical significance at the 10%, 5%,1% level, respectively.

Panel A Descriptive statistics

[15] Cyclical sectors include manufacture of wood, bamboo, rattan, palm, and straw products, process of timber, manufacture of furniture, manufacture of paper and paper products, printing and recorded media, manufacture of articles for culture, education and sport activity, processing of petroleum, coking, processing of nuclear fuel, manufacture of chemical raw materials and chemical products, manufacture of chemical fibers, manufacture of rubber, manufacture of plastics, manufacture of non-metallic mineral products, smelting and processing of ferrous metals, smelting and processing of non-ferrous metal, manufacture of metal products, manufacture of general purpose machinery, manufacture of special purpose machinery, manufacture of electrical machinery and equipment, manufacture of communication equipment, computers and other electronic equipment, manufacture of measuring instruments and machinery for cultural activity and office work, and other manufacturing. Non-cyclical sectors include processing of food from agricultural products, manufacture of foods, manufacture of beverages, manufacture of tobacco, manufacture of textiles, manufacture of textile, apparel, footwear, and caps, manufacture of leather, fur, feather and related products, and manufacture of medicines.

	Cyclical	Non-Cyclical	dif
mean	0.154	0.160	-0.006
median	0.113	0.136	-0.023

Panel B Cyclical sectors and non-cyclical sectors

	Cyclical Industries			Non-Cyclical Industries		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
RS	0.177***			-0.094		
	(2.939)			(-1.639)		
Ex ante RS		0.173***			-0.063	
		(3.267)			(-1.022)	
Ex post RS			0.016			-0.050
			(0.167)			(-0.979)
Constant	0.353**	0.357**	0.521***	0.409***	0.380***	0.321***
	(2.104)	(2.292)	(3.242)	(3.606)	(3.296)	(3.286)
Observations	209	209	209	209	209	209
R-squared	0.377	0.374	0.335	0.232	0.224	0.220

Panel C SOEs and non-SOEs in cyclical sectors

	SOE Cyclical			Non-SOE Cyclical		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
RS	0.068			0.182***		
	(1.054)			(3.045)		
Ex ante RS		-0.019			0.183***	
		(-0.266)			(3.304)	
Ex post RS			0.130*			0.010
			(1.800)			(0.102)
Constant	1.130***	1.205***	1.195***	0.294*	0.295*	0.467***
	(7.220)	(7.344)	(8.379)	(1.739)	(1.892)	(2.906)
Observations	209	209	209	209	209	209
R-squared	0.338	0.335	0.343	0.386	0.384	0.340

Panel B of Table 5 shows the results for the two types of industries. In Columns (1) − (3), we estimate Equation (4) by focusing on cyclical industries. The estimated coefficients of the variables of the whole and *ex ante* risk sharing are positive and statistically significant. Columns (4) − (6) estimate Equation (4) in the subsample of non-cyclical industries. The estimated coefficients of all the three risk sharing measures are statistically insignificant. Consistent with our expectation, risk sharing arrangements are important for geographical specialization in cyclical industries.

In Panel C, we further estimate the SOEs' and non-SOEs' specialization in cyclical industries. Consistent with our expectation, the whole and *ex ante* risk sharing arrangements play a significant part in insuring the production risks and promoting industrial specialization of non-SOEs in the cyclical sectors. By contrast, only *ex post* risk sharing measures produce statistically significant effects on SOE specialization in cyclical industries. Local governments also have incentives to carry out industrial policies for SOEs, and require SOEs to specialize in certain industries, so as to achieve high economic growth by exploiting the benefits of specialization. Naturally, local governments will cover the downside risk of specialization by providing continuous credit support or government subsidies to the SOE sector. In this sense, local governments can use fiscal subsidies and state-controlled bank loans to provide a safety net for the SOE sector (*ex post* risk sharing), which facilitates the industrial specialization of SOEs.

Note that, our finding that *ex post* risk sharing promotes SOE industrial specialization when all industries are examined suggests that government policies play an increasingly important part in shaping SOE industrial specialization pattern. In addition, we observe the significant effects of risk sharing on SOE industrial specialization among cyclical industries. Cyclical industries consist of mainly heavy industries, which are often industries with strategic importance and thus are subject extensively to the influences of government industrial policies and intervention. Consequently, the *ex post* risk sharing channels are important in shaping SOE industrial specialization.

4.4. Economic development zones

As part of its economic reform, China designated four cities as special economic zones in 1980, and extended similar reform policies to 14 coastal opening-up cities in 1984. By the end of 2015, there were about 219 national-level economic and technological development zones in 158 cities. At the beginning, economic development zones were established to attract foreign direct investment (FDI), where enterprises received various benefits including tax exemptions or reductions, better infrastructure and facilities, more transparent regulations and simplified administrative procedures (Cheng and Kwan, 2000). These economic development zones serve the Chinese economy very well. With rapid development over 20 years, these areas have established relatively sound legal and institutional environments in order to attract and retain FDI, and played an instrumental role in spurring the regional economy[16]. Besides,

[16] ZONE cities have more market-oriented land and FDI policy, transparent regulations and simplified administrative procedures according to the following policy documents: No.85, 1991, from the General Office of the State Council; No.134, 1993, from the General Office of the State Council; No.15, 2005, from the General Office of the State Council; No.28, 2010, from the State Council; No.257, 2006, from the Ministry of Commerce and Ministry of Land and Resources; No.209, 2010, from the Ministry of Commerce and Ministry of Land and Resources; No.94, 2012, from the Ministry of Finance.

national-level economic zones are independent of the local governments of the cities hosting them, according to the regulations of the State Council, China's cabinet. It helps reduce the degree of local government intervention. For example, development zones can submit project applications directly to the State Council without the approval of local governments. Thus, cities with such national-level economic development zones are expected to have a more open and market-oriented economy with better economic institutions.

There are several ways through which the reform and opening-up policy embodied in the cities hosting national economic development zones could shape the impacts of risk sharing arrangements on industrial specialization. First, the legal rules are potentially important determinants of what rights contract holders have, while the quality of law enforcement will determine how well these rights are protected. A strong legal and institutional environment can protect the interests of minority shareholders and improve the access of businesses and consumers to external financial markets, which in turn increases the efficiency of risk sharing arrangements. Second, streamlined regulation and simplified administration reduce the transactions costs of factor flows. In a broad sense, production factor flows include population flow, technology flow, capital flow, information flow and natural resources flow. As factor flows are the fundamental approach to resource allocations, they also strengthen the role of risk sharing mechanisms, especially *ex ante* channels. Finally, these economic development zones are policy-favored areas, which enjoy abundant credit and transfer resources than other cities. This is particularly important for the SOE sector, which relies more on *ex post* risk sharing channels. Thus, it is expected that risk sharing arrangements would have a larger impact on industrial specialization in cities with more open and market-oriented economies.

We obtain the list of national-level economic and technological development zones from the Ministry of Commerce of the People's Republic of China. We further classify cities into ZONE cities, where there are at least one economic and technological development zones, and OTHER cities otherwise. We then re-estimate our main specifications in the subsamples of ZONE cities and OTHER cities separately. Columns (1)−(3) of Panel A of Table 6 focus on the ZONE cities. The estimated coefficients of the whole and *ex ante* risk sharing indexes are both positive and statistically significant[17]. For the other no-zone cities in Columns (4)−(6), the risk sharing indexes do not have significant effects on industrial specialization. Consistent with our expectation, ZONE cities have better market institutions. Consequently, risk sharing, especially *ex ante* risk sharing, is more effective in promoting industrial specialization.

