THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

Economic History Working Papers No: 234/2016

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WORKING PAPERS
NO. 24 - FEBRUARY 2016

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Abstract

This article provides an empirical assessment of China's state price policies and strategies in relation to (1) market-rebuilding for the agricultural sector and (2) food security for China.[1] It traces main changes in government grain pricing, urban food subsidies, grain procurement and the administrative control over food circulation from 1979 to 2006 in a bid to transfer a non-market economy to a market one, commonly known as the post-Mao reforms.

Keywords: Market reforms, food prices, food security, food policies

JEL Codes: N15, N45, N55, P21, P22, P25, Q11, Q18

Acknowledgements: We gratefully acknowledge a grant from the Universities' China Committee in London (UCCL) which enabled the authors to collect data from the Universities Service Centre for China Studies of the Chinese University of Hong Kong. The authors thank Professor Robert F. Ash of the School of Oriental and African Studies of the University of London for his advice and comments on this work.

[1] The World Health Organization's (WHO) definition of food security is three-fold: food availability, food access and food use; see WHO. "Food Security," http://www.who.int/trade/glossary/story028/en/. Accessed 12 January 2016.

I. Introduction

When Mao died, a market economy had been absent in Mainland China for about three decades. Rather, the stiff administrative control over resources and resource allocation in the name of the Soviet centrally planned economy was the economy-wide norm in all sectors. As a result, economic efficiency was low, and the economic structure and growth were severely distorted.[2]

Deng Xiaoping's reforms in the post-Mao Era (i.e. after 1976) began in the food sector and were marked by a re-introduction of property rights and economic incentives among producers.[3] Despite the grassroots initiatives, under a party-state, China's reforms have been clearly state-led and state-promoted.[4] Moreover, changes were very gradual without the "shock therapy" of the Russian type.[5] In this context, the visible hand of a Gerschenkron state was busy in creating or rebuilding a food market for the economy, simultaneously handling both the demand and the supply sides.

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[2] See e.g. Lin, Justin Y., "Collectivization and China's Agricultural Crisis in 1959–1961," *Journal of Political Economy* 98/6 (1990): 1228–52; Lardy, Nicholas R., *Agriculture in China's Modern Economic Development* (Cambridge: Cambridge University Press, 1983); Feuchtwang, Stephan and Athar Hussain (eds), *The Chinese Economic Reforms* (London: Croom Helm, 1983); Perkins, Dwight H., "Reforming China's Economic System," *Journal of Economic Literature* 26/2 (1988): 601–45; Li, Li-an and Keyang Zheng (eds), *Deng Xiaoping Yu Gaige Kaifang Shisi Nian* (*Deng Xiaoping and Fourteen Years of Reforms and Opening Up*) (Beijing: Beijing Normal University Press, 1993); Fan, Qimiao and Peter Nolan (eds), *China's Economic Reforms* (Basingstoke: Macmillan Press, 1994); Leng, Shao-chuan, *Reform and Development in Deng's China* (Lanham: University Press of America, 1994); Larus, Elizabeth F., *Economic Reform in China, 1979-2003: The Marketization of Labour and State Enterprises* (Lewiston: Edwin Mellen Press, 2005).

[3] See e.g. McMillan, John, John Whalley and Lijing Zhu, "The Impact of China's Economic Reforms on Agricultural Productivity Growth," *Journal of Political Economy* 97/4 (1989): 781–807; Lin, Justin Y., "Rural Reforms and Agricultural Growth in China," *American Economic Review* 82/1 (1992): 34–51.

[4] White, Gordon, *The Road to Crisis: The Chinese State in the Era of Economic Reform* (London: Macmillan, 1991).

[5] Fan, Qimiao and Peter Nolan (eds), *China's Economic Reforms: The Costs and Benefits of Incrementalism* (Basingstoke: Macmillan Press, 1994).

It was a mammoth task. Under Maoism, food supply in the urban sector was heavily protected by the state. Urban food was strictly rationed at artificially low prices, sometimes even lower than the production cost. A direct consequence was the stifling of all state procurement prices for rural products which in turn stagnated the incentives, growth and development of the farming sector;[6] not to mention the unprecedented famine in peace time and with good weather during the late 1950s and early 60s.[7] In this context, the Maoist state acted as *the* sole food dealer between the food consumers and producers, and between the urban and rural sectors. Prices, if any, were used for accounting purposes only, as the consumer had no power to decide how much to eat and what to eat, while the producer was not allowed to decide when and where to grow what food, for whom, and by how much.

Deng Xiaoping's reforms endorsed the incentives of producers in the farming sector. This was achieved by the implementation of the "household contractual production responsibility system" (*jiating shengchan chengbao zeren zhi*) in the early 1980s, which empowered the producers for the first time since the communist takeover in 1949. Overnight, the peasantry became price sensitive again like their ancestors, ready for marketisation of rural produce.

There was however a caveat: a three-decade-long exploitative and harsh "food dictatorship" that was adopted by Mao from Lenin to squeeze as much surplus food as possible from the peasantry.[8] This led to a chronic farming recession to threaten China's food security (see Table 1). Any reduction in food prices would cause an even deeper recession in the farming sector. In other words, the revitalisation of China's agriculture after Maoist mismanagement necessitated higher food prices.

