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Vulnerability and public service delivery in China from 1985 to 1999

Mary-Françoise Renard[1] and Richard Schiere[2]

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[1] Mary Francoise Renard is President Economic Faculty of the University of Auvergne in France and is Head of the Department of Economic Research in China.
[2] Richard Schiere is a researcher at the Centre D'Etudes et de Recherches sur le Développement International (CERDI) at the University of Auvergne, France (Email of Richard Schiere: richard@schiere.com).

Abstract
This research focused on the determinants of vulnerability, as measured by the variable of expenditure on food consumption, by the quality of public service delivery as measured by three education variables (amount of students per teacher in primary education, amount of students per teacher in secondary education and amount of students per teacher in higher education) and two health variables (amount of doctors per bed and the amount of beds per hospital). To measure the impact of public service delivery on vulnerability we will use OLS regression, Fixed Effect, Two Stage Least Square (TSLS) and TSLS with Fixed Effect. The instrumental of the TSLS regressions are a group of political decentralization and inequality variables. Lags of respective one and two years are introduced as an additional robustness test. The conclusion is threefold: (i) the quality of primary education has a negative impact on vulnerability, probably due to the selection bias of children from poor families being taken out of school; (ii) the quality of the education service in higher education has a positive impact on vulnerability; and (iii) quality of health care has, at most, only a partial positive effect on reducing vulnerability.

Introduction

The issue of vulnerability has become a prominent study for poverty researchers (Dercon, 2001, Mansuri and Healy 2000, Wood 2003), in particular in developing and transition countries. This is particularly of interest in China, as this country has lifted about 500 million people out of poverty, although inequality has been rising both on a rural-urban basis as well as on between coastal and inland regions (Fan 1995a, Gustafsson & Li, 1998; Ravallion and Chen 1998, Yang, 1999 and Yao, 1999, Fan 1995b, Zhang and Zhang, 2002, Kanbur & Zhang, 2005, Wan 2007).

Unfortunately the issue of vulnerability has only been studied on a limited basis in China (Jalan and Ravallion, 1999, Jalan and Ravallion 2001, Mc Culloch and Calandrino, 2003) and use household level data. However, there are several reasons why the issue of vulnerability is of growing importance in the context of China. Firstly, although China is rapidly evolving economically, inequalities on a regional and social level are also on the rise.[3] In these kinds of circumstances, it is important to estimate vulnerability as this provides a more dynamic poverty perspective, instead of using absolute poverty measurements which often focus on income and expenditure variables (Lipton and Maxwell, 1992). Secondly, the aspect of vulnerability plays an important role in the decisionmaking of the poor because their resilience to negative shock is low (Wood 2003). Therefore, vulnerability does not just result from poverty, it can also reinforce poverty. Thirdly, a relative small number of households in China have an average consumption below the poverty line, but a much larger number of households are just above the poverty line (Mc Culloch and Calandrino, 2003). This means that with a relative minor negative shock, households could fall back into poverty. Finally, vulnerability is important from social cohesion perspective as a negative economic shock could create civil strife and therefore threaten the development of a harmonious society in China.

This paper enriches the literature on vulnerability by focusing on the quality of public services in the health care and education sector. The issue of public services has been debate particularly in the context of fiscal reforms (Luo, Zhang, Huang and Rozelle, 2007), but not in terms of vulnerability, as is the case in this paper. Vulnerability in this paper is defined as the risk to events in which a bad outcome could move the household into poverty on a provincial level.[4] The operationalized of this definition is to focus on food consumption expenditures by individual provinces.[5] The quality of public services is measured by three education variables (amount of students per teacher in primary

[3] Some coastal provinces in China have development indicators that perform more like a middle income country (such as in the area of literacy and infant mortality), while in western China these variables are comparable to low income countries (Kanbur & Zhang, 2005).

[4] This definition combines two elements: (i) the risk to an event in which a bad outcome could move the household into poverty (Alwang J., Siegel P. Jørgensen S., 2001); and (ii) the identification of geographical area which is more vulnerable than other areas (Guillaumont 2006).

5 This definition of vulnerability is reflected in the field of food insecurity which notes that vulnerability is "an aggregated measure, for a given population or region, of the risk of exposure to food insecurity" (Downing, 1991). Practical example of vulnerability being measured through food consumption expenditures are Barrett 1999 as well as Christiaensen and Boisvert 2000.

education, amount of students per teacher in secondary education and amount of students per teacher in higher education) and two health variables (amount of doctors per bed and the amount of beds per hospital).

The methodology in this paper determines the effects of public service deliveries in the health and education sector on vulnerability as measured by food consumption using annual panel data covering 1982 to 1999. The first step is to use a OLS regression and Fixed Effect (FE). The education sector is critical as it influences human capital accumulation, which is a key asset in increasing the capacity to seek employment or engage in productive activities as well as to recovery from crises (Adam and Jane 1995, Campa and Webb 1999). The health sector is important in terms of reducing vulnerability because descending households often have income shocks arising from ill health (Jalan Ravallion 1999, Sen 2003). Therefore the quality of both education and health sectors have an important role in reducing vulnerability.