Table 6 Alternative samples

Note: Panel A looks at the subsample of cities with national economic and technological development zones and the subsample of cities without such zones. We download the list of National Economic and Technological Development Zones from the website of the Ministry of Commerce of the People's Republic of China. Regressions in Columns (1)-(3) are based on the subsample of cities having at least one National Economic and Technological Development Zone (ZONE sample) while the regressions in Columns (4)-(6) are conducted in the subsample of cities without development zones (Non-ZONE sample). In Panel B, all regressions are conducted in the ZONE sample. The dependent variable for Columns (1)-(3) is the specialization index calculated for state-owned enterprises, while that for Columns (4)-(6) is the specialization index calculated for non-state-owned enterprises. Panel C follows Campbell and Mankiw

[17] The estimation results remain the same when we add entry year fixed effects controlling for different waves effect.

(1987) to analyze shock persistence. In an AR(p) process, $\Delta x_t = \mu + \sum_{i=1}^{p} \varphi_i \Delta x_{t-i} + \varepsilon_t$, persistence of the shock is defined as $1/(1 - \sum_{i=1}^{p} \varphi_i)$. We use the real GDP per capita growth rate time series from 1990 in order to lower the estimation error and choose three lags which is consistent with Asdrubali et al. (1996). Regressions in Columns (1)-(3) are carried out in the low-persistence sample while those in Columns (4)-(6) are in the high persistence sample. In Panel D, all regressions are for the high-persistence sample. The dependent variable for Columns (1)-(3) is the specialization index calculated for state-owned enterprises, while that for Columns (4)-(6) is the specialization index calculated for non-state-owned enterprises. In all these panels, control variables are included but not reported, including variables POP, POPDEN, GPC, GPC2, AGR, MIN, FAI, EDU, FISCAL, FREIGHT and constant. Robust t-statistics are in parentheses, and *,**,*** stand for statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Openness

	Zone Samples			Other Samples		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
RS	0.183***			0.130		
	(2.842)			(1.568)		
Ex ante RS		0.211***			0.120	
		(2.703)			(1.564)	
Ex post RS			0.088			-0.040
			(0.487)			(-0.425)
Constant	0.244	0.211	0.462**	0.536*	1.038***	0.643**
	(1.228)	(1.244)	(2.123)	(1.724)	(3.183)	(2.174)
Observations	107	107	107	102	102	102
R-squared	0.411	0.411	0.358	0.403	0.403	0.383

Panel B: SOE and non-SOE for ZONE samples

	SOE ZONE Samples			Non-SOE ZONE Samples		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
RS	0.130			0.197***		
	(1.334)			(3.284)		
Ex ante RS		-0.002			0.226***	
		(-0.020)			(2.920)	
Ex post RS			0.477**			0.096
			(2.536)			(0.564)
Constant	1.064***	1.221***	1.220***	0.195	0.160	0.429*
	(3.894)	(4.322)	(5.330)	(0.970)	(0.914)	(1.952)
Observations	107	107	107	107	107	107
R-squared	0.306	0.296	0.334	0.461	0.460	0.399

Panel C: Persistent shocks

	Low Persistence Sample			High Persistence Sample		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
RS	0.059			0.233***		
	(0.856)			(2.639)		
Ex ante RS		0.078			0.245***	
		(1.331)			(2.795)	
Ex post RS			-0.035			0.010
			(-0.220)			(0.086)
Constant	0.680***	0.659***	0.747***	0.118	0.094	0.303
	(3.187)	(4.003)	(4.134)	(0.429)	(0.331)	(1.110)
Observations	105	105	105	104	104	104
R-squared	0.529	0.533	0.525	0.369	0.370	0.297

Panel D: SOE and non-SOE high persistence samples

	SOE High Persistence Samples			Non-SOE High Persistence Samples		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
RS	0.327***			0.192***		
	(3.469)			(3.618)		
Ex ante RS		0.291			0.296***	
		(1.454)			(3.484)	
Ex post RS			0.324**			0.091
			(2.124)			(0.786)
Constant	0.817**	0.906*	1.114**	0.168	0.102	0.393
	(2.101)	(1.972)	(2.613)	(0.485)	(0.300)	(1.160)
Observations	103	103	103	104	104	104
R-squared	0.501	0.375	0.413	0.418	0.436	0.311

In Panel B of Table 6, we examine the impacts of risk sharing arrangements on SOE and non-SOE industrial specialization in ZONE cities separately. In Columns (1)−(3), the degree of the *ex post* risk sharing has positive and statistically significant effects on the industrial concentration of SOEs, while the whole and the *ex ante* risk sharing produce insignificant effects. In Columns (4)−(6), the whole and *ex ante* risk sharing arrangements cast positive and statistically significant effects on non-SOE industrial specialization, while *ex post* risk sharing produces positive but insignificant effects. Compared with the corresponding whole-sample results in Table 4, Panel B, the magnitude of the estimated coefficients of the *ex post* risk

sharing measure in Column (3) and the *ex ante* risk sharing measure in Column (5) is larger in the ZONE city sample analysis. This suggests a potent influence of the *ex ante* and *ex post* risk sharing mechanisms on industrial specialization in ZONE cities, which is made possible by the strong economic institutions, extensive production factor flows, and abundant financial and fiscal resources in these zone-hosting cities.

4.4. Permanent vs. temporary shocks

Economic shocks can be either permanent or temporary. *Ex ante* risk sharing helps smooth residents' income, and thus is effective in insuring against both permanent and temporary production shocks. In contrast, *ex post* risk sharing relies on borrowing and lending to smooth residents' consumption, and is more effective in dealing with temporary production shocks. When highly persistent shocks occur, portfolio investment and income diversification would help the city to smooth income and weather shocks so as to continue to specialize in the sectors with comparative advantage. Compared with the group of regions with lower-persistence shocks, regions facing higher-persistence shocks tend to have a larger and more significant capital market channel (*ex ante*) for consumption smoothing, but have a smaller and nearly insignificant credit market channel (*ex post*).

We further investigate the effect of risk sharing on industrial specialization in scenarios of persistent and temporary fluctuations. In reference to the measurement of persistence of economic fluctuations, Campbell and Mankiw (1987) define it as $1/(1-\sum_{i=1}^{p}\varphi_i)$ in an AR(p) process: $\Delta x_t = \mu + \sum_{i=1}^{p}\varphi_i \Delta x_{t-i} + \varepsilon_t$. In order to lower the estimation error, we use the time series data of real GDP per capita growth rate starting from 1990, which is the best we can find at the city level, and choose one, two, and three years lagged values which are consistent with Asdrubali et al. (1996). Sorting the sample cities by the persistence of economic fluctuation, we split the sample into the low-persistence group and high-persistence group based on the sample median.

In Panel C of Table 6, we examine the effects of risk sharing on industrial specialization in the two subsamples separately. It is interesting that the statistically significant results are concentrated in the high-persistence group, i.e., the whole and *ex ante* risk sharing significantly promote industrial specialization. Moreover, the magnitude of the estimated coefficients is relatively larger than that of our basic regression results in Table 3. On the contrary, in the low-persistence group, there is no influence of risk sharing on specialization. Our interpretation is that risk sharing appears to be more important when facing persistent shocks and there are fluctuations that amplify the gain from risk sharing for a given level of industrial specialization. If a region has a perfectly diversified economy, it will be immune to idiosyncratic production shocks. Risk sharing mechanism is found to be useless in these regions. High-persistence shocks make the risk sharing mechanism indispensable to the determination of industrial structure. Besides, in our previous results, *ex ante* risk sharing plays the dominant role in coping with production risks. *Ex post* risk sharing can hardly work well in the face of high-persistence shocks as households need to constantly borrow much for a long period in the credit market or the government needs to regularly provide special fiscal transfers, which are costly and infeasible. *Ex ante* risk sharing naturally works well in a high-persistence

environment, and it reinforces the relationship between risk sharing and industrial specialization in high-persistence samples.

We further examine the responses of SOE and non-SOE industrial specialization to risk sharing in the cities with high-persistence shocks. In Panel D of Table 6, Columns (1)−(3) look at the SOE specialization. The degrees of the whole and *ex post* risk sharing significantly promote SOE industrial specialization. Columns (4)−(6) report the results for the non-SOE industrial specialization. The degrees of the whole risk sharing and *ex ante* risk sharing have positive and statistically significant effects on non-SOE industrial specialization. This is consistent with the results in Panel B. Provided the dominance of non-SOEs in terms of sample firm number, *ex ante* risk sharing plays a more important part in shaping the industrial specialization pattern in cities that are subject to persistent economic shocks.