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[6] Deng, Kent G., *China's Political Economy in Modern Times: Changes and Economic Consequences, 1800–2000* (London: Routledge Press, 2011), pp. 128–40; Deng, Kent G., *Mapping China's Growth and Development in the Long Run, 221 BC to 2020* (London: World Scientific Press and Imperial College Press, 2015), pp. 157–61.

[7] Dikötter, Frank, *Mao's Great Famine: The History of China's Most Devastating Catastrophe, 1958-1962* (London: Bloomsbury Press, 2010).

[8] For "Food dictatorship" see Ryan, James, *Lenin's Terror, the Ideological Origin of Early Soviet State Violence* (London: Routledge Press, 2012), pp. 101–22.

Table 1. Internal Food Import-Export Balance under Maoism (10,000 tons)

	South China (1)	North China (2)	China's total (3)
Pre-collectivisation			
1953–5	688.5	204.3	892.8
Post-collectivisation			
1956–60	1,950.5	–472.0	1,478.5
1961–5	669.5	–2,013.5	–1,344.0
1966–70	942.0	–796.5	145.5
1971–5	952.5	–1,159.0	–206.5
1976–8	–22.8	–1,106.4	–1,129.2

Source: Based on Contemporary Agricultural History Study Group, Rural Economy Institute, Ministry of Agriculture (eds), *Dangdai Zhongguo Nongye Biange Yu Fazhan Yanjiu* (*A Study of Agricultural Reforms and Development in Contemporary China*) (Beijing: China's Agriculture Press, 1998), pp. 251.
Note: Negative figures mean food imports to bridge domestic food deficits.

There was, however, an institutional asymmetry. The consumers in urban China, accounting for about 20 percent of the country's population, were not yet ready for the market for food. Despite the government commitment to "forced industrialisation" which seemingly favoured the urban working class,[9] Maoism systematically halved China's urban real wages.[10] So, the "living wage" under Mao was built in name. As a result, even with government subsidies, urban food consumption had to be strictly rationed, or a famine would sweep across Chinese cities. Fundamentally, this combination of food-ration and food subsidies was determined by the absence of a labour market that set urban living wages at a market rate. As the re-establishment of an urban labour market appeared much later, food-rationing and food subsidies in the urban sector – the signature pattern of resource allocation under the Soviet central planning – had to continue. Low food prices were politically safe for the state.

[9] For the term, see Spulber, Nicolas, *Organizational Alternatives in Soviet-type Economies* (Cambridge: Cambridge University Press, 1979), pp. 209–16.

[10] Deng, Kent G., *Mapping China's Growth and Development in the Long Run, 221 BC to 2020* (London: World Scientific Press and Imperial College Press, 2015), pp. 168–9.

Consequently, although rural producers began to react to the price signal from the food market, urban consumers still responded to non-market signals of rations and subsidies. This rural-urban dichotomy and mismatch was responsible for "dual prices" for the same commodity (*shuangchong jiage*), as a result of different paces of reforms in the two key sectors of the economy.

It was now up to the post-Mao reformist state to somehow bridge the two sides of supply versus demand which represented two fundamentally different economies: an increasingly marketised economy and a moribund planned economy. It was a tall order. The reformist state acted as *the* "substitute for the missing market" *à la* Alexander Gerschenkron.[11] Its role was three-fold: (1) to create the price signal for the newly emerged market economy in the rural sector, (2) to fade out gradually the failed planned economy in the urban sector in conjunction with the re-establishment of an urban labour market with a real living wage at a market rate, and (3) to obtain food security for the country as a whole. These three major tasks were not always compatible with one another, which was the root cause of the government food policy swings during the period in question.

In the very beginning, such a "Gerschenkron state" acted as a price-giver for both the demand and supply sides. For the rural price-taking producers and urban price-taking consumers, the state represented the "proxy market demand" for food and the "proxy market supply" to distribute the same food. Both rural producers and urban consumers relied on the state prices to make choices and decisions. In such a system, it was not just a zero-sum game between the rural and urban sectors. If the procurement prices were set too low, the case shrank. So, China's annual aggregate food output, and hence food availability and food security for China, was at the mercy of the state monopsonic prices for rural output.

Technically speaking, the state was an arbitrager between the two sides but it was by no means a rent-seeker. Rather, as we will show, the state lost money in its arbitraging.

