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Size and Causes of Shadow Economy in China over 1978–2016: Based on the Currency Demand Method

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Abstract: Focusing on the size of China's shadow economy from 1978 to 2016, this paper constructs two models based on the currency demand method. The final result is that China's shadow economy varies greatly with changes in the country's economic background. It increased from 18.44% in 1978 to 32.16% in 1989, and then decreased to 4.27% in 2016. Total tax burden, regulation intensity, proportion of employment in the primary sector and fiscal decentralization all have a statistically significant influence on China's shadow economy. Analyzing the quantitative effect of each causal variable, all results demonstrate that regulation and employment in the primary sector have a larger effect on the shadow economy over a long time. In addition, fiscal revenue decentralization and fiscal expenditure decentralization have opposite effects on China's shadow economy.

Key words: Shadow economy of China; Size and Causes; Currency Demand Method

1. Introduction

Shadow economy is an important issue that attracts much attention because of its great influence on official economy growth, public finance safety, income inequality and government corruption. [1] Although researchers and

[1] Further discussion can be seen in Schneider and Enste (2000), Schneider and Enste (2013), Schneider and Hametner (2014), Fernández and Velasco (2014) and Dell'Anno (2016).

governments have undertaken intensive efforts to control the size of the shadow economy, it is still a difficult but common economic problem all over the world. Many empirical studies have shown the existence of the shadow economy.[2] Some of the most recent research was conducted by Medina and Schneider (2017), who measured the size of shadow economy in 158 countries during 1991–2015 using the MIMIC method. Their results showed that the average size of the shadow economy of these 158 countries over 1991–2015 was 32.5% of official GDP, and it was 34.82% in 1991 and decreased to 30.66% in 2015; even the lowest size which existed in East Asian countries still reached 16.77% over this period, and the highest level which existed in Latin American and Sub-Saharan African countries reached 35%.

China also faces the problem of shadow economy, and researchers have tried to estimate the size of the shadow economy in China using various different methods. A study conducted by Alm and Embaye (2013) applying the currency demand method with dynamic panel data showed that the average size of the shadow economy in China over 1990–2006 was 21.02%. Elgin and Öztunali (2012) constructed a DGE model to estimate the disaggregated size of the shadow economy in 161 countries during 1950–2009 and found that the shadow economy of China had declined from 34.06% in 1952 to 11.53% in 2008, and the average size over the period 1990–2006 was 15.54%. However, the research carried out by Medina and Schneider (2017), which measured China's shadow economy during 1991–2015 using the MIMIC method, found that the average size of the shadow economy over this period was 11.2%. As we see from these studies, there are large differences among these research results, and some of the results were achieved using panel data estimation techniques for many countries, meaning that some unusual factors which

[2] Specific results can be seen in Feld and Schneider (2010), Schneider (2010), Elgin and Öztunali (2012), Alm and Embaye (2013), Schneider (2014).

affect the shadow economy of China may be ignored in the simulation models. As the biggest developing country with the fastest development in the world, China has experienced great variations in economic systems, social situations and public governance regimes since it carried out its reform and opening-up policy in 1978, so researchers need to be careful when measuring the size of China's shadow economy.

In our paper we analyze for the first time the size and development of the Chinese shadow economy over the period from 1978 to 2014. We mainly focus on analyzing the main driving forces on the size of the shadow economy in China over the period 1979–2016 using the currency demand method. Our paper not only aims to measure the size of China's shadow economy more precisely, but also expects to provide some beneficial knowledge which could be used for other developing countries facing similar situations.

Our paper consists of six parts. After the introduction, we explore some theoretical considerations of how to define the shadow economy and reflect on its causes. A brief description of the economic background of China, which may affect the size of shadow economy, is provided in part 3. Then, in part 4, we use the currency demand method to undertake an econometric analysis of the shadow economy in China and calculate the value of the shadow economy (SE) for each year. Part 5 provides robustness checks. Finally, in part 6 we summarize our main findings of this research and provide some policy implications for China's shadow economy prevention.

2. Theoretical Background

2.1 Definition of shadow economy

It's difficult to define and measure the shadow economy precisely because of its unobservability, but many researchers and organizations have attempted to

give a reasonable definition. Unfortunately, up to now, there is still no consistent definition of shadow economy, and the terms shadow economy, underground economy, informal economy, unregistered economy and unofficial economy tend to be used interchangeably. One popular definition in the research is that the shadow economy comprises all unregistered economic activities and income which contribute to the officially observed Gross National Product.[3] Putniņš and Sauka (2014) took away illegal economic activities and income from this definition, and only referred to legal products and services that are hidden from the public authorities. Smith (1994, p. 18) emphasized the marketability of shadow economy and defined it as "market-based production of goods and services, whether legal or illegal that escapes detection in the official estimates of GDP."

To give a clear definition of shadow economy, the statistical offices of OECD and EU countries use a more uniform definition of underground economy.[4] In the definition used by the European Union statistics office,[5] the unobservable economy is divided into three sectors, which are:

1. Underground economy, which includes legal products and services which are not recorded by the government, for the purpose of escaping from tax and social insurance burden, government regulation or other administrative rules.
2. Informal economy, which includes all legal economic activities conducted by individuals, at home or in small enterprises, which are not recorded by the official statistics department, even if they are not intended to escape taxation and government deterrence.

[3] See Feige (1989, 2005), Schneider (2005) , Büehn and Schneider (2011).
[4] See Bojnec (2007), Dell'Anno and Solomon (2008), Orsi, Raggi and Turino (2012).
[5] In the National Accounting System (SNA) published by the UN and EU, the un-observed economy is also expressed as "all productive activities that may not captured in the basic data source used for national accounts compilation" and is divided into seven categories that can be summarized into four main groups, namely not registered, not surveyed, misreporting and others (Dell'Anno, 2016). A detailed description can be seen in UNECE (2008, p .4).

3. Illegal economy, which includes all criminal activities which are forbidden by law.

This taxonomy of an underground (or shadow) economy from the total unobservable economy shows how difficult a more precise definition of underground economy is. Another more specific and precise definition of the shadow economy is based on whether currency is used in transactions and whether the economic activities are legal.[6]

Table 2.1 gives a broad definition of the shadow economy and includes all unreported economic activities, however, the narrower definition should be used which only contains all market-based legal production of goods and services that are deliberately concealed from public authorities for the following reasons:

1. tax evasion or tax avoidance,
2. to avoid payment of social security contributions,
3. to avoid having to meet certain legal labor market standards, such as minimum wages, maximum working hours, safety standards, etc.,
4. to avoid complying with certain administrative procedures, such as completing statistical questionnaires or other administrative forms.

Table 2.1 A taxonomy of underground economic activities.

Monetary transactions	**Non-Monetary transactions**
Illegal activities	
-Trade in stolen goods	-Barter of drugs, stolen goods, smuggling, etc.
-Drug dealing and manufacturing	-Producing or growing drugs for own use
-Prostitution, Gambling, Smuggling, Fraud etc.	-Theft for own use

[6] Detailed discussions can be seen in Schneider and Bajada (2004), Schneider and Hametner (2014), Schneider and Buehn (2018).

Legal activities			
Tax evasion -Unreported income from self-employment -Wages, salaries and assets from unreported work related to legal services and goods	Tax avoidance -Employee discounts, fringe benefits	Tax evasion -Barter of legal services and goods	Tax avoidance -All do-it-yourself work and neighbor help

Source: Structure of the table is taken from Lippert and Walker (1997, p. 5) with additional own remarks.[7]

Hence, this paper doesn't deal with typical economic activities that are illegal and fit the characteristics of classical crimes like burglary, robbery, drug dealing, etc., and this definition also excludes all non-market based economic activities like neighbor help, household and do-it-yourself work.[8]

2.2 Driving forces of shadow economy

Numerous researchers have looked into causes of the shadow economy and the results show that tax and social security payment burden and government regulation are the most important driving forces, but some other key variables, such as the quality of public service, tax morality, changes in labor market and size of the agricultural sector also have an important influence on the shadow economy.[9]

Escape from taxation is the original driving force which stimulates the labor force to turn to the shadow sector. Allingham and Sandmo (1972) conducted theoretical research into the driving forces of income tax evasion, which was seen as a pathbreaking study into the causes of shadow economy. According

[7] This table also can be seen in Schneider and Bajada (2005), Schneider (2011), Williams and Schneider (2013), Schneider and Hametner (2014), Schneider and Buehn (2018) etc. In addition, Rădulescu, Popescu and Matei (2010) made a comprehensive summary and comparison of all kinds of definitions, and a similar framework can also be seen in their paper.

[8] This definition also was used in Nikopour and Habibullah (2010), Torgler and Schneider (2011), Quintano and Mazzocchi (2014).