The second step is to undertake a Two-Stage Least Squares (TSLS) and then a TSLS with Fixed Effect, which will instrumentalize public service delivery by four variables of political decentralization (integration score for party secretaries, integration score for governs, tenure in years for party secretaries and tenure in years for governors) as well as rural and urban inequality. Although political decentralization in China is different from other countries, it can be measured in terms of "closeness" of the China's political party to its local residence. The "closeness" could determine the quality of public services as the government would become pro-active in service delivery. Political integration could be used as an instrumental variable as political system is often used to ascertain citizens' needs (Joshi, p7, 2006). Rural and urban inequality could also influence public services as high inequality would reduce the quality of governance as elite capture state provisions (Bardhan & Mookherjee, 2000).

The remainder of this paper is organized as followed. The first section "Vulnerability and reforms of public services in China" provide an overview of the changes in the health and education sector in China during the transition period and its potential effect on vulnerability. The second section "Data description" describes the data as well as the sources. The third section "Methodology" presents the OLS regressions, Fixed Effect, Two Stage Least Square (TSLS) and TSLS with Fixed Effect regressions as well as the robustness tests. The fourth section "Results and robustness tests" presents the outcome of various regressions and its impact on vulnerability. Surprisingly, we also find a positive impact on the quality of public service delivery in the lower education. Finally, the section "Conclusion and policy implications" highlights the limitations of this paper as well as suggests policy recommendations that might reduce vulnerability in China.

Vulnerability and reforms of public service delivery in China

It is widely acknowledged that the reform in China which started in the beginning of the 80s has led to dramatic economic growth and reduction of poverty, although inequality increased significantly after the 1990s (Fan 1995a,Gustafsson & Li, 1998; Ravallion and Chen 1998, Yang, 1999 and Yao 1999, Fan 1995b, Fan, Zhang and Zhang, 2002, Kanbur & Zhang, 2005, Wan 2007). The issue of vulnerability has only been studied on a limited

basis in China (Jalan and Ravallion, 1999, Jalan and Ravallion 2003, McCulloch and Calandrino 2003). As noted by these studies, income and inequality has simultaneously increased dramatically. This is also reflected in the provincial food consumption expenditure, deflated by CPI, in China (see Table 1). This table indicates that there is an annual growth of food consumption from 155 yuan in 1982 to 309 yuan in 1999. However, both the Standard Deviation and the range also increased dramatically, respectively for Std Deviation from 49 in 1982 to 137 in 1999 and for the range from 252 (293.22-41.15) in 1982 to 617 (798.26-180.37) in 1999.

Table 1: Food consumption expenditures in China (in deflated yuan)

	Mean	Std Deviation	Minimum	Maximum
1982	155.86	49.45	41.15	293.22
1983	173.36	46.44	119.41	313.77
1984	185.78	52.92	124.88	355.04
1985	192.25	53.65	134.26	383.12
1986	206.65	64.37	144.28	432.042
1987	213.98	68.19	145.84	451.00
1988	211.61	71.90	134.54	453.49
1989	208.55	75.14	127.28	455.31
1990	222.26	72.76	138.86	462.18
1991	231.51	77.48	152.95	482.90
1992	235.76	80.05	150.12	499.88
1993	239.87	92.16	104.66	546.31
1994	268.53	105.18	165.99	587.64
1995	289.39	122.77	192.56	718.75
1996	299.72	138.95	99.87	807.83
1997	307.65	131.74	175.52	799.02
1998	300.39	131.60	176.67	784.94
1999	309.52	137.71	180.37	798.26

Source: China Data Center of the University of Michigan

Besides, the increase in food consumption, the transitional also had an important effect on public service provisions. Prior to the reforms China provided, through the introduction of the Cooperative Medical System (CMS), primary health care services to the majority of the Chinese population, thereby reducing the infant mortality rate from about 200 per 1000 life births (in 1949)to 47 per 1000 life births (in 1974), and increasing life expectancy from 35 to approximately 65 years (Liu et al., 1995, Gu X**.** 1993)[6]. As such, China had a model for community financing and organization of health care that was considered to be China's 'first health care revolution'. Similar results were achieved in the education sector from a literacy rate pre-communist of 20%, and school enrolment

[6] Pre-revolutionary deaths which occurred were linked to: (i) enteric infections, such as typhoid fever, bacillary dysentery and cholera; (ii) hookworm disease; (iii) childhood measles (often fatal), smallpox epidemics, diphtheria and tuberculosis, malaria, kala-azar, schistosomatosis, tetanus of the umbilical cord, venereal diseases; and (v) more widely, high death rates caused by impact of floods, drought, war or epidemic (Worth, 1973). Under CMS, the financing of health care relied on a pre-payment plan, which included farmers' premium contributions (0.5–2% of a peasant family's annual income), village Collective Welfare Fund, and subsidies from higher level governments.

of about 40-20%, to a literacy rate of 69% and nearly all children received a primary education at the end of the 70s (Hannum and Park, 2003).