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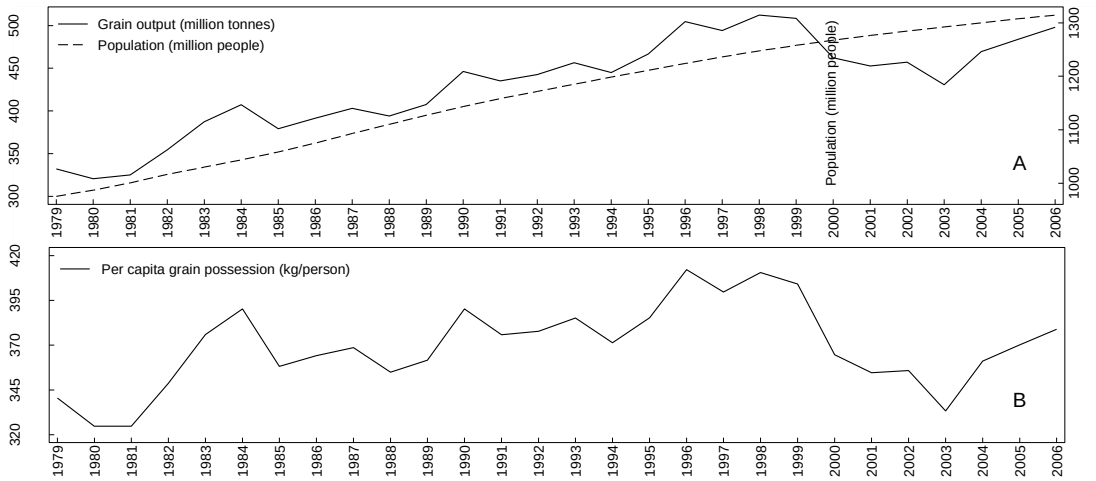
[11] Alexander Gerschenkron, *Economic Backwardness in Historical Perspective* (Cambridge: Harvard University Press, 1962).

The current study reveals that it is an illusion that with all the resources it controlled, China's almighty party-state was fully capable of assuring the country's food security with ease. This was not the case. As far as one can tell, China's food security was not that secure during the period in question. For the years 1983–95, China's grain output grew merely in pace with its population. Although food supply increased ahead of the population during 1996–9, it fell behind population growth in the period 2000–6 (see Figure 1-A). China's per capita food fluctuated violently, meaning that the country's food security was sometimes in jeopardy (see Figure 1).

Figure 1. Fluctuations in Food Output and Per Capita Food Stock, 1979–2006



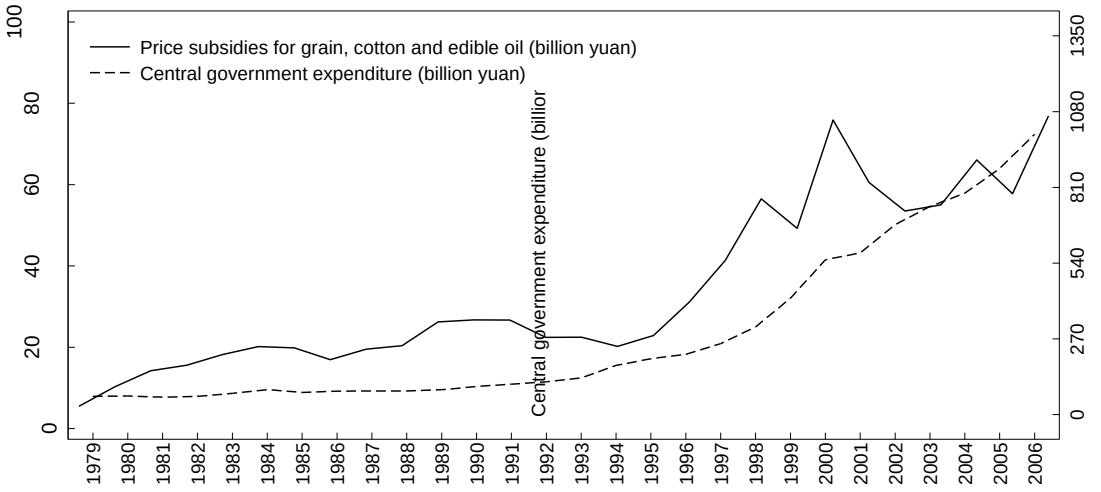
Source: National Bureau of Statistics, *Zhongguo Tongji Nianjian* (*China Statistical Yearbook*) (Beijing: China's Statistics Press, 1981–2007).

The deep reason lies in the budget constraint faced by the Gerschenkron state. The budget available directly impacted on the food stock produced by the rural sector: a larger food procurement budget allowed a higher monopsonic price and hence lured the peasantry to produce more food stock for the country; and *vice versa*. Assuming all individual farmers were rational economic agents who made their production decisions according to their expected future revenue from their grain sales,[12] it was the responsibility of the monopsonic state to set the "right price" for food. Meanwhile, urban labour market reforms turned out to be slow

[12] Schultz, Theodore W., *Transforming Traditional Agriculture* (New Haven: Yale University Press, 1964).

and apathetic, which forced the government to spend more on urban food subsidies rather than reducing them (see Figure 2). So, in both circumstances the "right price" depended on the depth of the government pocket to pay,[13] *ceteris paribus*. If so, the issue of budget constraint loomed large.

Figure 2. Urban Food Price Subsidies and Government Food Expenditure



Source: Ministry of Finance, *Zhongguo Caizheng Nianjian* (*Finance Yearbook of China*) (Beijing: China's Finance Magazine, 1991–2007).

Our study is inspired by economists who link Chinese agriculture to government food policies, and food security.[14] The existing literature usually

[13] Here, the Chinese state did not behave like a "developmental state" that purposely "gets the prices wrong" in order to change the growth trajectory of the economy; see Amsden, Alice H, *Asia's Next Giant* (New York: Oxford University Press, 1989), p. 139. Rather, the main concern was how to "get the prices right" for China's food security.