[9] Some existing literature also provides evidence for this, such as Schneider and Enste (2000), Schneider and Hametner (2014), Schneider and Buehn (2018).

to their research, as a rational individual, tax non-compliance depends on the expected benefits and costs of tax evasion. The expected benefits of tax non-compliance result from the marginal tax rate and true individual income, and the expected cost depends on possible fines and the probability of being inspected by tax and auditing departments. It's also consistent with the shadow economy because individuals will allocate their labor time in the official and shadow sectors rationally according to the tax burden and other opportunity costs of engaging in the official sector so that they achieve optimal revenue. Schneider and Buehn (2018) constructed the following structural equation which contains more variables to explain the driving forces of the shadow economy:

$$SE = SE\left[\overset{-}{p}(\overset{+}{A}, \overset{-}{F}); \overset{-}{f}; \overset{+}{B}(\overset{+}{T}, \overset{+}{W})\right] \quad (1)$$

Shadow economic activities (SE) negatively depend on the probability of detection p and potential fines f, and positively on the opportunity costs of remaining formal denoted as B. The opportunity costs are positively determined by the burden of taxation T and high labor costs W – individual income generated in the shadow economy is usually categorized as labor income rather than capital income – due to labor market regulations. Hence, the higher the tax burden and labor costs, the more incentives individuals have to avoid these costs by working in the shadow economy. The probability of detection p itself depends on enforcement actions A taken by the tax authority and on facilitating activities F accomplished by individuals to reduce detection of shadow economic activities. So, as we can see in the equation, tax burden and labor costs are direct causes of shadow economy and much empirical research from different countries also provides effective evidence of this. For example, Nchor et al. (2016) found that tax burden, government regulation and corruption all had a positive impact on the shadow economy in Nigeria. Buehn and Schneider (2011) estimated the size of the shadow economy in 162

countries over 1996–2006, and found that both tax burden and regulation quality were important causes of the shadow economy.[10]

However, it is noteworthy that an increase in the macro tax rate won't bring up the overall scale of the shadow economy necessarily, because there are still many other inherent factors which will affect individuals' tax morality and may moderate the effects of tax burden (Kanniainen, Pääkönen and Schneider, 2004). Theoretically, tax is just the price of public goods and services which individuals get from the government, so people pay tax with a desire to get more high-quality public goods and services. People's willingness for tax compliance will increase when there is good governance and available public goods because they may consider it a fair fiscal transaction; as a consequence, shadow economy activities aimed at tax evasion will decrease (Cummings et al., 2009). An investigation by Hanosek and Palda (2004) in the Czech and Slovak Republics found that the frequency of tax evasion among citizens would decrease by 13% when there was an increase of 20% in perceived quality of government. Meanwhile, it's clear that the quality of public governance also has a strong relationship with labor costs in the official sector. When people are unfortunate in a territory with poor public governance, they have to live with corrupt government, low quality laws and policies, and they can't get enough protection for their legal property and necessary public facilities and services, and that will obviously enhance individuals' incentives to transact in the shadow sector (Burroni and Crouch, 2008). Bayar (2016) provided convincing proof of this with data from 11 central and eastern European countries over 2003–2014. His results demonstrated that six dimensions of public governance, including voice and accountability, political stability, government effectiveness, regulatory quality rule of law and control of corruption all had significant negative impacts

[10] When estimating the size of shadow economy in developing countries and transition countries, the authors used government size and business freedom instead of tax burden and regulation quality.

on the shadow economy.[11]

Government decentralization is also a non-negligible factor that may affect the shadow economy. It has been seen as an alternative instrument to improve the quality of institutions and public governance since Tiebout elaborated it in 1956. Theoretically, decentralization may affect the shadow economy through the "efficiency effect" and the "deterrence effect". On the one hand, local bureaucrats are closer to residents and have more access to understand their preferences in a more decentralized government; meanwhile, residents have more chances to supervise bureaucrats' behavior because decentralization may result in more transparent government.[12] On the other hand, it's more possible for bureaucrats to detect shadow economic activities due to the smaller distance between officials and economic agents in a decentralized government (Buehn and Lessmann, 2013). Furthermore, people and economic agents can "vote with their feet" and move to other jurisdictions with better governance instead of turning to the shadow sector in a decentralized government system (Dell'Anno and Teobaldelli, 2015). However, some studies have found that government decentralization might bring more shadow economy activity in countries which have no effective supervisory mechanisms for local governments because this might result in more corruption and collusion between bureaucrats and enterprises (Treisman, 1999). The existing literature has studied the relationship between different types of decentralization and shadow economy, such as physical decentralization, fiscal decentralization, political decentralization and virtual decentralization.[13]

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[11] Similar evidence can also be seen in research by Torglar and Schneider (2007)

[12] Some existing literature has discussed this, such as Torgler, Schneider and Schaltegger (2010), Teobaldelli and Schneider (2013), Goel and Saunoris (2016a, 2016b).

[13] Goel and Saunoris (2016a) constructed 3 types of decentralization which used the tiers of government as physical decentralization, the share of local expenditure and revenue as fiscal decentralization, and the share of local civil servants in total civil servants as employment decentralization and checked its effects on shadow economy. In another study, Goel and Saunoris (2016b) checked the influence of virtual decentralization with the development extent

The labor market is another important factor that has a direct connection with the shadow economy. Individuals may choose to participate in shadow economic activities when there are no work opportunities in the formal sector to provide financial support in unemployment; this was called the “substitution effect” by Bajada and Schneider (2009). Compared to those working in organizations, the self-employed receive less monitoring and have more opportunity to conceal their income (Williams, 2005). An investigation made by Engström and Holmlund (2009) in Sweden demonstrated that nearly 30 percent of income remained unreported in households which had at least one member engaging in self-employment. From this perspective, we can also infer that a higher share of agriculture may lead to a bigger shadow economy, because we can usually expect more self-employment in the agricultural sector.[14]

Hence, multiple factors may affect the shadow economy and all the causal factors are presented in table 2.2.

of Electronic Government. Teobaldelli and Schneider (2013) checked the effects of political decentralization on shadow economy with the variable of whether there was direct democracy.

[14] We also find support for this perspective in Salahodjaev (2015), Hannemann and Frey (1985).

Table 2.2. Main Causes of Shadow Economy

Sources: Refer to Schneider (2014), Schneider and Buehn (2014) with our own explanations

Cause	Theoretical reasoning	Main references
Tax and social security burden	Tax and social security burden affects individuals' decisions on time distribution among official sector, shadow sector and leisure, and a higher burden will lead to more shadow labor for tax evasion.	Torgler (2010); Schneider (2011, 2014); Schneider and Hametner (2014); Hoseini (2015)
Tax deterrence	It's more probable for shadow economy to be detected by bureaucrats in a government with higher intensity of deterrence.	Frey, Feld (2002); Busato, Chiarini (2006); Orsi, et al. (2014); Feld, Schmidt (2006)
Tax morality	Individuals with higher tax morality will have less motivation to escape from taxation.	Torgler, Schneider (2007); Torgler, et al. (2010)
Regulation intensity	Individuals will choose to turn to shadow sector to reduce labor costs when there is too much regulation.	Bouev (2003); Enste (2010); Georgiou (2013); Johnson et al. (1998); Mazhar (2015)
Public governance	Public governance, including control of corruption, responsiveness, transparency, quality of law and public service will all affect individuals' tax morality and labor costs in official sector.	Schneider and Enste (2000); Bayar (2016); Schneider and Hametner (2014); Schneider and Buehn (2018)
Decentralization	Decentralization can shorten the distance between government and residents thus improving government's efficiency and deterrence outcomes. But, it can also bring more corruption and collusion between bureaucrats and enterprises in countries which have no effective supervisory system, thus, may improve the shadow economy	Treisman (2000); Torgler, et al. (2010);Teobaldelli (2011); Alexeev, Habodaszova (2012); Teobaldelli, Schneider (2013); Buehn, et al. (2013); Goel, Saunoris (2016a, 2016b); Dell'Anno, Teobaldelli (2015)
Unemployment	Labor force will turn to shadow sector when they can't find work opportunities in the formal sector.	Adriana (2014); Boeri and Garibaldi (2014); Dell'Anno and Solomon (2014)
Self-employment	Self-employed people face less monitoring and can conceal their income more easily.	Holmlund and Engström (2007); Schneider (2014)
The share of agriculture	It's more convenient for those engaging in agriculture to work in self-employment, thus, easier to work in the shadow economy.	Christie, Holzner (2004); Elgin and Oyvat (2013); Hassan, Schneider (2016)
Development of official economy	A higher growth rate of official economy always means more work opportunities and income. Thus, people will have less motivation to turn to shadow economy, ceteris paribus.	Schneider, Williams (2013); Feld and Schneider (2010)

3. The Economic Background of China from 1978 to 2016

Although many researchers and officials have attempted to solve the puzzle of the rapid growth of China's economy, little attention has been paid to the shadow economy. It's necessary to analyze the economic background which may affect the shadow economy of China so we can find its driving forces and measure the size precisely. At the end of 1978, China decided to end the Cultural Revolution political movement and take economic development as the country's most important goal. To prompt economic development, the Chinese government began to implement the Reform and Opening Policy. On the one hand, the Chinese government implemented a series of reforms to change the highly centralized political and economic system and attempted to construct a more decentralized government and a market-oriented economic system; on the other hand, they took a more active part in international trade, and began to attract more foreign direct investment due to their cheap labor force and relatively stable political environment. From then on, China started its fast growth journey of economic development, and the average real growth rate was as high as 9.6% over the period 1979–2016.[15]

For a long time, private industry wasn't permitted in China, and there were intensive regulations around labor and commodity markets, hence, many private economic activities occurred in the shadow sector. However, things altered after 1978. The economic reform started in rural areas with the implementation of "the family-contract responsibility system". Under that policy, all land still belonged to the whole village, households could rent the land from the village by paying agricultural tax as the rent, and the most important change was that households could distribute their labor time freely, thus, the liberation of rural labor forces provided hundreds of millions of cheap workers for the coming development of non-agricultural industry and urban construction.