During the transition in China, public services provisions provided by the state, such has health care and education services, tend to have rising costs that were transmitted by an increase in userfees (Milanovic, Lanjouw, Paternostro, 1999). The health care sector, in the combination with the de-collectivization in the rural areas and the privatization of State Owned Enterprise (SOEs), led to dramatic reduction of health care provisions and the introduction of services fees. This resulted in 87% of the rural population and 44% of the urban population to have no health benefits and pay for all medical costs directly out-of-pocket (Banister and Zhang, 2005). In addition, this increases inequality as well as reduces the ability of the poor to access health care services in China. This situation creates greater health vulnerability for those who are initially at greater risk of disease but not under the cover of social protection (Zhu, 2004).

This had negative ramification health care provisions in terms of vulnerability as health stricken households resort to in out-of-pocket expenditure with which most of China's people pay for basic level of care at clinics or outpatient departments of hospitals (Henderson *et al.*, 1994). But for catastrophic or chronic medical needs whose costs are high and poorer people often cannot afford pharmaceuticals or hospital fees. In practical terms, this means that if an individual gets very sick, his or her family may not be able to pay for needed medications or hospital costs. From a vulnerability perspective access to health care is important as many of the households that fall below the poverty line were actually health-stricken rather than poverty-stricken (Gustafsson and Li 2004, Banister and Zhang 2005). In addition, medical services can help patients recover from ill health as well as mitigate the burden of medical expenditure. This latter has a strong crowd-out effect on other goods and services, which include human capital investment[7], physical capital investment[8] and investment in development of human well-being[9] (Wang Zhang Hsiao, 2006).

[7] Human capital investment. Expenditures on education for children or adults are human capital investments that tend to increase productivity in the long run. The results from this study indicate that medical expenditures, especially due to hospitalization, significantly influence households' investment on education expenditure. Households with ill health members have less investment on education than households without ill health members.

[8] (2) *Physical capital investment in farm production*. The results of this study also suggest that households with ill health members spend less on physical capital investment for farm production, such as farming tools and seeds, than households without ill health members. The increase of each 100 Yuan in medical expenditure leads to 0.22 percentage point decline (4.5 Yuan decline) in farming investment. Thus, excessive medical expenditure reduces physical capital investment in farm production, and therefore reducing farming productivity.

[9] *Investment in development of human well-being*. In addition to economic development, many households' consumptions are critical for the human survival and well-being, such as food, clothes, and social activity. Households with ill health members and high medical expenditures must sacrifice their consumptions on those categories, which could have both short- and long-term negative impacts on human development.

Because of the lack of health coverage, the insurance industry in China has developed rapidly, especially since the 1990s. However, the increased wealth gap between urban and rural incomes still remains a problem which means that rural residents lack the means to pay for insurance. In turn, this leads to a growing gap in terms of quality and accessibility of services between rural and urban areas (World Bank, 2005). Low coverage exposes rural Chinese residents to health and financial risks, and may have negative effects on economic development, both because they have to be keep financial buffers as well as because the lack of medical treatment lead to loss of productive workforce, and a reduction of investment in human capital. All of these have a negative impact in terms of vulnerability.

In the education sector, there is a similar situation as in the health sector. Despite the introduction of the "Law of Compulsory Education" in 1986 which officially made nine years of schooling compulsory throughout China (six years of primary school, three years of middle school), only 76% of the counties had realized universal primary education though the population of those counties was 91% of the national total (He, 1996)**.** Furthermore, the issue of quality and equipment of school is also been an area were inequality is evident between urban and rural areas. The inequality in education is caused by the fact that the schools are funded at the local level and therefore have lower quality and less equipment. Resource constraints differentially affect access to schooling of individuals in different parts of China, especially in rural areas and in the West. (Heckman, 2005). Moreover, economic reform also changed the opportunity cost for the poor. For example, a rural family's income is now more closely linked to its own work effort, which leads to children, especially girls, from households that are both poor and credit constrained to have three times as likely to drop out of school than households that are not financially constraint (Connelly and Zheng 2003). Migrants in the urban areas face addition financial burdens as they "education endorsement fees" (*jiaoyu zanzhu fei),* could be an heavy burden for parents given the large concentration of migrants in low-paying occupations (Zai and Por, 2007)**.**

2. Data Description

The objective of this research is to measure the effects of public service delivery in the health and education sector, on vulnerability, using a panel dataset. The panel dataset covers 28 provincial from 1982 till 1999. The dataset is limited to 1999 because the variable of political integration, which is an instrumental variable in the TSLS, is limited to this year. Tibet is excluded for lack of data. The provinces of Guangdong-Hainan and Sichuan-Chingqing have been merged to make the datasets compatible.