[14] E.g. Kueh, Y. Y., "China's New Agricultural-Policy Program: Major Economic Consequences, 1979–83," *Journal of Comparative Economics*. 8/4 (1984): 353–75; Ash, Robert F., "The Evolution of Agricultural Policy," *China Quarterly* 116 (1988): 529–55; and his "The Peasant and the State," *China Quarterly* 127 (1991): 493–526; Lin, Justin Y., "An Economic Theory of Institutional Change: Induced and Imposed Change," *Cato Journal* 9 (1989): 1–33; and his "Rural Reforms and Agricultural Growth in China," *American Economic Review* 82/1 (1992): 34–51; Sicular, Terry, "Redefining State, Plan, and Market: China's Reforms in Agricultural Commerce," *China Quarterly* 144 (1995): 1020–46; Huang, Jikun and Scott Rozelle, "Technological Change: Rediscovering the Engine of Productivity Growth in China's Rural Economy," *Journal of Development Economics* 49/2 (1996): 337–69; Fan, Shenggen, "Technological Change, Technical and Allocative Efficiency in Chinese Agriculture: the Case of Rice Production in Jiangsu," *Journal of International Development* 12/1 (2000): 1–12.

assesses China's food policies with various output data. Such an approach commonly refers to farming inputs such as new chemical fertilizers,[15] new seed varieties,[16] better irrigation and farming machinery.[17] These inputs are quantified in physical terms. Unlike physical inputs, institutions and their effects are not always quantifiable. Thus, input-output analysis is routinely conducted as a proxy for any institution-output inquiry.[18] The challenge is whether the input-output proxy is able to reveal the mechanisms with which institutions influence producers' incentives and decisions and by how much. So far, few studies have paid sufficient attention to how government price policies impacted on China's food output, urban wage bill and national food security. This work fills in this gap in scholarship.

Our source of information comes mainly from decrees and regulations of the central government in Beijing. The government motives fell into two main categories: monopsonic availability and fiscal affordability. Due to data availability,[19] our observations are made for the period from 1979 to 2006 when China moved step by step towards marketisation of food, including procurement pricing (1979), bilateral contractual procurement (1984), abolition of urban grain rationing (1993), new regulations on procurement fund (1995–6), grain bureau

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[15] See Fan (2000), and Ma, Nathaniel, Peter Calkins and Johnson Stanley, "Technological and Allocative Efficiency vs. Equity in Shuyang County, Jiangsu: General Household vs. Specialized Households," in John Longworth (eds), *China's Rural Development Miracle: with International Comparisons* (St Lucia, Queensland: University of Queensland Press, 1989).

[16] Lin, Justin Y., "The Household Responsibility System Reform and the Adoption of Hybrid Rice in China," *Journal of Development Economics* 36/2 (1991): 353-72; Lin, "Rural Reforms and Agricultural Growth;" Jin, Songqing, Hengyun Ma, Jikun Huang, Ruifa Hu and Scott Rozelle, "Productivity, Efficiency and Technical Change: Measuring the Performance of China's Transforming Agriculture," *Journal of Productivity Analysis* 33 (2010): 191–207.

[17] Yao, Shujie and Zinan Liu, "Determinants of Grain Production and Technological Efficiency in China," *Journal of Agricultural Economics* 49/2 (1998): 171–84.

[18] Huang, Jikun and Scott Rozelle, "Technological Change: Rediscovering the Engine of Productivity Growth in China's Rural Economy," *Journal of Development Economics* 49/2 (1996): 337–69; Lin, "An Economic Theory;" his "Rural Reforms and Agricultural Growth;" Fan, Shenggen, "Effects of Technological Change and Institutional Reform on Production Growth in Chinese Agriculture," *American Journal of Agricultural Economics* 73 (1991): 266–75.

[19] For example, urban subsidy on grain, cotton and edible oil data stops at the year of 2006.

deregulation (1998), and grain market liberalization (2004). We also notice that specific policies appeared in cluster (e.g. urban subsidies during 1990–3, grain procurement during 1995–7, and the grain bureau reforms during 1998–2003).

Methodologically, we build a time series dataset of annual changes in grain output, food procurement price and the central government expenditure for 1979 to 2006. We use the Granger causality method to see if the relationship between food output and government expenditure was causal. Moreover, we adopt an unrestricted vector autoregression (VAR) approach to detect the link between food policies and food output. We also check whether the link we detect econometrically matches the historical reality. Our results show that food output in China was causally determined by government capacity to pay for food. Government policies enhanced farmers' physical inputs in food production, as government monopsonic price was positively reflected in grain production in a lagged term. This was the endeavour to get the food price right.

There was however a conflict between state monopsony and national food security. Each time food output peaked and hence increased national food supply, the increased procurement costs pushed policy–makers to tighten food price control and reverse the increased output which in turn put China's food security in jeopardy, also part of the endeavour to get the food price right.

This article is organised as follows: Section I provides an overview of the Chinese government dealing with food supply and food security. Section II is devoted to methodology and empirical results. Section III discusses rationales of government policies and their changes. Section IV simulates the central policy–making procedure, and section V contains the final conclusions.