[15] Data source: website of the National Bureau of Statistics of China. http://data.stats.gov.cn.

After completion of the rural land reform, the Chinese government also tried to restructure the urban economic system from 1984, and the most important measures over this period were reform of state-owned enterprises and the relaxation of price control. To improve incentives for state-owned enterprises, the central government divided them into central SOEs and local SOEs and decentralized management rights to the enterprises. As a result, the average real growth rate of GDP increased to 12% over 1984–1988 with great improvement in SOEs' motivation and efficiency.[16] To match the rapid development of SOEs, the government tried to relax commodity market regulation, especially in price control. However, due to the lack of necessary market laws and regulations, there were many corrupt and illegal market activities which led the government to strengthen market regulation again, and the pace of market-oriented reform slowed down again until 1992. As a consequence, the average growth rate of GDP also decreased to 5.8% in the period 1989–1991. To prompt economic development, the Chinese Communist Party suggested ending the transition step and adopted market economy[17] as the essential aim of economic reform at the end of 1992. Since then, China maintained an average annual growth rate of 10% over 1992–2016, despite experiencing the Asian financial crisis in 1997 and the world financial crisis in 2008.

The government reform mainly focused on fiscal decentralization. Before 1978, the unified fiscal mode had been carried out in China for nearly 30 years, and all fiscal revenues and expenditures were distributed by the central government. To stimulate the motivation of local government, the Chinese government started decentralized reform of the fiscal system in 1980. According to the new policy, central government and local government should

[16] Data source: website of the National Bureau of Statistics of China. http://data.stats.gov.cn.
[17] Although many countries don't accept China's market economy status, it's clear that China's economy possesses more and more characteristics of a market economy.

share fiscal revenue in certain proportions and be responsible for disaggregated fiscal expenditure duties. This provided more financial support for local government to prompt economic development and infrastructure construction. However, the local governments always intended to conceal fiscal revenue so that turned over less revenue to central government and shirked their fiscal expenditure responsibilities. This led to a serious fiscal problem within the central government, and the central government even had to borrow money from some developed provinces, such as Guangdong Province. To solve this problem, another policy called "tax division, revenue and expenditure check, graded responsible"[18] was implemented in 1985, but the problem still wasn't completely solved and imbalances between different districts became a new critical problem. Over 1980–1994, the average value of fiscal revenue of local government as a percentage of total fiscal revenue was 68.43%, but the average value of fiscal expenditure of local government as a percentage of total fiscal expenditure was only 59.04%.[19] Remarkably, in 1994, to strengthen tax collection, the Chinese central government divided the tax system again and set up the National Administration of Taxation and Local Administration of Taxation to charge for central taxation and local taxation independently. After 1994, revenue centralization and expenditure decentralization gradually became the most important characteristics of the Chinese fiscal system. Fiscal revenue centralization ensured local governments obeyed the strategy set by central government, and fiscal expenditure decentralization gave local governments more autonomy in providing public products. China's fiscal decentralization was called "market-preserving fiscal federalism" and was regarded as one of the most

[18] Tax division implied that all taxes collected were divided into taxes of central government, taxes of local government and taxes shared by both governments. Revenue and expenditure checks implied that all tax revenues and expenditures of local governments should be included in the budget. Graded responsible defined the fiscal expenditure responsibilities of different grades of governments and that they should manage them by themselves.

[19] Data source: website of the National Bureau of Statistics of China. http://data.stats.gov.cn.

important political driving forces of China's economic success.[20]

Meanwhile, China had experienced a rapid process of urbanization and industrialization over 40 years, which had important effects on the labor market. After 1978, China started to attract massive amounts of foreign direct investment to provide capital for economic development, and many labor-intensive enterprises were built in the eastern provinces which produced huge demand for labor forces. Simultaneously, there was a lot of surplus labor in China's rural areas after the new land reform was completed in 1982. However, according to China's household registration system, rural labor forces couldn't move to urban areas unless they could get a formal job in the public sector or SOEs, so many workers had to work in the shadow sector if they wanted to work in cities. To solve this contradiction, the Chinese government reformed the household registration system to loosen regulation of labor forces in 1984 and the new mechanism allowed famers to look for work opportunities in urban areas freely, which inspired many rural laborers to move to urban areas. As a consequence, more and more workers transferred to the manufacturing and service sectors from primary industry.[21] China's urbanization rate had increased to 57.35% in 2016 from 17.92% in 1978, and the ratio of employment in primary industry had reduced to 27.7% in 2016 from 70.53% in 1978.[22]

Over the past 30 years, China has experienced huge changes in its economic system and structure, fiscal system and labor market regulation. As we have concluded, tax and social insurance burden, government quality, regulation

[20] More detailed discussion can be seen in Qian and Weingast (1996,1997), Jin, Qian and Weingast (2005).
[21] China divides its economy into three sectors. Primary industry includes agriculture, forestry, animal husbandry, fisheries and aquaculture, the second industry is the industrial sector and the third industry is the service sector.
[22] Data source: website of the National Bureau of Statistics of China. http://data.stats.gov.cn.

burden, development of official economy, changes in labor market and the size of the agricultural sector are all potential driving forces of the shadow economy. So, we can also expect changes in China's shadow economy with the huge change in the economic background.

4. Empirical estimates of the size of the shadow economy in China

4.1 A review of the estimation method: currency demand approach

Estimating the size of the shadow economy precisely has been always a key problem in studies of shadow economy. There are different approaches to measuring shadow economies. Generally speaking, we can divide them into three categories: the direct approach, the indirect approach and the model approach. The currency demand approach is the most credible indirect method, especially when measuring the size of the shadow economy of a single country, although there are some criticisms. Hence, this paper will select the currency demand approach to measure the size of shadow economy in China from 1979 to 2016.

Cagan (1953) conducted pathbreaking research using the currency demand method, which analyzes variables affecting the currency ratio of the total money supply. He especially implied that tax evasion and the black market were important causes of variety in the currency ratio of the USA, and then he analyzed the correlation between tax pressure and the currency ratio for the United States over the period 1919 to 1955. Tanzi (1983) developed this approach further and used it to measure the size of the underground economy in the USA. He thought that underground economic activities were mainly undertaken by cash to prevent observation by the authorities, and tax evasion was the main cause of people turning to the underground economy. Hence, he constructed a model which used the tax rate to capture currency demand

produced by the underground economy. It represented currency demand in the official economy when the tax rate was set at zero, which demonstrated that there was no underground economy, and the difference between the total currency ratio and the ratio without any tax pressure resulted in the underground economy. Then, he could measure currency demand in the underground economy using the ratio difference multiplied by the total money supply M2. As he couldn't get the velocity of M0 in the underground economy, he assumed that the velocity of M0 was equal in both economic sectors, and could finally obtain the size of the underground economy using demand for M0 in the underground economy multiplied by the velocity of M0 in the official economy. The following regression model was used by Tanzi (1983); it was also regarded as the basic model for the currency demand method for much other later research:

$$\ln(C/M_2) = \beta_0 + \beta_1 \ln(1 + TW)_t + \beta_2 \ln(WS/Y)_t + \beta_3 \ln R_t + \beta_4 \ln(Y/N)_t + \upsilon_t \quad (1)$$

with β1 > 0, β2 > 0, β3 < 0, β4 > 0, where ln denotes natural logarithms, C/M2 is the ratio of cash holdings to current and deposit accounts, TW is a weighted average tax rate (as a proxy for changes in the size of the shadow economy), WS/Y is a proportion of wages and salaries in national income (to capture changing payment and money holding patterns), R is the interest paid on savings deposits (to capture the opportunity cost of holding cash) and Y/N is per capita income.[23] However, there are still some disadvantages of Tanzi's research. For example, he only considered one cause of the shadow economy, and set the tax rate at 0 to get official currency demand, besides, currency velocity in the shadow economy has also been argued by many researchers.[24] So, later researchers considered more variables apart from tax pressure to capture currency demand in the shadow economy, such as government