To measure food expenditure, we weight urban food consumption expenditure as well as rural food consumption expenditure with the urbanization rate (see equation 1), which is referred to as Weighted Food Expenditure and is the dependent variable. In addition, we use five independent variables of which three variables to measure the quality of the education sector (respectively amount of students per teacher in primary education, amount of students per teacher in secondary education and amount of student per teacher in higher education), while two variables to measure the quality of the health sector (respectively amount of doctors per bed as well as amount of medical persons per bed). In

addition, we use political integration as well as rural and urban inequality as instrumental variables of public services delivery in the TSLS.

The description of the data as well as the sources areas followed:

1. Weighted Food Expenditure (WFE): The Weighed Food Expenditure is Urban consumption weighed by urban population as well as rural food expenditures weighed by rural population (see equation 1), deflated by Consumer Price Index (CPI). This is panel data by province and by year. A person is counted as rural if he/she was born in rural areas or has at least lived in rural areas for one year. This variable is based on China Statistical Data Compilation of Michigan University. Furthermore, food expenditure is negatively associated with vulnerability in the food insecurity literature (Barrett 1999 as well as Christiaensen and Boisvert 2000) and is noted in equation 2.

(1) $$WFE_{pt} = \sum_t \sum_p Urb * UFE + \sum_t \sum_p (1 - Urb) RFE$$

(2) $$V_{pt} = -WFE_{pt}$$

With the following annotations: WFE is the deflated weighted food expenditure, Urb is the percentage of urbanized population, UFE is the deflated Urban Food Expenditure, RFE is Rural Food Expenditure, V is vulnerability, p one of the is the respective province 28 provinces, t is the respective individual year starting from 1982 till 1998. To measure public service delivery in health and education sector, the following five independent variables are used:

1. Education 1 (Edu1): public services in the primary education sector, which are the amount of teachers divided by the amount of students. This could measure the quality of public services in primary education. The data is based on China Statistical Data Compilation of Michigan University.

2. Education 2 (Edu2): public services in the secondary education sector, which are the amount of teachers divided by the amount of students. This could also measure the quality of public services in secondary education. The data is based on China Statistical Data Compilation of Michigan University.

3. Education 3 (Edu3): public services in the higher education sector, which are the amount of teachers divided by the amount of students. This could also measure the quality of public services in higher education. The data is based on China Statistical Data Compilation of Michigan University.

4. Health 1 (HC1): public services in health care Amount of doctors (per 10000) divided by the amount of beds (per 10000). This measures the quality of public service delivery in health sector. The data is based on China Statistical Data Compilation of Michigan University.

5. Health 2 (HC2): public services number of medical personnel provincial divided by number of doctors provincial. The data is based on China Statistical Data Compilation of Michigan University.

The Two-Stage Least Squares (TSLS) and TSLS with Fixed Effect (FE) estimations ran with the following six instruments, which are respectively four political decentralization variables well as rural and urban inequality variables:

1. Political decentralization 1 (partyint): the integration score for party secretaries from 1 (lowest) to 4 (highest). Political integration could be used as an instrumental variable as political system is often used to assert citizens' needs (Joshi, p7, 2006). In the case of China, if the integration score is higher, than the party secretary is closely integrated into its jurisdiction and "know" what its residence desire. The data was provided by Yiu Por Chen, from the University of DePaul in Chicago.

2. Political decentralization 2 (govint): the integration score for governors, which is the same as for partyint. Political integration could be used as an instrumental variable as political system is often used to assert citizens' needs (Joshi, p7, 2006). In the case of China, if the integration score is higher, than the governor is closely integrated into its jurisdiction and "know" what its residence desire. The data was provided by Yiu Por Chen, from the University of DePaul in Chicago.

3. Political decentralization 3 (partyten): tenure measured in years for party secretaries. The longer the tenure within a province, the more integrated the party is with its jurisdiction. As such, it would be more likely that the party secretary is more closely associated with its constituency and to be more responsive to its needs. As such, they would provide better health and educational services. Political integration could be used as an instrumental variable (Joshi, p7, 2006) as political system is used to ascertain citizens' needs. The data was provided by Yiu Por Chen, from the University of DePaul in Chicago.

4. Political decentralization 4 (govint): tenure in years for governors. The longer the tenure within a province, the more integrated the party is with its jurisdiction. As such, it would be more likely that the party secretary is more closely associated with its constituency and to be more responsive to its needs. As such, they would provide better health and educational services. Political integration could be used as an instrumental variable (Joshi, p7, 2006) as political system is used to ascertain citizens' needs. The data was provided by Yiu Por Chen, from the University of DePaul in Chicago.

5. Rural Inequality (RI): Inequality of rural areas is measured by the Engles inequality, which is from the China Statistical yearbook. This is particular the case as inequality can affect the quality of public service as more inequality leads to less public services (Bardhan & Mookherjee, 2000). For instance, inegalitarian

societies are shown to generate more redistribution than less inegalitarian ones, but because redistribution goes through the tax system. This is because the middle class "promote" public services for everybody.