II. Policy Determinants

Due to the availability of data, our observations allow for 12 time series, six for grain production, five for fiscal conditions of the central government, and one for inflation. The time period chosen covers the years 1979 to 2006. The starting year marks the beginning of Deng Xiaoping's reforms. After 2006, China had undergone fully-fledged marketisation; the mission of the Gerschenkron state was accomplished.

Most data for this research come from *China's Statistical Yearbooks* and

Finance Yearbooks of China. National statistics in post-Mao China are not perfect but serve as a "good enough" source of information regarding challenges and concerns faced by China's decision-makers. The data extracted from these yearbooks include (1) a change rate of deflated (and hence real) expenditure of the central government eG_t, measured by nominal central government expenditure divided by inflation rate (consumer price index, hereafter CPI), (2) a change rate of grain output Y_t^g, as a proxy of China's national food security.[20]

Our premise is that in a transition from the Soviet economy to a market economy, China's Gerschenkron state needed a sizable budget to create semi-market incentives for the peasantry to produce more and better as well as to warrant the urban industrial class its basic needs. In this context, the government food procurement prices determined China's grain production for the subsequent year, which in turn determined China's national food security. Meanwhile, it is known that the food price offered by government grain procurement was subject to the government fiscal capacity. A Granger-causality test indeed shows the interrelation between the central government fiscal expenditure and the grain output from 1979 to 2006. Table 2 presents our results.[21]

Table 2. Granger Causality Test between Central Government Fiscal Capacity and Grain Output, 1979–2006

Unit root test (Part One)	Level (*t*-statistics)		
Variables	(1)	(2)	(3)
Y_t^g	–5.4190***	–5.3955***	–5.0166***
eG_t	–3.1390**	–3.8819**	–2.9279***
Granger-causality test (Part Two)			
Null hypothesis	Obs	*F*-statistic	*P*-value
eG_t does not cause Y_t^g	27	10.1025	0.0040***
Y_t^g does not cause eG_t		0.2386	0.6296

Note: In the augmented Dickey-Fuller (ADF) unit root test, all three model specifications (1) with constant only, (2) with constant and time trend, and (3) with no constant or tend are included; the lag order is chosen, based on the Schwarz Criterion (SC); ***, ** and * indicate statistical significance at

[20] In addition to grain output, we also run the same test against the change rate of rice output Y_t^r in the Appendix A. Results show the same.

[21] Detailed empirical model and testing results are presented in Appendix A.

the 1%, 5% and 10% levels respectively.

Our results of unit root test imply that all variables are stationary at levels (Table 2, Part One); hence the Granger causality test for statistical significance of lagged level terms can be used. The causality test results are reported in Part Two of Table 2 where the computed *F*-statistics show that sequential unidirectional causality is significant. The *p*-value shows whether the null hypothesis can be rejected. The result from eG_t to Y_t^g is significant. So, the Granger causality is unidirectional from the real central government expenditure to farmers' grain production for the next production cycle.

In reality, the Gerschenkron state had its limits. Every time food procurement pressure on the government budget became too high, China's policy-makers opted for deregulation to avoid a fiscal crisis. In doing so, the government either procured less grain or offered a lower price, or did a bit of both. Changes in government procurement were communicated to the farmers, which in turn reduced China's food output and national food security in the following year. The alarm was then raised by the watchdog the National Statistical Bureau and the government had to reverse its price policy. This is demonstrated by a government food policies chronicle from 1979 to 2006.

Table 3 shows changes in food policies in three categories.[22] Price control was the main concern from 1979 to 1988. It was replaced by urban food subsidies from 1989 to 1993, and then grain procurement fund and grain bureaus during 1994 to 2003. Noticeably, each category coincided with a grain production cycle. Did these policy switches lead to changes in grain production?

Table 3. Changes in Food Production, Food Security and Food Prices, 1979–2006

Year	Production turning points (million tons)	Average growth rate [a]	Key changes	Policy package
1979–84	↗ 407 (max, 1984)	5.1%	Increasing the "quota price" by 20% and the "above quota price" by 50%	

[22] To show policy bias, we identify two types: fiscal policies and monopsony policies. Government monopsony is further specified in terms of pricing, subsidies, procurement fund and grain enterprise power. See Table A6 for detail.

			(1979) (P); facing budget deficits (1982) (F)	
1985–8	↘ 379 (min, 1985)	–0.7%	Reversing 30:70 ratio (1985) (P)	Reducing prices
1989–90	↗ 446 (max, 1990)	6.5%	Reforming state procurement (1990) (M); increasing the grain rationing price (1991) (S); purchasing and selling at the same price (1992) (S)	Reducing urban subsidies
1991–3	→ 435 (min, 1991)	0.8%	Allowing private traders to trade agricultural products (1993) (M); abolishing urban grain coupon system (1993) (S)	Ending urban grain-rationing
1994–8	↗ 512 (max, 1998)	2.4%	Withholding accounts and suspending interests (1994) (F); reforming grain purchase fund (1998) (G); reforming the Grain Bureau (1998) (G)	Reforming procurement fund and the Grain Bureau
1999–2003	↘ 430 (min, 2003)	–3.3%	Liberalizing the grain trade (2003) (M)	Ending monopsony
2004–6	↗ 498 (max, 2006)	5.0%	Withdrawing pricing rights from grain enterprises (2004) (G); abolishing the agricultural tax (2004–05) (M)	Marketising the food sector

Note: [a] Average growth rate of rice output is calculated as the average value of annual growth rate compared with the output level in the preceding year.
Sources: See Tables A6 and A7.