[23] The detailed steps are presented in Tanzi (1983).
[24] Schneider (2000) discussed the disadvantages of the currency demand method in detail.

regulation, institution quality, unemployment, self-employment and so on.[25] In addition, Schneider (2015, 2016) thought that we should set the cause variables as the minimum value in history instead of 0 to get currency demand in the official economy, and the velocity of currency in the shadow economy should be set as the velocity of M1 in official economy because many shadow economic activities were also undertaken by M1. However, Ahumada et al. (2007) provided another approach to calibrate currency velocity in the shadow economy. They found that the currency velocity in the two economic sectors wouldn't be equal unless the long run elastic coefficient of income and currency demand was equal to 1, and if not, we should use the elastic coefficient to calibrate the result.[26]

4.2 Variables and estimation model

To measure the size of the shadow economy of China precisely, we collected consistent data from 1978 to 2016 which contained all the data we might use. We extracted probable variables that may have an influence on the shadow economy as the dependent variables after taking the analysis of China's economic background and constructed two estimation models to measure the shadow economy. One uses real M0 per capita as the independent variable, the other uses the currency ratio of the total currency supply M0/M2 as the independent variable. The estimation model based on M0PC is as follows:

$$\begin{aligned} LnM0PC_t &= \beta_0 + \beta_1 LnTTAX_t + \beta_2 LnREG_t + \beta_3 LnGDPPC_t + \beta_4 LnEMPP_t \\ &\quad + \beta_5 FEDD_t + \beta_6 FRDD_t + \beta_7 IRDD_t + \beta_8 ERD_t + \beta_9 t + \mu_t \end{aligned} \tag{2}$$

The estimation model based on M0/M2 as following:

$$\begin{aligned} LnM0M2_t &= \beta_0 + \beta_1 LnTTAX_t + \beta_2 LnREG_t + \beta_3 LnGDPPC_t + \beta_4 LnEMPP_t \\ &\quad + \beta_5 FEDD_t + \beta_6 FRDD_t + \beta_7 IRDD_t + \beta_8 ERD_t + \beta_9 t + \mu_t \end{aligned} \tag{3}$$

[25] Detailed research can be seen in Addizzi et al. (2014), Alm and Embaye (2013), Schneider and Hametner (2015), Hassan and Schneider (2016).

[26] For the detailed approach to calibrate the result made by currency demand approach please refer to Ahumada, Alvaredo and Canavese (2007).

According to the theory of the currency demand method, currency demand in the real economic world consists of demand in the official economy and demand in the shadow economy. So, in our model, we extract the following variables to capture currency demand in the official economy:

1. the real Gross Domestic Product per capita, positive sign expected.
2. the first difference of benchmark interest rate of the real one-year term deposit published by the Central Bank of China (IRDD), negative sign expected.
3. the first difference of the real yearly average exchange rate of the Chinese RMB to the US dollar (ERD), positive sign expected.

And the variables to explain currency demand in the shadow economy are as follows:

4. the total tax burden (TTAX, the real total tax revenue as a percentage of real GDP), positive sign expected.
5. government regulation to capture the change of the regulation intensity in China (REG, employment in the public sector as a percentage of the total employment), positive sign expected.
6. the ratio of primary industry employment as a percentage of total employment to capture the change in China's labor market (EMPP), positive sign expected.
7. the first difference of fiscal revenue decentralization (FRDD), positive sign expected.
8. the first difference of fiscal expenditure decentralization (FEDD), negative sign expected.
9. finally, we use the variable T to capture the time tendency of M0PC and M0M2, positive sign expected.[27]

[27] Detailed description of these variables is provided in appendix A, table A1.

According to monetary theory, for the official sector, a higher level of real GDP per capita will result in more demand for currency, a higher interest rate means a higher opportunity cost for holding cash, and a higher exchange rate represents increasing currency demand from abroad. Hence, we can expect a positive impact of GDPPC and ER on currency demand, and a negative impact of IRD. For the shadow sector, we can expect that tax burden, regulation intensity and employment in the agricultural sector will all have positive impacts on the shadow economy. As to fiscal revenue decentralization and expenditure decentralization, combined with the situation in China, we can expect different effects, and fiscal revenue decentralization may have a positive impact on the shadow economy, while fiscal expenditure decentralization will have a negative impact on the shadow economy by improving the quality of public governance. All in all, for all the estimation coefficients in both models, we can make following hypotheses:

β_1, β_2, β_3 and $\beta_4>0$; $\beta_5<0$; $\beta_6>0$; $\beta_7<0$; $\beta_8>0$; $\beta_9>0$

4.3 Estimation results

We use the Prais-Winsten model to correct the autocorrelation, and construct three currency demand models to simulate the shadow economy. Table 4.1 presents the regression results of these three models.

Table 4.1 Regression results of the currency demand method

	Model 1	Model 2	Model 3
	LnM0PC	LnM0PC	LnM0M2
constant	-11.6665; (-7.31)***	-10.9104; (-4.86)***	-0.6839; (-0.7)
LnTTAX	0.1669; (3.76)*** 0.0401	0.1328; (2.88)*** 0.0313	0.1182; (4.15)*** 0.0595
LnREG	1.2335; (9.68)*** 0.1637	1.0027; (4.51)*** 0.1330	0.7876; (6.14)*** 0.2230
LnGDPPC	0.9194; (4.12)*** 0.8511	0.9503; (3.53)*** 0.8798	-0.2507; (-1.87)* -0.4952
LnEMPP	1.6495; (13.13)*** 0.4237	1.4767; (6.35)*** 0.3793	0.4415; (3.74)*** 0.2420

FEDD	-0.0081; (-2.23)** -0.0209	-0.0090; (-2.44)** -0.0234	-0.0069; (-3.12)*** -0.0381
FRDD	0.0067; (2.12)*** 0.0388	0.0080; (2.58)** 0.0463	-0.0029; (-1.5) -0.0361
IRDD	-0.0102; (-5.8)*** -0.0454	-0.0089; (-4.07)*** -0.0393	-0.0076; (-7.21)*** 0.0721
ERD	0.1011; (2.8)*** 0.0518	0.1070; (2.82)*** 0.0548	-0.0618; (-2.79)*** -0.0675
T	0.0598; (3.33)** 0.6513	0.0429; (2.15)** 0.4680	0.0178; (1.6) 0.4140
Lag1		0.2496; (1.32) 0.2464	0.7034; (6.69)*** 0.2105
Lag2		-0.1580; (-1.14) -0.1538	-0.1469; (-1.74)* -0.1356
N	39	37	37
Freedom Degree	29	25	25
$\overline{R}^2$	0.9989	0.9991	0.9985
D-W	2.0454	2.1715	2.0766

Notes: 1. regression coefficient, t statistics and beta coefficient are reported in Table 4.1;
2.* represents significance at 10% confidence level, **represents significance at 5% confidence level, and *** represents significance at 1% confidence level.

data source: our calculation

For model 1, we use the natural logarithm of M0 per capita (LnM0PC) as the independent variable and receive estimation results that are significant at least to the 5% statistical level and consistent with our hypothesis. In model 2, all the dependent variables are also significant except the first order lag value and the second order lag value of LnM0PC. However, in model 3, when we use the natural logarithm of the ratio of M0 to M2 as the independent variable, the natural logarithm of GDP per capita, the first difference of fiscal revenue decentralization and the first difference of exchange rate all have opposite coefficients to what we expect.

GDP is the most important factor that affects cash demand in the official economic sector. As we can see in model 1, the natural logarithm of GDP per capita (LnGDPPC) has a very significant positive correlation with LnM0PC. Per

capita demand for M0 will increase by 0.9194 percent when GDP per capita increases by 1 percent, and it increases by 0.9503 percent when considering the first and second order lag terms of LnM0PC in model 2. However, when we use the natural logarithm value of the ratio of M0 to M2 (LnM0M2) as the independent variable in model 3, it has a negative influence on the cash ratio of M0 to M2 at the 10% confidence level and the cash ratio will decrease by 0.2507 percent when GDP per capita increases by 1 percent. This is mainly because people won't hold too much cash in order to avoid risk of devaluation or loss, or to prepare for future expenditure. Chinese residents have a stronger preference for saving than people from other countries, hence, the cash ratio will decrease with the increase of GDP per capita, bringing out a higher increasing extent for M2 than M0.