5. Robustness tests

5.1 Sensitivity tests

In this section, we test the sensitivity and robustness of our basic results. We first consider the robustness of our results to alternative measures of local industrial specialization. We re-estimate Equation (4) using two alternative measures, namely Herfindahl index and the Gini index

$$\mathrm{HHI}^{i} = \sum_{s=1}^{S} \left(\frac{OUTPUT_i^s}{OUTPUT_i^M}\right)^2 \tag{5}$$

$$Gini_i = \frac{1}{2S^2\mu} \sum_j \sum_k |s_{ij} - s_{ik}| \tag{6}$$

HHI^{i} is a direct measure of industrial specialization. S is the number of industrial sectors. $OUTPUT_i^s$ is the gross industrial output value of sector s in city i. $OUTPUT_i^M$ is the total industrial output of all manufacturing sectors in city i. If all economic activities in city i concentrate on a specific industry, $\mathrm{HHI}^{i} = 1$. Similarly, if all economic activities in region i spread evenly among s number of industries, then the Herfindahl index would be $HHI^i = 1/s$. The index ranges from 0 to 1.

$Gini_i$ provides an alternative measure of geographic concentration of industries. s_{ij} and s_{ik} are the gross output share of sector j and sector k in city i, respectively. S represents the total number of sectors and μ denotes the average sector share. Gini index ranges from zero to one, reflecting the inequality of industry distribution. If all industries in a city have the same output share, Gini index takes value of zero and there is a perfectly diversified industrial structure. When a city concentrates on a specific sector, which means a completely specialized industry structure, the Gini index equals one.

In Panel A of Table 7, Columns (1)−(3) use the Herfindahl index as a measure of industrial specialization, whereas Columns (4)−(6) employ the Gini index. Because the "Gini

index" ranges from zero to one and is similar across cities, we carry out the logit transformation of it to obtain the dependent variable. It is shown that when both measures are used, the estimated coefficients of the whole and *ex ante* risk sharing indicators are positive and statistically significant.

Panel B of Table 7 reports the sensitivity of our basic regressions to the alternative estimation method and alternative industry classifications. In Columns (1)−(3), we restrict the measures of risk sharing to a range from zero to one[18]. In Columns (4)−(6), we calculate the industrial specialization index at the three-digit industry level and use it as the dependent variable.[19]. All the results remain qualitatively equivalent. Risk sharing, in particular *ex ante* risk sharing, continues to be an important factor in shaping local industrial specialization.

Note that cities within a province are able to share their risks through interaction with other cities in the same province or with cities in other provinces (Ho et al., 2015). If *ex post* risk sharing is more likely to be a government orchestrated risk sharing mechanism, we should expect that *ex post* risk sharing should be more relevant to the risk sharing within a province. The rationale is that protectionism at the provincial level prevents a city from relying on financial resources in another province to bail out production risks. The more powerful the municipal government is, the more likely the city is able to use the financial resources within this province to insure its production risks. To provide further support to the hypothesis, we split the sample into large cities and small cities, based on whether the size of a city's GDP is above or below the median level of GDP within a province. Panel C reports the estimation results in both small and large cities. Consistent with our expectation, the *ex post* risk sharing has a more pronounced effect on industrial specialization in large cities, while it has no effect in small cities. A possible explanation is that large cities have a better access to fiscal resources within the province and can allocate more financial resources to SOEs.

As shown in Figures 1-3 providing the scatterplots of the relations between the three risk sharing indices and industrial specialization, some of the risk sharing measures could be suspected to be "outliers" which may be caused by the estimation error. To check the robustness, we conduct a sensitivity test by excluding the estimated coefficients with a level of low statistical significance. Columns (1)-(3) of Table 7, Panel D, report the estimation results in samples with estimated coefficients significant at the 10% level[20]. All the results remain qualitatively unchanged.

The risk sharing mechanism mainly works through the dispersion of a city's risk among other cities over a long time period. The longer the sample period used to estimate risk sharing, the lower the measurement errors (Kalemli-Ozcan, et al., 2003). Therefore, longer time-series data is instrumental to the estimation of risk sharing indicators by minimizing the short-term disturbances. The baseline results in Table 3 are derived using cross-sectional regressions, where the risk sharing indicators are estimated with the whole sample period time-series data. Nevertheless, people may be concerned about whether there is a time dimension in the relationship between risk sharing and industrial specialization and whether this relationship still holds when considering the time dynamics. To address this concern, we estimate risk sharing over time and across regions. We follow Kose et al. (2009) by estimating the basic

[18] In theory, the level of regional risk sharing should vary from zero to one. Restricted regression allows us to rule out the impact of outliers that strongly affect the regression lines.

[19] We obtain similar results using four-digit level industry classification. For brevity, these results are not reported.

[20] Due to the small sample size, we do not use samples with estimated coefficients significant at the 5% or 1% level.

regression models (1)-(3) over nine-year rolling periods[21], and obtain the estimates of risk sharing over each 9-year period. Correspondingly, we also construct the averages of the specialization indices and control variables over the same 9-year period[22]. We repeat the benchmark regression analysis by controlling for both city and year fixed effects. The results in Columns (4)-(6) of Panel D show that our empirical results remain qualitatively unchanged[23].

Table 7 Sensitivity tests

Note: In Panel A, the dependent variable of Columns (1)-(3) is the HHI Index estimated by Equation (5). The dependent variable of Columns (4)-(6) is the logarithm of the Gini Index estimated by Equation (6). In Panel B, Columns (1)-(3) report the estimation results with the constraint that the risk sharing index β ranges from zero to unit. Columns (4)-(6) report the results of 3-digit industry classification. Panel C reports the estimation results in small cites (columns (1)-(3)) and large cities (columns (4)-(6)). Panel D provides additional tests. Columns (1)-(3) reports the estimation results in samples with estimated risk sharing coefficients significant at the 10% level. Columns (4)-(6) reports the estimation results using time varying risk sharing estimates over nine-year rolling periods. Control variables are included but not reported, including variables POP, POPDEN, GPC, GPC2, AGR, MIN, FAI, EDU, FISCAL, FREIGHT and constant. Column (4)-(6) additional controls the year and city fixed effects. Robust t-statistics are in parentheses, and *,**,*** stand for statistical significance at the 10%, 5%, 1% level, respectively.

Panel A: Alternative measures of industrial specialization

	Herfindahl Index			Gini Index		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
RS	0.177***			0.579***		
	(2.943)			(2.950)		
Ex ante RS		0.188***			0.621***	
		(3.591)			(3.402)	
Ex post RS			-0.005			-0.029
			(-0.053)			(-0.091)
Constant	0.570***	0.561***	0.738***	3.020***	2.982***	3.569***
	(2.807)	(3.130)	(4.070)	(4.994)	(5.299)	(6.420)
Observations	209	209	209	209	209	209
R-squared	0.435	0.438	0.395	0.538	0.540	0.517

Panel B: Alternative methods

	OLS Regression with Constraint			3-digit Industry Codes		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
RS	0.150***			0.155***		
	(2.605)			(2.776)		
Ex ante RS		0.188***			0.169***	
		(3.050)			(3.539)	

[21] For example, the extent of whole risk sharing in 2011 is equal to β_7, which represents the estimates for the period from 2003 to 2011.

[22] We also use the annual specialization indices and control variables and obtain similar results. For brevity, these results are not reported, but available upon request.

[23] The results remain unchanged after controlling city and province-year fixed effects.