To test this interaction in food policies, we employ the unrestricted VAR model. Upon the policy changes shown in Table 3, three new variables are added for regressions: (1) government rice procurement price index, (2) urban subsidy index for cotton and edible oil and grain, and (3) government procurement fund index, all in real terms.[23] The VAR testing aims to see if government monopsony-related policies individually or jointly caused grain production to change in order to establish a link between farmers' producing behaviour seen from a change in physical inputs following the government policy swing. To further look into the impulse-leading-responses of China's food production to

[23] Unfortunately, the data for the grain bureau deficits are available only from 1998 to 2006. We omit the data and instead use grain procurement fund for the test.

shocks from each individual determinant, we use year-on-year change rates of variables (denoted as $Y_t^g, L_t, K_t, F_t, T_t, eP_t, eS_t, eR_t$) as estimators in the model (see Appendix B for detail). All the variables are stationary at levels, $I(0)$.[24] Empirical observations show that policies impacted on farmers' production expectations for one to two years in the future.

After minimising testing statistics, two-lag length is used on each variable to secure the whiteness of residuals. To do so, we run the regression without policy variables first to test input-led output changes only. The results are reported in Column 1 of Table 4. After three policy variables are introduced, the fitness of regression R^2 increases from 0.52 to 0.86. It thus conforms that policy changes increased the significance of physical inputs (Table 4 Column 2 and Column 4).[25]

However, one of the health diagnostic checks on residual shows heteroskedasticity.[26] Weighted Least Squares (WLS) is used to address this problem (Column 4 and Column 5). The results are significant at the five percent level or higher, derived either from the procurement price index (eP_t) or from the procurement fund (eR_t). Furthermore, we test the joint-causality of all three policy variables together. The results are significant at a 99 percent level (Columns 3 and 5).[27]

In addition, the VAR test reveals a long-term equilibrium between China's national grain output on the one hand and the government procurement price/fund in the preceding year on the other. Although the variable for urban food subsidies (eS_t) is not individually significant in either the Ordinary Least Square (OLS) or the WLS tests, eP_t, eS_t and eR_t jointly influence the grain output in the future one to two years with an above-95 percent level of

[24] See Appendix B for detail.

[25] Intuitively, resource inputs such as fertilizer were insignificant for the long-run agricultural output. However, Fan Shenggen found that fertilizer was only an important input at early stages of China's reforms before 1985; see Fan, "Technological Change." Our testing result conforms this, i.e. when observations are extended to a longer period, the significance of fertilizer was critically reduced in grain production.

[26] Our model passed ARCH heteroskedasticity check but not Breusch-Pagan-Godfrey test. To make sure the power of regression, we use the WLS to further correct the heteroskedasticity. See Appendix B for detail.

[27] For diagnostic check of the system equation and regression residuals; see Appendix II for detail.

significance. Empirically, this result is reasonable since urban food subsidy was most effective from 1979 to 1993.

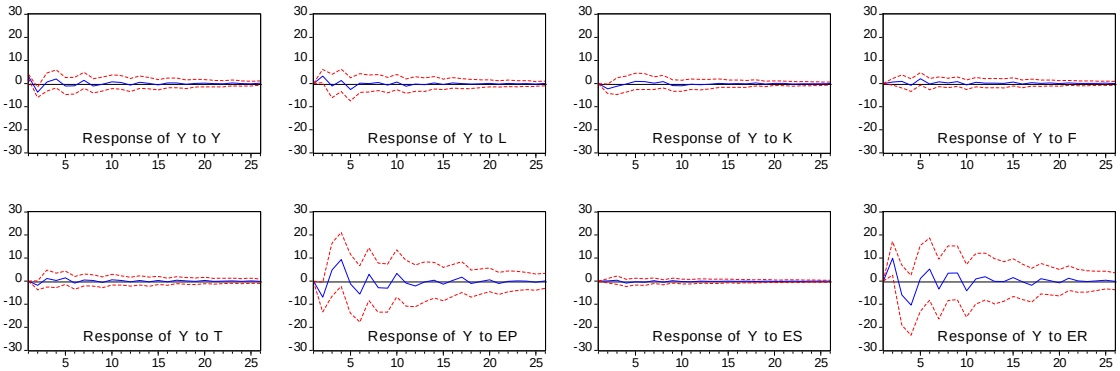
The Wald joint causality testing result further confirms the impact of policy changes (eP_t, eS_t and eR_t) shown in Table 4 (Columns 3 and 5).