6. Urban Inequality (UI): Inequality of urban areas is measured by the Engles inequality, which is from the China Statistical yearbook. This is particular the case as inequality can affect the quality of public service as more inequality leads to less public services (Bardhan & Mookherjee, 2000). For instance, inegalitarian societies are shown to generate more redistribution than less inegalitarian ones, but because redistribution goes through the tax system. This is because the middle class "promote" public services for everybody.

3. Methodology & Robustness test

To measure the impact of service delivery on vulnerability, we use the following regressions: Ordinary Least Squares (OLS), Fixed Effect (FE) and Two-Stage Least Squares (TSLS) and TSLS with FE. This approach has been chosen as the OLS regression does not control for potential simultaneity and omitted variables bias, which is related to the endogeneity between food consumption and public service delivery. Unfortunately, the data on public service delivery could not disaggregate between rural and urban areas as the data is only on provincial level. Therefore we use weighed food consumption expenditure as a dependent variables to measure the effect of public services on vulnerability, which is the following two equations:

$$(3) \qquad V_{pt} = \alpha Edu1_{pt} + \beta Edu2_{pt} + \chi Edu3_{pt} + \delta HC1_{pt} + \varepsilon HC2_{pt} + \phi_p + \gamma_{pt}$$

The equation has the following annotation: V is Vulnerability as measure by Weighed Food Expenditure (Equation 1 and 2), Edu1 is public services in the primary education sector (amount of students per teacher in primary education), Edu2 public services in the secondary education sector (amount of students per teacher in secondary education), Edu3 is public services in the higher education sector(amount of students per teachers in higher education), HC1 is health care services (amount of doctors divided by the amount of beds on the provincial level) and HC2 is health care provisions (amount of medical health institutes divided by number of doctors in health institutes), p one of the is the respective province 28 provinces, t is the respective individual year starting from 1982 till 1998, α, β, χ, δ and ε are the respective coefficients of the variables and Φ is the constant, and γ is random error.

The second step is to undertake a fixed effect regression. Fixed effects methods essentially offer control for all stable characteristics of the observations and therefore isolates the effects of public service delivery in the health and education sector on vulnerability. The F-test will measure if the Fixed Effect is significant, thereby taking the advantage that the panel data offers.

The third step is to apply a Two-Stage Least Squares (TSLS) as well as TSLS with Fixed Effect. We use the OLS regression models assume that errors in the dependent variable are uncorrelated with the independent variable(s). When this is not the case (for example,

when relationships between variables are bidirectional), linear regression using ordinary least squares (OLS) no longer provides optimal model estimates. Therefore the Two-Stage Least Square (TSLS) regression addresses the problems of OLS regression by controlling for potential simultaneity and omitted variables bias, which is related to the endogeneity between vulnerability and public service delivery. This is because vulnerability could also affect public service delivery as low food consumption could indicate an overall "poor" country, which would also have a negative effect on the quality of public services.

The instrumental variables for the Two-Stage Least Squares (TSLS) are four variables representing political integration and two variables representing respectively rural inequality (RI) and urban inequality (UI). In total there are therefore six instrumental variables, while there are five dependent variables. The four political integration variables are linked to public services delivery because the former will increase "the responsive" to needs of their citizens (Joshi, p7, 2006) and therefore the performance will increase in the health and education sector. In addition, inequality has a relationship on public services delivery as a less unequal society "promotes" public services for everybody.

We control for the quality of the instruments through first-stage of TSLS method and through Hansen-Sargan test that focuses on overidentifying restrictions. We check that excluded instruments are collectively relevant to public service delivery in the first-stage of the TSLS method. The Hansen-Sargan test, checks if the joint null hypothesis of the instruments are valid i.e., uncorrelated with the error term, and that the excluded instruments are correctly excluded from the estimated equation. Under the null, the test statistic is distributed as chi-squared in the number of overidentifying restrictions. A rejection casts doubt on the validity of the instruments. For the 2SLS estimator, the test statistic is calculated as N*R-squared from a regression of the IV residuals on the full set of instruments. In addition, as with the FE, the F-test will measure if the Fixed Effect are significant.

Finally we introduce two time lags of respectively 1 year and 2 years, to determine the effect on public service delivery on food consumption over time. This could be a robustness test in addition to the TSLS with FE. The reason for this is that it could take 1 or 2 years when reforms are initiated to actually have effect on vulnerability. This could be a "policy lag" in which a change in policy could take several years to have an effect on the dependent variable. A practical example could be that vulnerability due to human capital accumulation, could take a few years to actually decrease vulnerability.

4. Results

This section presents the results of the four regressions, which are respectively OLS regression, Fixed Effect, Two-Stage Least Squares (TSLS) regression and Two-Stage Least Squares (TSLS) regression with Fixed Effect. This can be viewed in table 2. Finally, we introduce a lag of respectively 1 year (Table 3) and 2 years (Table 4) into all these regressions. The results of the first stage regression are demonstrated in annex 1.