Ex post RS			0.023			-0.013
			(0.222)			(-0.141)
Constant	0.434**	0.399**	0.573***	0.504***	0.491***	0.651***
	(2.338)	(2.433)	(3.347)	(2.707)	(3.030)	(3.951)
Observations	209	209	209	209	209	209
R-squared	0.403	0.410	0.372	0.446	0.451	0.409

Panel C: Small and large cities

	Small			Large		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
RS	0.126***			0.227***		
	(2.804)			(3.414)		
Ex ante RS		0.144***			0.244**	
		(3.137)			(2.486)	
Ex post RS			0.008			0.225***
			(0.108)			(2.822)
Constant	-0.031	-0.098	0.101	0.332	0.193	0.536
	(-0.250)	(-0.680)	(0.656)	(0.992)	(0.516)	(1.481)
Observations	98	98	98	111	111	111
R-squared	0.742	0.746	0.698	0.564	0.522	0.502

Panel D: Other tests

	Samples with estimated risk sharing coefficients significant at the 10% level			Time varying		
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
RS	0.387***			0.031***		
	(5.961)			(3.884)		
Ex ante RS		0.421***			0.027***	
		(4.522)			(2.926)	
Ex post RS			0.054			0.004
			(0.362)			(0.581)
Constant	-0.038	-0.021	0.153***	-0.816*	-0.692	-0.647
	(-1.420)	(-0.608)	(4.302)	(-1.822)	(-1.533)	(-1.392)
Year & City FE				YES	YES	YES
Observations	187	196	37	1,045	1,045	1,045
R-squared	0.223	0.227	0.004	0.984	0.984	0.983

5.2 Endogeneity

There could be concern over the endogeneity of the relationship between risk sharing and industrial specialization. For example, cities that specialize in certain industries may have greater incentives to participate inter-regional risk sharing arrangements. To address this kind of concern, we use two distinct indicators of cultural barriers, specifically the number of genealogies in each city and the distance between the local dialect of a city and Beijing Mandarin, as the two alternative instrumental variables for risk sharing.

China has a long history of being a patriarchal society. In the traditional Chinese society, a clan was a large extended family where family members lived together and helped each other. Clanship, i.e., all members with a common patrilineal ancestor, built and sustained trust among clan members, which facilitated daily communications and lowered transactions costs. The culture of clanship naturally contributes to a practice of classifying people into groups with different affinities. People would trust those who belong to the same clan more, and other people without blood relations less even when they lived nearby. Moreover, people from the same village, city or region are trusted more than those from outside. Clanship is bound up with local residents from their birth and gets strengthened throughout their whole life. People who live in the cities rich in clanship are expected to generate a strong cultural identity and emotional attachment to their clan and in turn their hometown. As found by Spolaore and Wacziarg (2015), people with different cultural identities are less likely to exchange with each other. Thus, given the persistence of the clanship culture, it is reasonable to expect that clanship generally shapes the current residents' local identity and further obstructs cross-city risk sharing by increasing interaction between residents within a city and deterring interpersonal exchanges between cities. The Chinese Genealogy Knowledge Service Platform in Shanghai Library provides comprehensive statistics of genealogies in China, including 76755 genealogies with their family names, genealogical ancient locations, starting time, printing methods and collection locations. Some of the genealogies' full texts are available online. Following Zhang (2020) and Fan et al. (2021), we use the number of genealogies in each city (*Clanship*) to measure the strength of the cultural legacy of clanship.

China, an old civilization with a vast land area and varied ethnic groups, has manifold and complex languages and dialects. Mandarin is the official language of China. It is formulated on the basis of Beijing Mandarin phonologically. However, Beijing Mandarin is only one of the 17 dialects of Chinese Han language, and is not even the dominant dialect in most cities[24]. For example, people in Shanghai speak Wu in their daily conversation rather than Beijing Mandarin. The literature highlights the importance of languages on cross-border exchanges (Grinblatt and Keloharju, 2001; Melitz and Toubal, 2014). Obviously, local dialects become a barrier to communication and mutual trust when residents in a city interact with people from other cities or provinces with a different dialect. A larger difference between dialects means a higher cost of cross-region economic exchanges. For instance, it is found that dialects, as a form of cultural identity, lead to "border effects" in intra-national migration and trade in China (Su et al., 2018; Wang and Ruan, 2019). Following Spolaore and Wacziarg (2015), we use language trees, a method borrowed from cladistics, to measure the distances among dialects within Han Chinese. Language trees denote the ancient relations among different dialects, reflecting the long-standing situations of economic and cultural exchanges between different cities and regions. Because our study is not conducted on the basis of city or province-pairs, we

[24] Zhang (2021) plots a map of different dialects' geographic distribution in China.

employ the distance between a local dialect and Beijing Mandarin to measure cultural barriers. Given Mandarin is the official language based on Beijing Mandarin, people would normally communicate with those speaking a different dialect in Mandarin. Nevertheless, a greater distance between a local dialect and Beijing Mandarin typically means it is more difficult for local residents to learn to speak Mandarin and less comfortable for them to communicate in Mandarin. Thus, they face more barriers to build trust in people from other regions around China, and are less likely to conduct economic and social exchanges with non-locals. Thanks to *Language Atlas of China* published by Commercial Press in 2012, we obtain the information on the dominant dialect in each city and the ancient relationship between different dialects. We use the distance between a local dialect and Beijing Mandarin (*Dialect*) to measure the dialect distance, and examine its effects on risk sharing (Appendix table 3 provides the language trees of Chinese Dialect).

The IV regression results are reported in Table 8. In Panel A, the second stage regressions show that the whole and *ex ante* risk sharing indices produce positive and statistically significant impacts on local industrial specialization, providing further support for the importance of *ex ante* risk sharing in promoting industrial specialization. From the first stage regression results in Panel B, we observe that the number of genealogies in each city and the distance between local dialect and Beijing Mandarin are negatively correlated with the extent of risk sharing, both the whole risk sharing and the *ex ante* risk sharing. These results are consistent with the expectation of a negative relationship between cultural barriers and inter-city risk sharing[25].

Table 8 Instrumental variable regressions

Note: This table reports the 2SLS regression results by using the number of genealogies in each city (Column (1)-(2)) and the distance between the local dialect of a city and Beijing Mandarin (Column (1)-(2)) as the two alternative instrumental variables. Panel A and Panel B report the second stage regression and the first stage regression, respectively. Control variables are included but not reported. Robust t-statistics are in parentheses, and *,**,*** stand for statistical significance at the 10%, 5%, and 1% level, respectively. The F-statistic in the first-stage provides the F statistic for the significance of the instrument, and the Prob>F is the p-value for weak instrument test. Panels C and D provide the results of exclusion restriction test. We use the residual from the second stage to conduct the regression on the instrumental variable and display the results in Panel C. Panel D reports the WLS results like Columns (4)-(6) in Table 3, but we employ the instrumental variable as an independent variable together with the risk sharing measure. Robust t-statistics are in parentheses, and *,**,*** stand for statistical significance at the 10%, 5%, and 1% level, respectively.

VARIABLES	(1)	(2)	(3)	(4)
Panel A Second Stage				
RS	0.511***		0.499**	
	(3.041)		(2.519)	
Ex ante RS		0.783***		0.656***
		(3.065)		(2.721)
Controls	YES	YES	YES	YES
Panel B First Stage				
Clanship	-0.029***	-0.020***		
	(-4.145)	(-3.633)		

[25] Detailed results of first stage and second stage regressions are reported in Appendix 5.