Table 4. Unrestricted VAR of Grain Output on Inputs and Policy Variables, 1979–2006

	OLS			WLS	
	Grain output	*Grain output*	*Grain output Wald test (Chi-square)*	*Grain output*	*Grain output Wald test (Chi-square)*
Variables	(1)	(2)	(3)	(4)	(5)
Grain output (–1) (Y_{t-1}^{g})	–0.29 (1.01)	–1.22 (-3.82) ***		-1.21 (-6.50) ***	
Grain output (–2) (Y_{t-2}^{g})	0.12 (0.43)	–0.70 (-1.82)		-0.70 (-3.10) **	
Labour (–1) (L_{t-1})	1.25 (1.42)	1.80 (2.36) **		1.80 (4.01) ***	
Labour (–2) (L_{t-2})	–0.26 (-0.33)	–1.20 (-1.54)		-1.19 (-2.62) **	
Land (–1) (K_{t-1})	–1.05 (-1.17)	–1.75 (2.42) **		-1.75 (-4.12) ***	
Land (–2) (K_{t-2})	–2.61 (-2.34) **	–2.14 (-2.31) **		-2.14 (-3.92) ***	
Fertilizer (–1) (F_{t-1})	0.29 (0.81)	0.26 (0.87)		0.26 (1.47)	
Fertilizer (–2) (F_{t-2})	–0.05 (-0.15)	0.18 (0.67)		0.18 (1.13)	
Machine(–1) (T_{t-1})	–0.72 (-1.16)	–1.21 (1.94) *		-1.21 (-3.30) ***	
Machine (–2) (T_{t-2})	–0.23 (-0.47)	–0.33 (0.63)		-0.33 (-1.06)	
Procurement price (–1) (eP_{t-1})		–0.70 (-2.30) **		-0.70 (-3.91) ***	
Procurement price (–2) (eP_{t-2})		–1.36 (-3.87) ***		-1.35 (-6.59) ***	
Urban subsidy (–1) (eS_{t-1})		0.02 (0.18)		0.01 (0.30)	
Urban subsidy (–2) (eS_{t-2})		–0.00 (-0.22)	22.21***	-0.00 (-0.37)	64.17***
Grain procurement fund (–1) (eR_{t-1})		0.80 (2.91) **		0.80 (4.95) ***	
Grain procurement fund (–2) (eR_{t-2})		1.24 (3.90) ***		1.24 (6.63) ***	
Constant	9.95 (2.17) **	13.38 (2.70) **		13.38 (4.60) ***	
Observations	26	26		26	
R^2	0.52	0.86		0.86	
Serial correlation [a]		0.90 [0.45]			
Heteroscedasticity [b]		0.23 [0.64]			
Normality [c]		0.38 [0.83]			
Stability [d]		Stable			

Notes: [a] Breusch-Godfrey serial correlation LM test; [b] Auto-regressive conditional heteroscedasticity (ARCH) test; [c] Jacque-Bera normality test; [d] Cumulative sum of recursive residuals (CUSUM) test; The *t*-statistics for variables are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

Figure 3. Impulse Responses in the Production-Inputs-Policy VAR



Note: The shock corresponds to one standard deviation of the residual in each variable.

Our impulse-responses' results demonstrate the findings in VAR regression from the view of each individual variable (Figure 3). The unilateral changes in government grain procurement price and grain purchase fund caused long-run volatile fluctuations in food production. But response to changes in food subsidies was weak. Interestingly, in contrast to the regression result, food production returned quickly to equilibrium from shocks to non-policy variables, which indicates that China's agricultural technology was advanced enough to cope with shocks to physical inputs for food production. Compared with physical inputs, food production in China was more sensitive to policy changes.

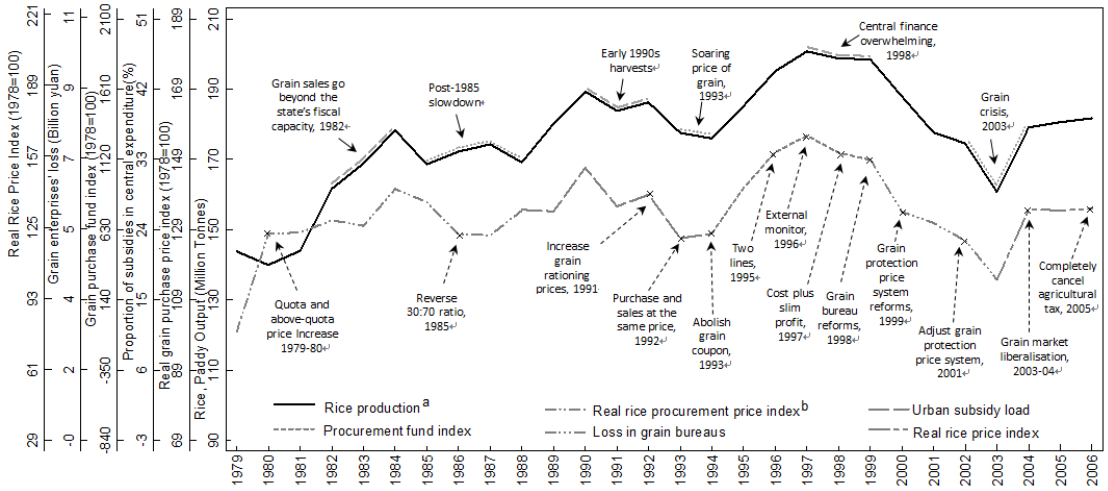
What can be argued from the above empirical results is that output fluctuations in China's food production were a result of the government food policy swings that were ultimately determined by the "visible hand" of the Gerschenkron state that aimed to guide the economy towards a simulated, price based market signal system. Eventually, the state trained the peasantry to read the price signals and at the same time weaned the urban consumers from generous food subsidies to allow them to face the market. In the end the "visible hand" withdrew, as intended.