Table 2: Regression on provincial vulnerability with no lag

	OLS	FE	TSLS	TSLS, FE
Edu1	-250624.4***	-262329.1***	-418555**	-420579.1**
	(25133.11)	(25547.4)	(191029.8)	(196106.2)
Edu2	11932.83	12431.71	-61354.63**	-61350.97*
	(7971.745)	(8017.985)	(31209.3)	(32464.87)
Edu3	38743.84***	33429.31***	78870.21	77800.42
	(10908.44)	(11238.9)	(71382.04)	(73657.18)
Health1	39.12394	45.63448	303.469	304.5571
	(45.14423)	(58.51675)	(1085.963)	(1104.838)
Health2	-48.53819*	-61.83762*	252.4186	253.7904
	(27.961)	(32.69077)	(749.9417)	(763.7897)
Constant	-199.25	-168.6565*	-739.9688	-750.114
	(73.58438)	(88.2466)	(1991.471)	(2044.109)
R-square	0.15	0.12	0.13	0.13
F-test		34.87		17.96
		(0.00)		(0.00)
Hansen-Sargan p-value			0.64	0.64
Observation	421	421	375	375
Significant	* is significant at 10%, ** is significant at 5% *** significant at 1%			

Table 2 presents the results of the all the regressions with no lags and note that the quality of education (Edu1) at higher education is significant in all four regressions. This means that the better service delivery at higher education would reduce vulnerability. The quality of secondary education (Edu2) has a negative impact on vulnerability under TSLS and TSLS with Fixed Effect, but not with an OLS regression and Fixed Effect. The quality of primary education (Edu3) has positive impact on vulnerability in the OLS and Fixed Effect, although not in the TSLS. This means that, under OLS and FE, vulnerability would increase if public services in primary education would improve. This is somewhat surprising as it is expected that education at the lower level would have a more direct impact on vulnerability. However, this result could be linked to a selection bias as the poor households withdraw their children, especially girls, from school, if the household needs additional resources or because of opportunity costs, i.e. children earn money by working in field, instead of going to school (Connelly and Zheng, 2003). The quality of health sector has only partially reducing vulnerability as Health 2 has a negative impact with the OLS and OLS with Fixed Effect, although not at the TSLS. The Handsen-Sargans Test indicates that there is no over identification and the F-test demonstrates that the Fixed Effect are significant in both the OLS and TSLS regressions. Finally, the first test demonstrates that the instrumental variables are moderately significant (see annex: table 5).

Table 3: Regression on provincial vulnerability with a lag of 1 year

	OLS	FE	TSLS	TSLS, FE
Edu1 - lag1	-258543***	-272094.5***	-362815.1**	-364650.9*
	(26082.35)	(26513.98)	(182794.8)	(188092.3)
Edu2 - lag1	3164.871	3624.24	-84470.95***	-84418.14*
	(8016.313)	(8058.345)	(32329.31)	(33520.46)
Edu3 - lag1	41054.02***	35058.61***	131101.6*	130133.8
	(11224.99)	(11567.39)	(77200.39)	(79945.85)
Health1- lag1	28.78076	26.8225	425.3241	424.463
	(47.19402)	(62.92536)	(1034.343)	(1055.286)
Health2 - lag1	-46.18959	-65.64078***	279.9138	279.7866
	(29.2322)	(34.8011)	(740.5842)	(756.1961)
Constant	-192.1111	-144.1626	-984.2035	-993.8993
	(77.28889)	(94.78968)	(1891.677)	(1945.718)
R-square	0.14	0.11	0.12	0.12
F-test		35.52		19.11
		(0.00)		(0.00)
Hansen-Sargan p-value			0.57	0.57
Observation	397	397	375	375
Significant	* is significant at 10%, ** is significant at 5% *** significant at 1%			

Table 3 presents the results of the all the regression is with a lag of 1 year. Education (Edu1) at higher education is again significant in all four regressions. The negative impact demonstrates that better quality of education in higher education leads to less vulnerability with a lag of 1 year. Again, the quality of secondary education (Edu2) has a negative impact on vulnerability under TSLS and TSLS with Fixed Effect, but not with a OLS regression and Fixed Effect. This means that vulnerability would increase if public services in primary education would improve. The results for the quality of primary education are again surprising, as this has a positive impact on vulnerability in the OLS, OLS with Fixed Effect and TSLS, but not TSLS with Fixed Effect. The quality of health sector has only partially reducing vulnerability with Health 2 with Fixed Effect, but is not significant with the other regressions. The Handsen-Sargans test indicates that there is no over identification and the F-test demonstrates that the Fixed Effect are significant in both the OLS and TSLS regressions. Finally, the first test demonstrates that the instrumental variables are moderately significant (see annex: table 6).