Dialect			-0.101***	-0.083***
			(-3.160)	(-3.351)
Controls	YES	YES	YES	YES
Observations	209	209	209	209
F-statistic	17.2	13.2	10.0	11.2
Prob > F	0.0001	0.0004	0.0018	0.0010
Panel C Residual regression on instrument				
Clanship	-0.005	-0.005		
	(-1.603)	(-1.578)		
Dialect			-0.019	-0.018
			(-1.551)	(-1.454)
R2	0.012	0.011	0.009	0.008
Panel D Test of exclusion restriction				
RS	0.146***		0.147***	
	(2.796)		(2.660)	
Ex ante RS		0.154***		0.163***
		(3.728)		(3.403)
Clanship	-0.014	-0.014		
	(-1.308)	(-1.303)		
Dialect			-0.048	-0.044
			(-1.463)	(-1.506)
Controls	YES	YES	YES	YES

A valid instrument should satisfy both the relevance condition and exclusion restriction condition. From the first stage regression results, *Clanship* and *Dialect* are negatively and statistically significantly correlated with the extent of both the whole and *ex ante* risk sharing. The associated F-value is 10 or above, which is sufficiently large to alleviate the concern over a weak instrumental variable (Staiger and Stock, 1997).

With regard to the exclusion restriction condition, i.e., the instrumental variable does not affect industrial specialization through channels other than risk sharing, we implement two additional tests on the exclusion restrictions. First, if the IV influences industrial specialization through other channels, the residuals of the second-stage regression should be correlated with the IV. The results in Panel C of Table 8 show that the correlation between the two variables is small and statistically insignificant at the conventional confidence level. Second, if the instrumental variable influences industrial specialization only through risk sharing channels, the IV should have statistically insignificant effects on industrial specialization conditional on risk sharing. In Panel D of Table 8, we regress industrial specialization on both the instrumental variable and risk sharing measures. The results show that all the estimated coefficients of the instrumental variables become statistically insignificant.

6. The nature of *ex ante* and *ex post* risk sharing channels

The causal mechanism of our main hypothesis is that the *ex ante* risk sharing channel is primarily market-based while the *ex post* one is mainly government-administered in shaping China industrial specializations. If our hypothesis is correct, we should observe that market factors and government-administered factors are the primary determinants of *ex ante* and *ex post* risk sharing, respectively. To provide further evidences, we use a standard risk sharing

regression model that contains indicators of the various channels controlling for time and city fixed effects.

$$\Delta\log GDP_{it} - \Delta\log CON_{it} = v_t + \vartheta_i + \beta_2 \Delta\log \mathrm{GDP}_{it} + \gamma \Delta\log \mathrm{GDP}_{it} \times Channel_{it} + \epsilon_{it} \quad (7)$$

where $Channel_{it}$ is the set of indicators of *ex ante* or *ex post* risk sharing channels in region i.

A positive value of the estimated coefficient vector γ indicates that the greater the value of these channel variables in a city, the greater the amount of risk sharing achieved there. In addition, to examine the specific channels of *ex ante* and *ex post* risk sharing separately, we conduct regressions with specifications of the following Equations (8) and (9), respectively. These channel regressions are similar to Equation (7) in specification but examine whether some potential channels truly contribute to *ex ante* or *ex post* risk sharing. If the estimated coefficient γ is statistically significant, that potential channel variable proves an effective *ex ante* or *ex pos*t risk sharing channel.

$$\Delta\log GDP_{it} - \Delta\log INC_{it} = v_t + \vartheta_i + \beta_2 \Delta\log \mathrm{GDP}_{it} + \gamma \Delta\log \mathrm{GDP}_{it} \times Channel_{it} + \epsilon_{it} \#(8)$$

$$\Delta\log INC_{it} - \Delta\log CON_{it} = v_t + \vartheta_i + \beta_2 \Delta\log \mathrm{INC}_{it} + \gamma \Delta\log \mathrm{INC}_{it} \times Channel_{it} + \epsilon_{it} \#(9)$$

6.1. *Ex ante* risk sharing channels

Capital markets

Capital markets primarily refer to bond markets and equity markets. China's capital markets have not achieved the goal of providing finance for large swathes of corporations, especially non-SOEs. China's corporate bond market is underdeveloped. According to China Securities Regulatory Commission (CSRC), the ratio of corporate bond issues outstanding to GDP in 2016 remained as low as 20.86%, and SOEs constituted 91% of the issuers. China's stock market has enjoyed rapid expansion since its formation in the early 1990s. The ratio of stock market capitalization to GDP surged from only 3.93% in 1992 to 68.28% in 2016. Nonetheless, China's equity market has long tilted toward SOEs, which still made up 38 % of the listed firms at the end of 2016. The limited corporate coverage of the equity market is accompanied by a low participation rate (18%) of Chinese households in stock markets, according to China Household Finance Survey, which is much lower than that in the U.S. [26] Moreover, China's equity markets are characterized with pervasive insider trading and speculations, which is manifested in high turnover rates of 249.2% (2016) in Shanghai and Shenzhen stock exchanges, much higher than those in most of matured financial markets (Allen et al, 2019). These deficiencies weaken the effectiveness of capital markets in resource allocation and risk diversification. To gauge the impact of capital markets on risk sharing, we construct a variable of *Capital markets* as the ratio of the sum of stock market capitalization and the outstanding principal balances of corporate bonds (long-term and short-term) to GDP (He et al., 2017).

Industrialization and urbanization process

China's industrialization and urbanization process has encouraged large numbers of redundant rural laborers to leave farming and the countryside to move either to cities within the

[26] According to the 2016 wave of Survey of Consumer Finances (SCF) in the US, more than 50% of households participate in the financial market by holding stocks or mutual funds.

same province or to the booming coastal provinces and cities (this form of migration is called *litu lixiang* in Chinese). However, because of the household registration system (*Hukou*), these migrant workers do not officially migrate to cities, but only take temporary jobs there. Typically, they remit a big chunk out of their wages back to their families in the countryside. Hence, rural-urban migration has substantially altered the sources of household income in rural China, especially in the poorer inland provinces. The remittance of non-farming income by migrant labor has become an increasingly important source of income for rural households (de Brauw and Giles, 2008) and, at the same time, an effective instrument for interregional risk sharing. Du et al. (2011) show that some alternative channels, such as urbanization and alternative finance, play important roles in promoting interprovincial consumption risk sharing. We use *Migration ratio*, the ratio of migration outflow and inflow over the population in a city, to gauge the size of migrant labor.

General fiscal transfer

China's fiscal transfer system differs from most western countries in that most of the local (both provincial and municipal) government's fiscal resources rely on transfers from the central government[27]. In 1994, a far-reaching central-local government tax sharing reform resulted in a higher central government revenue and lower local government revenue. General transfers are determined in the government budget at the beginning of each year, which can hardly respond to emergency needs. General transfers aim to fill the gap between local revenue and local expenditure, as well as reduce economic disparity among regions[28]. The amount of general transfers is calculated by a standardized method and listed in the government budget that must be approved by the local-level People's Congress in the beginning of the year. Under the flypaper effect, local governments have incentives to expand public spending, even for less efficient uses, in order to obtain a larger amount of general transfers from the upper-level governments in the next year. Gradually, general transfers become a conventional arrangement to alleviate disparity among different regions, and thus act more like a long-term institutional arrangement to balance interregional economic development; it varies little with the economic fluctuations during the year. In this sense, it can be regarded as an *ex ante* risk sharing mechanism.

6.2. *Ex post* risk sharing channels

Credit markets

China has a bank-centered financial system. According to the measures from World Development Indicators, the ratio of bank credit to GDP in China is 156.22% in 2016, much higher than the world average 87.13%. However, most of the credit is controlled by state-owned banks. SOEs enjoy a privileged access to bank credit, while non-SOEs have difficulties in gaining access to loans and struggle in the credit market. Household credit, especially consumption credit, is extremely limited. In addition, the Chinese government still maintains a strict regulation of bank operations. The government's dual role as the regulator and as the dominant owner in the banking sector diminishes the effectiveness of both the state-owned banks and the entire credit market[29]. We use the ratio of the sum of loans and

[27] Shen et al. (2012) provided a comprehensive review of fiscal decentralization in China.

[28] The central-local government transfer system is especially important for inland cities. In hinterland cities in Xizang and Qinghai, nearly 90% of local budget counts on the central government transfers.

[29] Even after serval waves of deregulation and marketization, the central or local government is still the biggest shareholder of

deposits to GDP as the proxy variable for the development of credit markets (see Appendix 2 for details).