As to the interest rate, we can see that it has a significant negative correlation with currency demand in all three models just as we expect. According to model 1 (model 2), demand for per capita M0 will decrease by 0.0102% (0.0089%) if the interest rate increases by 1, and the cash ratio of M0 to M2 will decrease 0.0076% according to model 3. Another important factor in the official economic sector, the exchange rate, also has a significant impact on currency demand at the 1% confidence level in all three models. However, its impacts are different when we use different independent variables, and it demonstrates a negative impact in that the ratio of M0 to M2 will decrease by 0.0618% when the exchange rate increases by 1. Currency demand from abroad occurs mainly through the banking system, especially in international trade settlements, so the ratio of M0 to M2 will decrease despite the exchange rate representing increasing demand for total currency when the exchange rate is increasing.

Our interest mainly focuses on currency demand coming from the shadow economic sector. Tax burden and regulation intensity are the most important causes of the shadow economy; as we can see in Table 4.1, these two variables both have a significant positive effect on currency demand in each model. This demonstrates that there is an increase in the shadow economy when the tax burden and regulation intensity are increased. We can see that per capita demand for M0 will increase by 0.1669% (0.1328%) when the tax burden increases by 1% in model 1 (model 2), and the cash ratio value of M0 to M2 is 0.1182% in model 3. Similar to the impact of tax burden, a 1% increase in regulation intensity will result in an increase of 1.2335% (1.0027%) in model 1 (model 2), and the ratio of M0 to M2 also will increase by 0.7876% when it increases by 1%.

We also considered another two important factors which could affect the Chinese shadow economy. Here, we can see that there is a statistically significant positive impact of the proportion of employment in the agricultural sector to total employment (EMPP) on currency demand. It results in an increase of 1.6495% (1.4767%) in per capita demand of M0 in model 1 (model 2) when there is a 1% increase in EMPP, and the ratio value for M0 to M2 is 0.4415% in model 3. As we have concluded that more and more Chinese workers are transferring to the industrial and service sectors from the agricultural sector with the rapid process of industrialization and urbanization, it would be beneficial to reduce the surplus labor force and self-employment in rural areas; as a result, currency demand originating from the shadow economy which is caused by unemployment and self-employment would also decrease alongside the decreasing employment in the agricultural sector. Considering the characteristics of Chinese fiscal decentralization, we have to distinguish the impacts of fiscal revenue decentralization (FRD) and expenditure decentralization (FED) on the shadow economy. At first, we can

see that there is a significant negative impact of FED on cash demand in all three models. Per capita demand for M0 will decrease by 0.0081% (0.0090%) when FED is increased by 1 in model 1 (model 2), and the ratio of M0 to M2 will decrease by 0.0067% when FED is increased by 1 in model 3. Then we can see a different impact of FRD on currency demand. In model 1 and model 2, FRD has a significant positive effect on per capita demand for M0, however, it has a negative impact on the ratio of M0 to M2, although not so significant. This is largely because the expenditure of central government is realized mainly through fiscal transfers rather than cash, so the extent of the increase in M2 will be more than M0 when FRD is improved. It's interesting to find the different impacts of FED and FRD on the shadow economy in China as, unlike in other developed countries, improving fiscal revenue centralization can increase supervision and restraint to local government fiscal budgets and expenditure effectively, thus potentially decreasing corruption and improving the efficiency of fiscal expenditure.

We also considered the first order and second order lag terms of the independent variable in our model. Neither of them are significant when we use LnM0PC as the independent variable, but the first order lag term is significant at the 1% confidence level and the second order lag term is significant at the 10% confidence level when we use LnM0M2 as the independent variable in model 3. To compare the estimation results using different independent variables, we kept the lag term of LnM0PC in model 2. But we have to point out that the ratio of M0 to M2 may not reflect the demand for M0 as accurately as the variable of per capita M0, so model 1 is the best model to use for the simulation.

Finally, to compare the effects of different variables on the shadow economy, we also report the beta coefficient in Table 4.1, and it demonstrates the same

turn of causal variables in the three models. According to the value of the beta coefficient, we can infer that the variables causing China's shadow economy are the proportion of employment in the agricultural sector, regulation intensity, tax burden, fiscal expenditure decentralization and fiscal revenue decentralization.

4.4 Calculation of the size of the shadow economy

The Currency Demand Method is mainly based on the feature that transitions in the shadow economy tend to be completed using cash, so when a country has a bigger shadow economy, the demand for currency will be larger. We can use changes in these variables to capture currency demand coming from the shadow economy according to our econometric models.

We select model 1 to make the simulation. At first, we use model 1 to predict the natural logarithm value of per capita M0. Then we select the total tax burden, regulation intensity, proportion of employment in agricultural sector to total employment, fiscal revenue decentralization and fiscal expenditure decentralization as the causes of China's shadow economy. We set them to the minimum level (set fiscal expenditure decentralization as the maximum level) in history to predict the value of per capita cash holdings without shadow economy by model 1. Then we use them to get the per capita cash holding derived from the shadow economy and to get the per capita product in shadow sector using it multiplies the velocity of M1 in the official economy. Now, we can get the size of the shadow economy, which is presented by the per capita shadow product as a percentage of GDP per capita. Finally, we will use the long run elastic coefficient of GDP and cash demand to calibrate the calculation result of the shadow economy.[28]

[28] According to Ahumada, Alvaredo and Canavese (2007), if the size of shadow economy (SE_1) which get from the assumption that the velocity of currency in shadow economy and official economy are equal, and the long run elastic coefficient of the income and currency

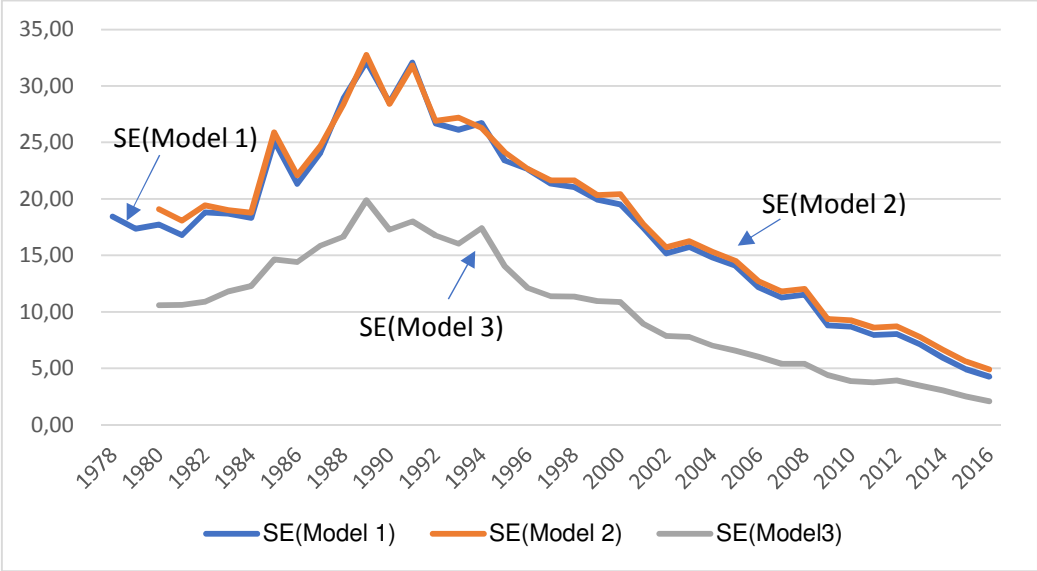

Figure 4.1 the size of China's shadow economy from 1978 to 2016 (%)[29]
Source: our calculation

As shown in Figure 4.1, SEmodel1 is the size of shadow economy calculated by model 1, SEmodel2 is the result calculated by model 2 and SEmodel3 is the result obtained from model 3. All results show similar trends over the whole period although there are differences among them. As model 1 is the best model to make the simulation, we will firstly analyze SEmodel1. After calibrating, the average size of China's shadow economy over the period 1979–2016 is 17.79% with a maximum size of 32.16% in 1989 and a minimum size of 4.27% in 2016. The result shows an increasing trend from 1979 to 1991, and then there is an obvious decreasing trend from 1991 to 2016. Combined with the economic background of China, we find that there were lots of surplus workers in rural areas after the new land policy was implemented in 1979, but there were still many regulations in the market that prevented them transferring to urban areas and non-agricultural sectors, hence, there was an increasing trend from 1979 to 1991. And the size in both 1989 and 1991 was higher than 32%, maybe because of the unstable social environment. However, China

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demand is β, then, the calibration value of SE_1 can calculated by the formula: SE_1^(1/β).

[29] The specific value of the shadow economy for each year can bee seen in Appendix C, table C1.

decided to end its transition step and built the market economic system in 1992; as a result, China opened up to more foreign direct investment and lots of factories were built in the eastern provinces, which attracted lots of surplus labor force from rural areas. Moreover, China's special fiscal decentralization which was carried out in 1994 stimulated competition among local governments and improved the efficiency of public products provision. So, there was an obvious decreasing trend from 1992 to 2016. As not all shadow economy activities were undertaken in cash,[30] maybe the actual size of China's shadow economy is even higher than the predicted value we obtain.