Table 4: Regression on provincial vulnerability with a lag of 2 years

	OLS	FE	TSLS	TSLS, FE
Edu1 – lag2	-270637.8***	-275490.3	-279462.2	-281604
	(22472.59)	(22674.08)		(181602.7)
Edu2 – lag2	1623.345	1336.014	-76584.11**	-76529.15**
	(8564.861)	(8614.852)		(32142.99)
Edu3 –lag2	50811.55***	48519.21	165469.5**	164326.2**
	(10689.63)	(10894)		(79211.39)
Health1-lag2	-52.12408**	-56.16358	339.5132	339.7856
	(22.79463)	(23.43893)		(941.4623)
Health2-lag2	-105.4477*	-111.8159	164.6647	165.3374
	(20.45173)	(20.92808)		(667.9178)
Constant	-74.41443	-57.40195	164.6647	-899.5028
	(49.85406)	(47.17312)		(1737.391)
R-square	0.13	0.12	0.17	0.17
F-test		37.23		23.96
		(0.00)		(0.00)
Hansen-Sargan p-value			0.60	0.60
Observation	372	372	375	375
Significant	* is significant at 10%, ** is significant at 5% *** significant at 1%			

Table 4 presents the results of the all the regression is with a lag of 2 year which are less clear-cut that the results of the previous two tables. The quality of higher education (Edu1) is only significant and negative with OLS regression, while the quality of secondary education (Edu2), is significant and has a negative impact on vulnerability under TSLS and TSLS with FE. In addition, the quality of primary education (Edu3) has a positive impact with OLS, Fixed Effect and TSLS. This means that vulnerability would increase if education services are improved at primary education. As mention earlier, we suspect that this is linked to earlier drop-out of children. The health sector has only limited effect on vulnerability as Health 1 and Health 2 having a negative impact with OLS, although not with a stand OLS and TSLS. The Handsen-Sargans Test indicates that there is no over identification and the F-test demonstrates that the Fixed Effect are significant in both the OLS and TSLS regressions. Finally, the first test demonstrates that the instrumental variables are moderately significant (see annex: table 7).

The combination of the four regressions (OLS, FE, TSLS and TSLS with FE) with various time lag of respective 1 year and 2 years provide a robustness test. The following observations can be made: (i) the quality of higher education have a negative impact on vulnerability with TSLS with FE with no lags and 1 lag. This means that public services in higher education reduces vulnerability; (ii) the quality secondary education has a negative impact in all regression with TSLS and TSLS with FE. This means that secondary education reduces vulnerability; and (iii) the quality of primary education has

positive impact with TSLS with FE with a lag of 2 years. This is a surprising result as most research indicates that poverty is reduced through education at the lower levels of the education system. However, in the case of China this could be linked to a selection bias as the poor households could withdraw their children, especially girls, from school, if the household needs additional resources or due to opportunity costs (Connelly and Zheng, 2003), and (iv) quality of health care has, at most, only a partial positive effect on reducing vulnerability.

Conclusion and policy recommendations

This research focused on the relationship between vulnerability, as measured by the dependent variable of food consumption, and the quality of public services as measured by three education variables (amount of students per teacher in primary education, amount of student per teacher in secondary education and amount of student per teacher in higher education) and two health variables (amount of doctors per bed and the amount of beds per hospital). The conclusion is threefold: (i) the quality of primary education has a negative impact on vulnerability, probable due to the selection bias of children from poor families being taken out of school (Connelly and Zheng, 2003); (ii) the quality of the education service in higher education has a positive impact on reducing vulnerability; and (iii) the health care has also a partially positive impact under the fixed effect under all the time lags.

As indicated earlier, we suggest that the positive impact in primary education could be linked to a selection bias as the poor households withdraw their children, especially girls, from school, if the household needs additional resources or because of opportunity costs, i.e. children earn money by working in field, instead of going to school (Connelly R. and Zheng Z, 2003). This is particularly relevant for migrant people often face addition costs in gaining access to public services such as through the "education endorsement fees" which is also referred to as *jiaoyu zanzhu fei* (Zai L. and Por Y. P., 2007). To a lesser extend the issue of "dropping out" could also be present at the secondary education. At higher education, only students that can afford this education, would be able reduced vulnerability, through the large positive externalities associated with education.

However, we have to interpret our results with caution. First of all, there is a very high inequality urban and rural divide in terms of service delivery, in particular as there is currently a policy of fiscal decentralization. Unfortunately, the independent variable does not allow to be disaggregated into an urban and rural region. Secondly, the issue of insurance has not been adequately addressed, which is relevant for the health sector. Thirdly, the issue of userfees, as a barrier to public services, has not been taken into consideration. The consequence of this is that the quality of public services could increase, but that these services are only for a selected group of middle and upper class people, while the poor are excluded.