Special fiscal transfers

Government fiscal transfers include both general transfers and special transfers. According to the *Administration Measures for the Special Transfer Payments from the Central Government to Local Governments* promulgated by Ministry of Finance in 2015, the central government provides funds for the local government to cope with natural disasters or other emergencies. In other words, special transfers are subsidies granted by the central government to the local government that undertakes specific-purpose tasks, including the aid for natural disasters, environmental protection, public transport, strategic industries, small firms, and renewable energy. Special transfers are made only if the local government undertakes corresponding tasks, so that they depend heavily on the government's strategic plan and economic performance in that year[30]. Thus, special transfers are a representative *ex post* risk sharing channel. For instance, after the Wenchuan Earthquake in May 2008, special transfers to Wenchuan City rose by 14.4 times, increasing from 87 million yuan in 2007 to 1259 million yuan in 2008, while general transfers went up from 91 million yuan in 2007 to 204 million yuan in 2008. Beyond that, many fiscal subsidies come from special transfers helping enterprises share the risk after the production shock occurs. For example, local governments can subsidize the semiconductor industry from the strategic industry special funds after the outbreak of the China-US trade war. Special transfers are a direct way to share risk among cities, and not surprisingly, become an important means of risk sharing.

6.3. Regression results

Table 9, Panels A, B, and C, examine the channels of whole risk sharing, *ex ante* risk sharing, and *ex post* risk sharing, respectively. In each panel, we present estimation results for each potential risk sharing channel by including the interaction term between each risk sharing channel and output growth one by one. In addition, we also conduct a regression by putting all the interaction terms with potential risk sharing channels together to test their robustness[31].

In Panel A, Column (1), we find that migration has a positive and significant effect on the whole risk sharing. Its effect remains significant in Panel A, Column (6), when all the potential channel variables are included in the regression together. In Panel B, Columns (1) and (4), the regressions show that migration is a significant and robust *ex ante* risk sharing channel. This testifies to the important role of migration in achieving *ex ante* as well as whole risk sharing. The large-scale movement of labor across provinces and cities began after Deng Xiaoping's tour of South China in early 1992 to launch a new round of economic reforms that further promoted industrialization and urbanization. Increasing numbers of migrant workers have flowed from rural areas to cities within the province or large cities in other provinces. As a consequence, the share of total rural net income accounted for by non-farming income increased substantially from 26% in 1990 to 58% in 2006 (National Statistics Bureau, 2007), to

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most of China's banks.

[30] Note that the local governments revenue relies heavily on the fiscal transfer system. For example, China's local fiscal revenue was 14664 billion RMB in 2016, including general transfers of 3186 billion RMB and special transfers of 2071 billion RMB from the central government.

[31] As a robustness, we employ the initial year value of the channel variables and re-estimate the results, and obtain similar results.

which the increasing value of remittances contributes a significant part. This not only reflects the industrialization process, but more importantly is evidence of the geographic and structural diversification of income sources of rural households.

Panel A, Column (2), suggests that capital market development significantly reduces the whole risk sharing when it is examined separately; nevertheless, Column (6) shows that the effect of capital markets is not robust when we include other potential risk sharing channels into the regression. From Panel B, Columns (2) and (4), we observe that capital market development plays a negligible part in achieving *ex ante* risk sharing in China. Although China's capital markets have developed fairly rapidly over the past three decades, the direct or indirect participation of households in capital markets still remains far from common and widespread. The cross-region or inter-city ownership of stocks and bonds is still relatively scarce so that it has not played a significant part in risk sharing.

In Panel A, Column (3) displays that general transfers do not have statistically significant effects on risk sharing, while Column (6) shows a 10% statistically significant negative effect of general transfers on the whole risk sharing conditional on other potential risk sharing channels. In Panel B, Columns (3) and (4), general transfers generate a positive but insignificant impact on the extent of *ex ante* risk sharing. This is not surprising. After the tax sharing reform in 1994, general transfers from the central government to provincial and municipal governments have become a regular arrangement to alleviate the disparity in fiscal revenues among regions. Moreover, general transfers are determined in the government budget at the beginning of each year, which can hardly respond to the changing local fiscal needs.

As shown in Panel A, Columns (4) and (6), special transfers play a striking role in improving the degree of whole risk sharing. Results in Panel C, Columns (1) and (3), demonstrate that special transfers serve as a significant *ex post* risk sharing channel. This substantiates our prediction that special fiscal transfers play a primary role in insuring residents' income and consumption in the wake of production shocks.

In Panel A, Columns (5) and (6), credit markets exert a negative and insignificant effect on the degree of the whole risk sharing. Similarly, in Panel C, Column (2) and (3) show that credit markets play an unpronounced role in affecting *ex post* risk sharing. Thus, credit markets are not an important channel for *ex post* risk sharing and the whole risk sharing. China's state-controlled banks favor enterprises that are state-owned or important to the local economy. When firms suffer from idiosyncratic shocks, SOEs are more likely to obtain credit, while non-SOEs are not. In addition, the formal credit markets including the banking system do not widely provide consumption loans. Hence, as the SOE sector accounts for a relatively small fraction of local GDP, the majority of economic agents get left out in formal credit markets. Thus, credit markets produce insignificant effects on consumption risk sharing, and even impede *ex post* risk sharing.

Table 9 Channels of consumption risk sharing in China

Note: Panel A, Panel B and Panel C report the analyses of the channels of whole, *ex ante* and *ex post* risk sharing, respectively. Year fixed effects and city fixed effects are included but their estimates are not reported for brevity. Robust t-statistics clustered at the province level are in parentheses, and *, **, *** stand for statistical significance at the 10%, 5%, 1% level, respectively.

Panel A: Channels of the whole risk sharing in China

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta \log GDP_{it}$	0.883***	0.940***	0.916***	0.992***	0.965***	0.884***
	(30.800)	(28.881)	(16.979)	(22.851)	(16.594)	(12.411)
$\Delta \log GDP_{it}$ ×migration ratio	0.071**					0.130***
	(2.013)					(3.537)
$\Delta \log GDP_{it}$ ×capital market		-7.945**				-7.529
		(-2.164)				(-1.659)
$\Delta \log GDP_{it}$ ×general transfer			-1.256			-3.173*
			(-0.832)			(-1.818)
$\Delta \log GDP_{it}$ ×special transfer				2.134***		2.545***
				(2.757)		(4.107)
$\Delta \log GDP_{it}$ ×credit market					-2.085	-1.049
					(-1.073)	(-0.431)
Observations	2,717	2,717	1,449	1,456	2,717	1,449
R-squared	0.544	0.544	0.540	0.556	0.544	0.547

Panel B: Channels of *ex ante* risk sharing in China

	(1)	(2)	(3)	(4)
$\Delta \log GDP_{it}$	0.855***	0.870***	0.907***	0.895***
	(37.781)	(49.148)	(43.662)	(41.190)
$\Delta \log GDP_{it}$ ×migration ratio	0.037***			0.018**
	(3.305)			(2.074)
$\Delta \log GDP_{it}$ ×capital market		2.432		-0.535
		(1.467)		(-0.257)
$\Delta \log GDP_{it}$ ×general transfer			1.324	1.231
			(1.147)	(1.107)
Observations	2,717	2,717	1,449	1,449
R-squared	0.633	0.633	0.551	0.552

Panel C: Channels of *ex post* risk sharing in China

	(1)	(2)	(3)
$\Delta \log INC_{it}$	0.535**	0.640**	0.633**
	(2.265)	(2.596)	(2.085)
$\Delta \log INC_{it}$ ×special transfer	2.278***		2.057***
	(3.764)		(3.743)
$\Delta \log INC_{it}$ ×credit market		-0.052	-0.056
		(-1.571)	(-1.221)
Observations	1,456	2,717	1,456
R-squared	0.302	0.207	0.305