To make a comparison of the results obtained from the cash holding model and the cash ratio model, we also present the calculation results from model 2 and model 3. The average size obtained from model 2 is 18.29% with a maximum value of 32.76% in 1991 and a minimum value of 4.9% in 2016. However, the average size obtained from the cash ratio model (model 3) is 10.6% with a maximum value of 19.89% in 1989 and a minimum value of 2.07% in 2016.

5. Robustness Check

To ensure the robustness of our model and results, we make a deeper check including the robustness of our models over different periods, the calculation results considering different causal variables and comparison with others' research results using different methods.

We selected five periods to check the robustness of model 1, all of which demonstrate stable results. The results show that model 1 is relatively stable in each period although some variables are not so significant for the periods 1978–2007 and 1978–2012. Moreover, all variables are significant in each

[30] Schneider (2000) pointed out that only 80% of shadow economic activities were undertaken by cash.

period when 1978 isn't included; this may be because China's reformation began at the end of 1978, and the situation in 1978 was very different to that in the following years. Meanwhile, the regression results for model 3 in different periods are also very stable, and all key variables are statistically significant at least at the 10% confidence level, except that LnEMPP is not so stable in the periods 1978–2011 and 1978–2013.[31]

In addition, to check the disaggregated effects of different causes, we make a calculation considering different causal variables. As shown in Figure 5.1, SE1(TAX) is the simulation result based on model 1 with total tax burden as the only cause; this shows an average size of 1.3455% with a lowest level of 0 in 1996 and a highest level of 2.6465% in 1987. SE1(TAX,REG) is the result based on model 1 with total tax burden and regulation intensity as causes. This shows an average size of 5.73% with a lowest value of 1.31% in 2016 and a highest value of 15.38% in 1989. SE1(TAX,REG,EMPP) is the result based on model 1 with total tax burden, regulation intensity and the proportion of employment in primary industry as causes; this shows an average size of 15.89% with a lowest value of 1.31% in 2016 and a highest level of 30.52% in 1989. SE1(TAX,REG,EMPP,FED,FRD) is the simulation result based on model 1 considering all five causes which we have reported before. As can be seen in Figure 5.1, regulation intensity and employment in the agricultural sector play an important role in China's shadow economy. However, with decreasing regulation and employment in the agricultural sector, tax burden and fiscal decentralization which reflect the quality of institutions and public products provision become more important for China's shadow economy. Figure 5.2 presents results based on model 3 with different causal variables. Although there is a difference between the results of these two models, the two models

[31] The robustness check results of model 1 and model 3 are shown in the Appendix B, table B1 and table B2.

present a similar trend when we use different causal variables.

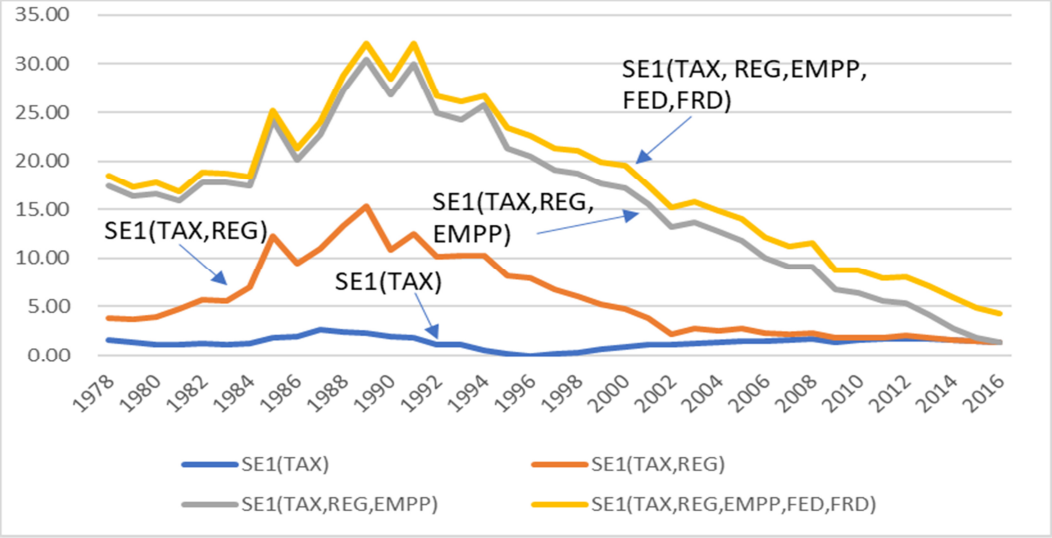

Figure 5.1 Calculation results based on model 1 with different cause variables (%)
Source: our calculation[32]

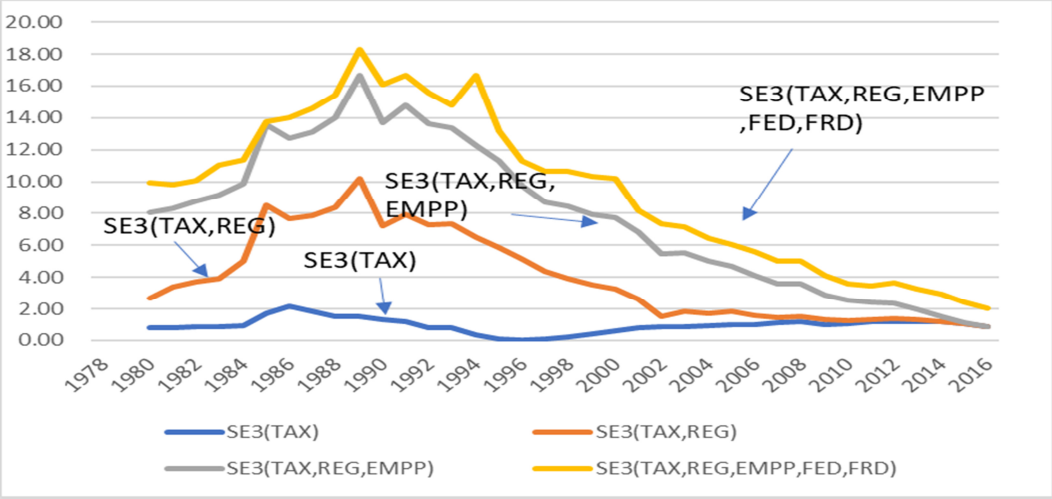

Figure 5.2 Calculation results based on model 3 with different cause variables (%)
Source: our calculation.[33]

Finally, we also collect others' research results on the size of China's shadow economy to make a comparison. The findings by Elgin and Öztunali (2012) with a DGE model show an average size of 17.49% over the period 1978–2007. Alm and Embaye (2013) used the currency demand method with dynamic panel data to estimate the size of China's shadow economy over the

[32] The calculation result is presented in Appendix C, table C1.
[33] The calculation results are presented in Appendix C, table C2.

period 1990–2006 and obtained an average size of 21.02%. Medina and Schneider (2017) also measured China's shadow economy using the MIMIC method and their result showed an average size of 11.49%. SE(model1) and SE(model 3) are results based on model 1 and model 3 considering all five cause variables. It's clear that there is a similar trend among these results and the values of the other three results fall between the results obtained from model 1 and model 3.

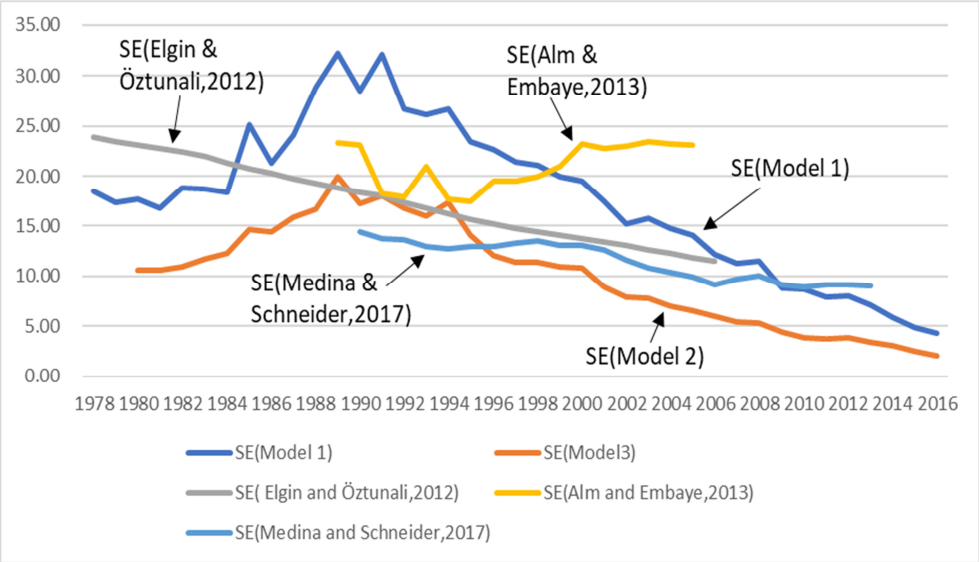

Figure 5.3 Comparison of different research results on China's shadow economy

6. Summary and conclusion

Applying the currency demand method, our paper constructed two stable currency demand models to measure the size of China's shadow economy over the period 1978–2016 based on theories of the shadow economy and China's economic background. Model 1 provides a stable currency demand model based on cash per capita and the result shows that the average size of China's shadow economy over the period 1978–2016 was 17.79% with a maximum size of 32.16% in 1989 and a minimum size of 4.27% in 2016. China's shadow economy presents great variety over this period, increasing from 17.79% in 1979 to 32.16% in 1991, and then decreasing to 4.27% in 2016 apart from an increase in 1991. Model 3 provides a currency demand

approach based on the cash ratio of M0 to M2 and the result shows that the average size of China's shadow economy was only 9.48% with a maximum value of 18.31% in 1989 and a minimum value of 2.03% in 2016. Although these two results differ, they show a similar trend.[34] However, we must point out that the result from model 1 is the most accurate result we obtained for China's shadow economy.