Despite these limitations, this paper does present a clear relationship between vulnerability and the quality of public services from 1982 to 1999. The policy implication of this research is that to reduce vulnerability would ensure that resilience to poverty would increase if there is a negative economic shock. This would reduce social tension

and contribute the development of a harmonious society in China. The Government of China could take the following policy measures into consideration:

1. Increase access to primary education. Despite the "Law of Compulsory Education" in 1986 which officially made nine years of schooling compulsory throughout China (six years of primary school, three years of middle school), it is clear that poor families tend to withdraw their children, especially girls from school (Connelly and Zheng, 2003). This is also a problem for migrant children, which have to pay "education endorsement fees" (Zai and Por, 2007). To address this issue, China could be inspired by international experience, in particular from Brazil, in which poor households get a month allowance if there children attend school and attend regular health check-up. For girls there would be an additional allowance as there is gender discrimination in China;

2. Increase the quality of higher education. Encourage human capital accumulation in an equitable manner as the research in this paper indicates that human capital formulation is closely linked to the reduction in the probability of becoming poor. Therefore, stimulation the accumulation of human capital, both at secondary as well as university level, would increase resilience of a region as it increases the capacity to cope with stress as well as to recover from crises situations. An entry point could be to introduce an amendment into the compulsory education law and extending the current 9 year period of free education by several years

3. Improve the function of health care system in China. The current system is only marginally improving vulnerability. In addition, it is highly likely that the userfees provide additional barriers to vulnerable and poor segments of society are excluded from these services. A possible solution could be to extend the health insurance coverage, in particular to rural populations. This would ensure that the health care system is accessible to a broader group of society, thereby encouraging human capital accumulation as well as developmental of a productive workforce. Both elements would reduce vulnerability.

With these measures, vulnerability in China would be reduced by increasing the resilience of the population to negative shocks on a macro level (i.e. macro-economic instability, financial market instability, oil price shock, etc) and on micro level (i.e. household member attracts chronic disease, accident at work, etc.). This would contribute to the strengthening of social cohesion as well as to the wellbeing of households in China. Moreover, in any potential future economic downturn households would have the capacity in absorbing negative shocks, thereby reducing the prospect of civil strife and enhancing political stability. These are all key elements in the development of a harmonious society in China.

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Annex 1: Results of first stage regression

Table 5: Results of First stage regression with 0 year lag

Endogenous Variables	Instrumental variables								
	poldec1	poldec2	poldec3	poldec4	Rural inequ.	Urban inequ.	Constant	Wal che(6)	Pro>chi2
Edu1	3.03E-06	-8.78E-06	2.32E-06	7.15E-07	0.0000048***	-.0000212***	0.0012331*	259	0.0000
Edu2	-2.78E-06	-0.0000156	8.55E-08	-0.0000315***	0.0000171***	0.0000523***	-0.0020852	172	0.0000
Edu3	-.0000136	-.0000424 **	-8.79e-06	.0000111*	2.78e-06*	.0000356	.0003974	107	0.0000
Health1	.0033776	.018159***	-.0038515***	.0006781	-.0007554	-.0005001***	.7425174***	26	0.0003
Health2	.0010594	-.0250415***	.0053077**	-.0007915	-.0002349	.0034495**	1.320115***	19	0.0046
Significant	* is significant at 10%, ** is significant at 5% *** significant at 1%								

Table 6: Result of First stage regression with 1 year lag

Endogenous Variables	Instrumental variables								
	poldec1	poldec2	poldec3	poldec4	Rural inequ.	Urban inequ.	Constant	Wal che(6)	Pro>chi2
Edu1	3.07e-06	-8.89e-06	2.22e-06	1.18e-06	5.17e-06***	-.0000213***	.0012202***	269	0.0000
Edu2	-8.04e-06	-.000014***	7.47e-07	-.0000319***	.0000162***	.0000514***	-.001978***	168	0.0000
Edu3	-.0000156	-.0000392*	-8.29e-06	9.64e-06	1.48e-06	.0000353***	.0004878	107	0.0000
Health1	.003427	.0181432***	-.0036955***	.0005853	-.000825	-.0007517	.7591623***	26	0.0002
Health2	.0013993	-.025299***	.0047601**	-.0004909	.0001418	.0043119***	1.255065***	21	0.0020
Significant	* is significant at 10%, ** is significant at 5% *** significant at 1%								

Table 7: Result of First stage regression with 2 year lag

Endogenous Variables	Instrumental variables								
	poldec1	poldec2	poldec3	poldec4	Rural inequ.	Urban inequ.	Constant	Wal che(6)	Pro>chi2
Edu1	3.90e-06	-.0000108	2.45e-06	1.42e-06	5.34e-06***	-.0000212***	.0012026	268	0.0000
Edu2	-.0000101	-.0000128	1.75e-06	-.000032***	.0000165***	. .0000505***	-.001952***	163	0.0000
Edu3	-.0000189	-.0000334	-8.77e-06	8.96e-06	8.64e-07	.0000343***	.0005746	102	0.0000
Health1	.003524	.0176689	-.0035572	.0006218	-.0008209	-.0007572***	.7588133	24	0.0004
Health2	.001637	-.0247431**	.0043224***	-.0007268	-.0000801	.0044987***	1.259529***	20	0.0023
Significant	* is significant at 10%, ** is significant at 5% *** significant at 1%								