The channels of both *ex ante* risk sharing and *ex post* risk sharing incorporate market-based ones and government-administered ones. For advanced economies, capital markets and credit markets are the primary market-based mechanisms of *ex ante* and *ex post* risk sharing, respectively. In an emerging market and developing economy like China, these two primary market-based channels do not play the expected role in helping achieve risk sharing. The relatively underdeveloped capital markets and credit markets and the limited

access to them make the formal financial system far from being able to provide appropriate, affordable and timely access to financial products and services for the majority of businesses and households. Consequently, the formal financial system is not able to help cities achieve risk sharing. Instead, migrants' remittances, a comparatively primitive form of market-based *ex ante* risk sharing mechanism, and the government-administered special transfers in response to emergency needs play the most significant part in attaining risk sharing for the cities. This shows that the market economy development in China is still rather insufficient and unbalanced. At the same time, the regular intergovernmental general transfers are not sufficient to ensure risk sharing. The special transfers made in response to emergency needs are particularly useful in providing subsidies to SOEs and households to achieve *ex post* risk sharing in the wake of some unexpected events. This displays the dwindling power of the government system in maintaining risk sharing. Hence, the Chinese economy is currently at such a stage that the market economy development has not been sufficient to allow the primary market-based channels such as capital markets to play a significant part in achieving risk sharing. At the same time, however, the general fiscal transfers are not strong enough to maintain *ex ante* and *ex post* risk sharing, either, although special transfers are instrumental to *ex post* risk sharing.

7. Conclusion

We dissect the relationship between risk sharing and industrial specialization in China. Unlike previous research based on a cross-country analysis, we concentrate on China as a representative of emerging market and developing economies, and conduct further exploration of the relationship between risk sharing and industrial specialization among prefecture-level cities in China. First, we unbundle the mechanisms of risk sharing into *ex ante* risk sharing and *ex post* risk sharing, and find that *ex ante* risk sharing as well as the whole risk sharing is important in promoting industrial specialization, whereas *ex post* risk sharing does not produce a significant impact. Second, our data sources allow us to refine the measurement of industrial specialization by separating SOE and non-SOE sectors and cyclical and non-cyclical industries. The effects of risk sharing on industrial specialization are more pronounced for the non-SOE sector and cyclical industries. Furthermore, the *ex post* risk sharing is significant in shaping the industrial concentration of SOEs, whereas the *ex ante* risk sharing primarily promotes the industrial specialization of non-SOEs. Third, whether institutional environment and the persistence of fluctuations affect the efficacy of risk sharing was discussed and modeled in the previous research (Obstfeld, 1994; van Wincoop,1994; Asdrubali et al.,1996; Acemoglu and Zilibotti,1997; Feeney, 1999). We provide empirical evidence for these theoretical models and show that risk sharing plays a more essential role in encouraging industrial specialization when the institutional environment is more appropriate and the economic fluctuation is more persistent. Fourth, we use the number of genealogies in each city and the distance between local dialect and Beijing Mandarin as instrumental variables to address the endogeneity concern in our intra–country setting, which provides a new efficient instrumental variable for risk sharing in the future research. Fifth, our research shows that interregional labor migration and special fiscal transfers are the primary means of *ex ante* and *ex post* risk sharing, respectively, in China. Capital markets and credit markets, which are the conventional dominant forces of *ex ante* and *ex post* risk sharing, respectively, in advanced economies are

rather underdeveloped and far from inclusive, and thus they fail to play a significant part in promoting risk sharing.

This study demonstrates that the significant deterrent effect of the underdevelopment and the ownership-based discrimination of the capital market and the credit market on the attainment of risk sharing and the deepening of industrial specialization in China's emerging market economy. This is a negative side effect and cost of the underdeveloped financial system that lead to considerable efficiency losses. It is anticipated that a country can benefit tremendously from the efficiency gain from enhanced risk sharing and industrial specialization if its financial system is better developed. In this sense, our findings point to a largely ignored benefit of financial development in promoting economic growth and development, which is particularly relevant for emerging economies and developing countries.

Appendix 1 City distribution and time series growth rates in China (2003-2015)

province	cities	GDP p.c.	income	consumption
Hebei	11	8.23%	7.58%	7.14%
Shanxi	6	10.46%	8.05%	7.35%
Inner Monogolia	4	14.49%	9.55%	7.84%
Liaoning	14	9.93%	8.67%	7.75%
Jilin	7	11.47%	7.60%	8.76%
Heilongjiang	11	7.81%	8.67%	9.31%
Jiangsu	11	11.27%	8.28%	7.59%
Zhejiang	9	9.92%	8.27%	7.20%
Anhui	11	10.85%	8.83%	7.85%
Fujian	8	9.78%	7.23%	7.25%
Jiangxi	6	12.37%	9.00%	8.34%
Shandong	14	10.31%	8.02%	7.27%
Henan	13	9.54%	8.58%	8.39%
Hubei	10	10.05%	8.01%	6.76%
Hunan	11	10.65%	7.69%	7.15%
Guangdong	18	9.40%	7.12%	6.11%
Guangxi	8	9.66%	7.86%	6.75%
Hainan	2	10.00%	7.83%	6.62%
Sichuan	12	10.80%	8.39%	7.62%
Guizhou	3	13.24%	8.22%	8.28%
Yunnan	3	9.11%	8.25%	9.02%
Shannxi	7	12.74%	9.60%	8.88%
Ningxia	5	9.54%	7.55%	6.94%
Qinghai	1	13.42%	6.58%	7.33%
Gansu	2	12.88%	7.47%	7.09%
Xijiang	2	7.99%	6.27%	7.36%

Notes: We present the annual average growth rates of several key variables for sample cities within each sample province. GDP per capita is the gross domestic product per capita. Income is the average of urban household disposable income and rural household net income. Consumption is measured as the average of urban and rural consumption expenditure per capita. The growth rates are calculated in terms of real Yuan in each year and take the average value for the period 2003-2015. All the growth rates are the averages of the sample cities in this province.

Sources: Urban Household Survey, Rural Household Survey, China City Statistics Yearbooks, Comprehensive Statistical Data and Materials on 60 Years of New China, China National Bureau of Statistics.

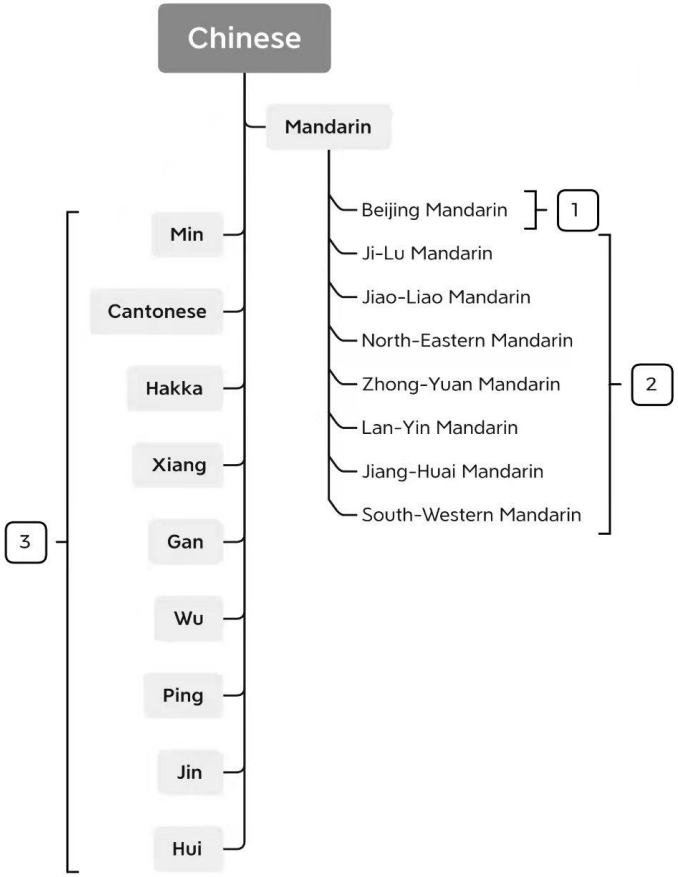
Appendix 2 Variable definition and data sources