The other important conclusion is about the causes of China's shadow economy. We selected five variables, including total tax burden, regulation intensity, employment proportion in the agricultural sector, fiscal revenue decentralization and fiscal expenditure decentralization, to capture currency demand derived from the shadow economic sector in both models. The econometric results show a stable impact of all these variables. However, we find that these causes played different roles in different periods. Regulation burden and employment in agriculture played important roles in earlier times. As government regulation and employment in the agricultural sector decreased, tax burden and fiscal decentralization, which are related to the quality of institutions and public service, played more important roles in China's shadow economy. This phenomenon provides an important policy implication for many developing countries and transition countries in preventing shadow economy. It is important to loosen regulation intensity and decrease unemployment and self-employment through urbanization and industrialization for many transitioning and developing countries. However, decreasing the tax burden and improving government quality should be effective methods for developed countries. In addition, the regression result presents a difference effect of fiscal revenue decentralization and fiscal expenditure decentralization. So, similar to China, it's important for countries without mature and effective

[34] The specific values for each year based on model 1, model 2 and model 3 can be seen in Appendix C, table C1.

supervisory mechanisms to strengthen supervision and restrict local governments when implementing decentralization reforms.

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Appendix A: Table A1 detailed description of the variables used

Variable		obs	Mean	Std.Dev.	Min	max	source
Name	**Label**						
M0PC	Real cash holding(M0) per capita in China (China RMB), base year:1978	**39**	**289.91**	**242.72**	**22.02**	**787.23**	**[1]**
M0M2	Ratio of M0 to M2 in China (%)	**39**	**12.41**	**5.35**	**4.41**	**21.13**	**[1,2]**
GDPPC	Real GDP per capita in China, base year:1978	**39**	**2738.12**	**2468.24**	**385**	**8630.15**	**[1]**
TTAX	Real total tax income in % of real GDP	**39**	**13.89**	**3.63**	**8.02**	**21.94**	**[1]**
REG	Urban Employment in public sector in % of total employment in urban areas	**39**	**4.88**	**0.68**	**4.04**	**6.24**	**[1,3]**
EMPP	Employment in primary industry in % of total employment	**39**	**51.14**	**12.56**	**27.7**	**70.53**	**[1]**
FED	Fiscal expenditure decentralization (local government expenditure in % of total government expenditure)	**39**	**68.68**	**12.15**	**27.7**	**70.53**	**[1]**
FEDD	First difference of FED.	**39**	**0.82**	**2.71**	**-3.7**	**12.8**	**o.c.**
FRD	Fiscal revenue decentralization (local government revenue in % of total government revenue)	**39**	**57.69**	**11.64**	**44.3**	**84.5**	**[1]**
FRDD	First difference of FRD	**39**	**-0.83**	**6.02**	**-33.7**	**6.1**	**o.c.**
IRD	Real average benchmark interest rate of 1 year term deposition	**39**	**0.04**	**4.33**	**-13.24**	**6.87**	**[4]**
IRDD	First difference of IRD	**39**	**-0.03**	**4.64**	**-13.13**	**13.74**	**o.c.**
ER	Exchange rate	**39**	**5.77**	**2.45**	**1.5**	**8.62**	**[1]**
ERD	First difference of ER	**39**	**0.12**	**0.54**	**-0.66**	**2.86**	**o.c.**
CPI	Consumer price index, base year:1978	**39**	**354.02**	**179.20**	**100**	**627.5**	**[1]**

Notes: 1. As we can't get consistent data for total employment in the public sector, we have to use urban employment in the public sector as a percentage of total employment in urban areas as the proxy for regulation intensity.

2. As the Chinese government didn't publish M2 before 1990, we have to refer to the result of Wang(2001) which is the most commonly used result in China to get the predicted M2 before 1990.

3. Sources: see numbers in listing of empirical sources; o.c.=own calculations.

Empirical Sources:

[1] Website of National Bureau of Statistics of China, http://data.stats.gov.cn/easyquery;
[2] Y. Wang, (2001), Currency Demand and Circulation Velocity in Economic Transition, Journal of Economic Research, pp: 20-28.
[3] National Bureau of Statistics of China, China Statistic Yearbook [M], Beijing: China Statistics Press, 1978–2003 (the annual China Statistic Yearbook will be published next year)
[4] Website of the People's Bank of China, http://www.pbc.gov.cn/zhengcehuobisi/125207/125213/125440/ .

Appendix B: Tables for Robustness Check

Table B1 Robustness of Model 1 in different periods

	Model 1 (LnM0PC)				
period	1978–2007	1978–2012	**1978–2016**	1983–2016	1986–2016
constant	-8.0922 (-1.42)	-7.7010 (-2.10) **	**-11.6665** **(-7.31) *** **	-11.4558 (-7.59) ***	-13.0248 (-5.09) ***
LnTTAX	0.1488 (2.78) ***	0.1524 (3.35) ***	**0.1699** **(3.76)*** **	0.1245 (2.85) ***	0.1440 (2.59) **
LnREG	1.1968 (7.95) ***	1.2029 (9.52) ***	**1.2335** **(9.68)*** **	0.8308 (4.09) ***	1.2091 (2.78) **
LnGDPPC	1.0652 (1.06)	0.5297 (1.35)	**0.9194** **(4.12) *** **	1.1232 (4.8) ***	1.0876 (4.25) ***
LnEMPP	1.7407 (2.06) *	1.2756 (3.67) ***	**1.6495** **(13.13)*** **	1.5295 (12.58) ***	1.7526 (6.25) ***
FEDD	-0.0067 (-1.65)	-0.0067 (-1.83) *	**-0.0081** **(-2.23)** **	-0.0092 (-2.54) **	-0.0076 (-1.3)
FRDD	0.0066 (1.77) *	0.0064 (2.01) *	**0.0067** **(2.12) ** **	0.0097 (2.98) ***	0.01 (2.76) **
IRDD	-0.0105 (-5.25) ***	-0.0113 (-6.05) ***	**-0.0102** **(-5.8)*** **	-0.0104 (-6.5) ***	-0.0105 (-6.45) ***
ERD	0.1008 (2.33) **	0.0986 (3.09) ***	**0.1011** **(2.8)*** **	0.1351 (3.75) ***	0.1364 (3.37) ***
T	0.0831 (2.37) **	0.0853 (3.67) ***	**0.0598** **(3.33) *** **	0.0346 (1.68) *	0.0492 (1.96) *
N	30	34	**39**	34	30
Freedom Degree	20	24	**29**	24	20
$\overline{R}^2$	0.9984	0.9989	**0.9990**	0.9989	0.9985
D-W	2.2436	2.2859	**2.1761**	2.0184	2.079

Note:* represents significance at 10% confidence level, **represents significance at 5% confidence level, and *** represents significance at 1% confidence level.