variable	definition	data sources
Spec	industrial specialization index following Kalemli-Ozcan et al. (2003)	Annual Survey of Industrial Firms
HHI	industry Herfindahl index based on Herfindahl index, measuring industry concentration in a city	Annual Survey of Industrial Firms
Gini	industry Gini index based on Gini Coefficient, measuring the distribution of different industries in a city	Annual Survey of Industrial Firms
RS	whole risk sharing index	Urban Household Survey, Rural Household Survey, China City Statistics Yearbooks
Ex ante RS	*Ex ante* risk sharing index	Urban Household Survey, Rural Household Survey, China City Statistics Yearbooks
Ex post RS	*Ex post* risk sharing index	Urban Household Survey, Rural Household Survey, China City Statistics Yearbooks
Migration ratio	the ratio of migration outflow and inflow over population	China City Statistics Yearbooks
Capital market	the ratio of stock market capitalization and corporate bond (long-term and short-term) outstanding principal balance to GDP	China City Statistics Yearbooks; Wind Financial Terminal
General transfer	the ratio of net general transfer (inflow minus outflow) to GDP	China City Finance Statistics Yearbooks
Special transfer	the ratio of net special transfer (inflow minus outflow) to GDP	China City Finance Statistics Yearbooks
Credit market	the ratio of loans and deposits to GDP	China City Statistics Yearbooks
POP	the logarithm of population (10 thousand)	China City Statistics Yearbooks
POPDEN	population density (10 thousand/sq km)	China City Statistics Yearbooks
GPC	gross domestic product per capita (real million yuan)	China City Statistics Yearbooks
AGR	the ratio of agricultural sector GDP to total GDP (%)	China City Statistics Yearbooks
MIN	the ratio of mining sector gross output (÷ 10) to total GDP (%)	Annual Survey of Industrial Firms, China City Statistics Yearbooks
FAI	the logarithm of fixed asset investment per capita	China City Statistics Yearbooks
EDU	the ratio of primary and secondary school enrollment to population (100%)	China City Statistics Yearbooks
FISCAL	the ratio of fiscal expenditure to total GDP	China City Statistics Yearbooks
FREIGHT	the logarithm of freight (in million tons)	China City Statistics Yearbooks
Clanship	the logarithm of the number of genealogies	Shanghai Library
Dialect	the distance between local dialect and Beijing Mandarin	*Language Atlas of China*

Note: The inflation prices for each province are drawn from Comprehensive Statistical Data and Materials on 60 Years of New China and China National Bureau of Statistics.

Appendix 3 Chinese Dialect Language Tree

Note: This image provides the language trees and detail distance scores for each dialect. Not only Mandarin, other dialects also have sub-branches, but they all equal to the same score 3 and are unnecessary to list them here. Data sources: *Language Atlas of China*.



Appendix 4 Spearman rank correlations

Note: This table provides spearman rank correlations of risk sharing indicators and specialization. * indicates statistical significance at the 1% level.

		1	2	3	4	5	6	7	8	9	10	11	12	13
1	Spec	1												
2	RS	0.30*	1											
3	*Ex ante* RS	0.35*	0.83*	1										
4	*Ex post* RS	-0.01	0.33*	-0.17	1									
5	POP	-0.52*	-0.34*	-0.40*	0.03	1								
6	POPDEN	-0.41*	-0.28*	-0.34*	0.05	0.42*	1							
7	GPC	-0.01	0.08	0.11	-0.03	-0.18	0.20*	1						
8	AGR	-0.09	-0.04	-0.09	0.08	0.18	-0.24*	-0.81*	1					
9	MIN	0.24*	0.22*	0.20*	0.09	-0.22*	-0.31*	-0.17	0.05	1				
10	FAI	-0.04	0.12	0.13	-0.02	-0.19*	0.19*	0.93*	-0.80*	-0.13	1			
11	EDU	0.12	-0.01	0.10	-0.23*	0.00	0.21*	-0.10	-0.11	-0.03	-0.08	1		
12	FISCAL	0.25*	0.09	0.09	0.02	-0.23*	-0.50*	-0.69*	0.53*	0.23*	-0.56*	-0.03	1	
13	FREIGHT	-0.37*	-0.14	-0.22*	0.10	0.62*	0.38*	0.36*	-0.36*	-0.09	0.36*	-0.05	-0.47*	1

Appendix 5 detail results of IV regression

Note: This table provides details about IV model specification and estimation results for both first stage and second stage. Robust t-statistics are in parentheses, and *,**,*** stand for statistical significance at the 10%, 5%, 1% level, respectively.

	(1)		(2)		(3)		(4)	
VARIABLES	First	Second	First	Second	First	Second	First	Second
RS		0.511***				0.499**		
		(3.041)				(2.519)		
Ex ante RS				0.783***				0.656***
				(3.065)				(2.721)
Clanship	-0.029***		-0.020***					
	(-4.145)		(-3.633)					
Dialect					-0.101***		-0.083***	
					(-3.160)		(-3.351)	
POP	-0.010	-0.063***	0.020	-0.075***	-0.057*	-0.060***	-0.014	-0.074***
	(-0.323)	(-2.957)	(0.849)	(-3.571)	(-1.955)	(-2.964)	(-0.604)	(-3.971)
POPDEN	0.245	-0.620*	0.181	-0.692*	-0.456	-0.364	-0.255	-0.455
	(0.476)	(-1.737)	(0.443)	(-1.837)	(-0.857)	(-1.102)	(-0.607)	(-1.355)
GPC	-15.218**	16.200***	-3.897	11.997**	-11.897	18.028***	-0.808	13.087***
	(-2.123)	(3.080)	(-0.695)	(2.326)	(-1.616)	(3.442)	(-0.140)	(2.801)
GPC2	209.066**	-152.889**	96.945	-129.179*	168.462*	-183.177**	54.281	-140.940**
	(2.138)	(-2.099)	(1.272)	(-1.789)	(1.669)	(-2.500)	(0.689)	(-2.143)
AGR	0.145	-0.058	-0.061	0.003	-0.050	0.171	-0.149	0.213**
	(0.945)	(-0.503)	(-0.509)	(0.031)	(-0.287)	(1.614)	(-1.090)	(2.053)
MIN	0.162	-0.092	0.127	-0.164	0.094	0.044	0.099	-0.001
	(1.042)	(-0.783)	(1.066)	(-1.345)	(0.556)	(0.387)	(0.751)	(-0.008)
FAI	0.066	-0.100***	-0.036	-0.039	0.026	-0.089***	-0.061*	-0.039
	(1.594)	(-3.351)	(-1.079)	(-1.197)	(0.613)	(-3.238)	(-1.820)	(-1.334)
EDU	-1.139***	1.142***	-0.535*	1.035***	-0.362	0.917***	0.050	0.726***
	(-3.198)	(3.593)	(-1.873)	(3.458)	(-0.814)	(2.846)	(0.141)	(2.596)
FISCAL	-0.991***	0.615**	-0.537**	0.551**	-0.728**	0.307	-0.460*	0.249
	(-3.425)	(2.486)	(-2.365)	(2.302)	(-2.410)	(1.306)	(-1.946)	(1.137)
FREIGHT	-0.026	0.024	-0.024	0.026	-0.016	0.011	-0.020	0.012
	(-0.962)	(1.249)	(-1.141)	(1.243)	(-0.588)	(0.610)	(-0.947)	(0.675)
Constant	0.766***	-0.038	0.314**	0.098	1.066***	-0.001	0.563***	0.166
	(4.635)	(-0.212)	(2.291)	(0.628)	(5.442)	(-0.003)	(3.552)	(1.134)
Observations	209	209	209	209	209	209	209	209
R-squared	0.607	0.339	0.696	0.289	0.604	0.455	0.693	0.450

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