data source: our calculation

Table B2 Robustness of Model 3 in different periods

	Model 3 (LnM0M2)				
period	1979-2011	1979-2013	**1979-2016**	1982-2016	1985-2016
constant	3.8715 (1.32)	1.4798 (0.74)	**-0.6839** **(-0.7)**	-0.84 (-0.9)	-2.7561 (-2.55) **
LnTTAX	0.1109 (3.79) ***	0.1118 (3.84) ***	**0.1182** **(4.15)*** **	0.1654 (4.33) ***	0.1857 (5.48) ***
LnREG	0.7884 (5.96) ***	0.7786 (5.95) ***	**0.7876** **(6.14)*** **	1.1315 (4.93) ***	1.3759 (5.57) ***
LnGDPPC	-0.7166 (-2.29) **	-0.4772 (-2.08) **	**-0.2507** **(-1.87)***	-0.4215 (-2.68) **	-0.3424 (-2.74) **
LnEMPP	-0.0057 (-0.02)	0.2349 (1.17)	**0.4415** **(3.74)*** **	0.6161 (4.12) ***	0.7976 (4.96) ***
FEDD	-0.0055 (-2.31) **	-0.0059 (-2.48) **	**-0.0069** **(-3.12)*** **	-0.0051 (-2.24) **	-0.0065 (--3.47) ***
FRDD	-0.0039 (-1.88) *	-0.0035 (-1.73) *	**-0.0029** **(-1.5)**	-0.0060 (-2.35) **	-0.0041 (-1.9) *
IRDD	-0.0083 (-7.16) ***	-0.0080 (-7.15) ***	**-0.0076** **(-7.21)*** **	-0.0068 (-6.22) ***	-0.007 (-8.13) ***
ERD	-0.0753 (-3.16) ***	-0.0706 (-3.03) ***	**-0.0618** **(-2.79)*** **	-0.0828 (-3.41) ***	-0.0685 (-3.48) ***
T	0.0498 (2.22) **	0.0337 (1.96) *	**0.0178** **(1.6)**	0.0353 (2.48) **	0.0388 (3.31) ***
Lag.1	0.7412 (6.77) ***	0.7227 (6.71) ***	**0.7034** **(6.69)*** **	0.5293 (3.72) ***	0.5455 (4.6) ***
Lag.2	0.1583 (-1.81) *	-0.1444 (-1.68)	**-0.1469** **(-1.74)***	-0.0837 (-0.93)	-0.0632 (-0.88)
N	32	34	**37**	35	32
Freedom Degree	20	22	**25**	23	20
$\overline{R}^2$	0.9981	0.9983	**0.9985**	0.9987	0.9993
D-W	2.2275	2.1477	**2.0766**	2.0161	2.3985

Note:* represents significance at 10% confidence level, **represents significance at 5% confidence level, and *** represents significance at 1% confidence level.

data source: our calculation

Appendix C: Calculation results of China's Shadow Economy

Table C1 Size of China's shadow economy (%)

Year	Model 1(LnM0PC)		Model 2(LnM0PC)		Model 3(LnM0M2)	
	Original result	Calibration result	Original result	Calibration result	Original result	Calibration result
1978	21.13	18.44				
1979	19.99	17.36				
1980	20.39	17.74	20.71	19.07	11.85	10.60
1981	19.40	16.80	19.69	18.08	11.85	10.60
1982	21.51	18.80	21.07	19.43	12.17	10.90
1983	21.40	18.69	20.65	19.02	13.11	11.79
1984	21.01	18.32	20.39	18.77	13.64	12.29
1985	28.10	25.14	27.70	25.90	16.09	14.62
1986	24.17	21.34	23.80	22.08	15.86	14.41
1987	26.99	24.06	26.45	24.68	17.37	15.85
1988	31.92	28.88	30.18	28.35	18.19	16.64
1989	35.24	32.16	34.63	32.77	21.55	19.89
1990	31.56	28.52	30.26	28.43	18.85	17.28
1991	35.15	32.07	33.68	31.82	19.62	18.02
1992	29.67	26.68	28.72	26.91	18.33	16.77
1993	29.09	26.11	29.01	27.19	17.55	16.02
1994	29.72	26.72	28.10	26.29	18.98	17.40
1995	26.31	23.41	25.91	24.14	15.49	14.05

1996	25.51	22.63	24.40	22.67	13.47	12.13
1997	24.19	21.36	23.34	21.63	12.67	11.38
1998	23.85	21.03	23.35	21.64	12.65	11.35
1999	22.70	19.94	22.01	20.34	12.23	10.96
2000	22.25	19.50	22.08	20.41	12.13	10.86
2001	20.06	17.42	19.36	17.77	10.07	8.93
2002	17.68	15.18	17.23	15.72	8.93	7.87
2003	18.28	15.75	17.80	16.26	8.82	7.77
2004	17.28	14.81	16.83	15.33	8.01	7.02
2005	16.48	14.07	15.99	14.53	7.51	6.56
2006	14.43	12.17	14.09	12.72	6.92	6.02
2007	13.43	11.26	13.12	11.80	6.24	5.40
2008	13.72	11.53	13.36	12.02	6.22	5.38
2009	10.70	8.80	10.53	9.36	5.14	4.40
2010	10.58	8.69	10.41	9.25	4.55	3.88
2011	9.75	7.95	9.72	8.61	4.41	3.74
2012	9.85	8.04	9.83	8.70	4.60	3.91
2013	8.81	7.12	8.83	7.78	4.10	3.47
2014	7.44	5.92	7.61	6.65	3.64	3.06
2015	6.28	4.93	6.45	5.59	3.01	2.50
2016	5.51	4.27	5.69	4.90	2.51	2.07

Table C2 Size of China's shadow economy calculated with different causes

Year	Model 1(LnM0PC)				Model 3(LnM0M2)			
	SE1 (T)	SE1 (T,R)	SE1 (T,R,E)	SE1 (T,R,E,F)	SE3 (T)	SE3 (T,R)	SE3 (T,R,E)	SE3 (T,R,E,F)
1978	1.59	3.84	17.39	18.44				
1979	1.34	3.65	16.34	17.36				
1980	1.12	3.89	16.67	17.74	0.80	2.67	8.06	9.96
1981	1.13	4.76	15.87	16.80	0.82	3.37	8.33	9.82
1982	1.26	5.69	17.84	18.80	0.84	3.71	8.76	10.05
1983	1.17	5.61	17.74	18.69	0.84	3.89	9.19	11.02
1984	1.23	6.93	17.42	18.32	0.91	5.04	9.88	11.37
1985	1.79	12.23	24.20	25.14	1.70	8.48	13.57	13.76
1986	1.95	9.51	20.19	21.34	2.13	7.70	12.70	14.03
1987	2.65	11.03	22.69	24.06	1.86	7.83	13.09	14.61
1988	2.44	13.28	27.35	28.88	1.53	8.37	13.99	15.42
1989	2.34	15.38	30.52	32.16	1.52	10.17	16.65	18.31
1990	1.94	10.91	26.80	28.52	1.29	7.19	13.68	16.07
1991	1.87	12.54	29.97	32.07	1.18	7.93	14.77	16.70
1992	1.15	10.21	24.91	26.68	0.83	7.26	13.66	15.59
1993	1.09	10.28	24.21	26.11	0.80	7.37	13.40	14.79
1994	0.53	10.23	25.82	26.72	0.34	6.50	12.29	16.67
1995	0.13	8.12	21.28	23.41	0.10	5.87	11.31	13.14
1996	0.00	7.88	20.45	22.63	0.00	5.13	9.71	11.28

1997	0.18	6.81	19.13	21.36	0.12	4.35	8.69	10.62
1998	0.35	5.99	18.72	21.03	0.25	3.92	8.42	10.63
1999	0.60	5.28	17.67	19.94	0.43	3.52	7.95	10.30
2000	0.86	4.75	17.17	19.50	0.61	3.25	7.75	10.21
2001	1.13	3.82	15.52	17.42	0.81	2.63	6.83	8.22
2002	1.17	2.18	13.26	15.18	0.84	1.53	5.44	7.33
2003	1.27	2.72	13.68	15.75	0.86	1.81	5.52	7.17
2004	1.37	2.58	12.76	14.81	0.92	1.70	5.02	6.45
2005	1.46	2.81	11.84	14.07	0.98	1.84	4.71	6.02
2006	1.45	2.33	10.03	12.17	1.02	1.61	4.10	5.59
2007	1.61	2.12	9.10	11.26	1.11	1.44	3.61	5.02
2008	1.73	2.26	9.08	11.53	1.18	1.53	3.61	5.00
2009	1.39	1.81	6.72	8.80	1.02	1.31	2.88	4.09
2010	1.59	1.88	6.44	8.69	1.06	1.24	2.53	3.59
2011	1.67	1.81	5.58	7.95	1.19	1.29	2.40	3.48
2012	1.76	2.05	5.33	8.04	1.22	1.42	2.35	3.67
2013	1.73	1.87	4.19	7.12	1.21	1.31	1.95	3.29
2014	1.65	1.65	2.74	5.92	1.19	1.19	1.49	2.95
2015	1.48	1.48	1.83	4.93	1.04	1.04	1.13	2.44
2016	1.31	1.31	1.31	4.27	0.85	0.85	0.85	2.03

Notes: 1.SE1(T) and SE3(T) means shadow economy calculated by model 1 and model with tax burden as cause; SE1(T,R) and SE3(T,R) means shadow economy calculated by model 1 and model 3 with tax burden and regulation as causes; SE1(T,R,E) and

SE3(T,R,E) means shadow economy calculated by model 1 and model 3 with tax burden, regulation and employment in primary industry as causes; SE1(T,R,E,F) and SE3(T,R,E,F) means shadow economy calculated by model 1 and model 3 with tax burden, regulation, employment in primary industry, fiscal expenditure decentralization and fiscal revenue decentralization as causes.

2. **Data source:** our calculation.