III. Changes in Policies and Food Production

The causal relationship identified in Section II is further supported by evidence shown in Figure 4 where the policy curve (lower curve) shows (1) the 1979–88 procurement price data, (2) the 1989–93 food subsidy data, (3) the 1994–7 rice budget data, (4) the 1998–2003 data for business loss of government grain

bureaus, and (5) the 2004–6 price index data.[28] Considering the lag in the empirical model, we move the policy curve one year to the right. Changes in food production mirror the trend of policy changes.

Figure 4. Changes in Policies and Food Security, 1979–2006



Note: [a] [b] The rice procurement price index excludes the weight of the current year's consumer price index.

Source: National Bureau of Statistics, *Zhongguo Tongji Nianjian* (*China Statistical Yearbook*) (Beijing: China's Statistics Press, 1981–2013); Ministry of Finance, *Zhongguo Caizheng Nianjian* (*Finance Yearbook of China*) (Beijing: China's Finance Press, 1991–2013); National Bureau of Statistics, *Zhongguo Jiage Tongji Nianjian* (*China Price Statistical Yearbook*) (Beijing: China's Statistics Press, 1981–2013); Ministry of Agriculture, *Zhongguo Nongye Nianjian* (*China Agriculture Yearbook*) (Beijing: China's Agriculture Press, 1980–2013).

Along the lower curve, the first round of reforms took place in 1979 to 1988 to boost grain output with an increase in government "procurement quota pricing" (*tonggou jia*) and "above-quota bonus pricing" (*chaogou jia*) in order to nurture the market for the rural sector for the first time after China's chronic food shortage under Mao's collectivisation. In accordance with the 1979 Decisions of the Fourth Plenary Session of the Eleventh Chinese Communist Party Central Committee (CCPCC), the government procurement price for grain increased 50–80 percent. The peasantry responded. From 1979 to 1984, China enjoyed successive bumper harvests, with an annual growth rate of 5.1 percent. The rice output increased 30.2 percent from the 1978 level, and wheat, 63.1 percent.

[28] Data for government grain bureau deficits are available only for 1997 to 2003.

Such a rise in total food output in conjunction with higher procurement prices led to government's fiscal difficulty. It is stated in Document No. 137 issued in 1982 by the CCPCC that the sharp increase in the grain sales has exceeded the state's fiscal capacity. This can only be understood in conjunction with China's urban food subsidies which prevented the government from recouping its grain procurement costs. At that time, to deregulate urban food pricing seems to have been politically dangerous. The government's only option was to reduce its procurement price for the peasantry. The new pricing policy was called the "reversed 30:70 ratio" (*dao san qi*) announced in 1985.[29] The rice procurement price was cut by 6.9 percent in 1986. This unilateral change reversed the growth momentum in grain production: wheat output fell 10.3 percent, and China's aggregate grain output declined 0.7 percent in response to the new pricing. Clearly, the Chinese peasantry became market-price literate. Nevertheless, this drop threatened China's national food security.

To rescue food security, the government introduced stimuli.[30] China's grain production again responded. In 1990, the total outputs of rice and wheat reached their highest level since 1949. China's total rice output in 1990 was 189.33 million tonnes, 11.1 million tonnes higher than the previous peak in 1984 and about 40 percent higher than in 1978 when reforms began. China's wheat output reached 98.2 million tonnes in 1990, an increase of over 80 percent from the level of 1978. The government had to buy in more food thanks to its food monopsony despite its unchanged urban monopolistic sale price of grain, which

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[29] This means that 30 percent of the government procurement price was subject to a lowered baseline and 70 percent of government procurement price fetched a bonus price of 50 percent higher than the baseline price. Overall, the government procurement price increased 135 percent from the 1984 level. The calculation is as follows:

$$\begin{aligned} ProcurementPrice_{1985} &= 30\% \cdot QuotaPrice_{1984} + 70\% \cdot AboveQuotaPrice_{1984} \\ &= 30\% \cdot QuotaPrice_{1984} + 70\% \cdot (150\% \cdot QuotaPrice_{1984}) \\ &= 135\% \cdot QuotaPrice_{1984} \end{aligned}$$

In CCPCC 1 (1985), the state also imposed a "protected price" (*baohu jia*) equal to the preceding year's quota price. Such a price was lower than the baseline price. The policy had a negative influence on farmers' production incentives.

[30] The policy linked production to the provision of subsidized chemical fertilizers (*pingjia huafei*) and diesel oil for farming machines.

meant an increasing budget burden for the state.[31] As Figure 2 shows, the urban food subsidies amounted for 22.4 billion yuan, or a quarter of the central government average revenue of the time.

This ushered in the second round of reforms in 1989 to 1993 (Table 3 and Figure 4). In 1991, the central government reduced urban food subsidies as a way to introduce the market to the urban consumers. A mere year later, a new "one price" policy, or "purchasing and selling grain at the same price" (*gouxiao tongjia*), was attempted to eradicate urban food subsidies completely. A new law was passed in 1993 to address this issue.[32] The share of the urban food subsidies in central government budget spending soon plummeted from 23.5 percent in 1993 to 7.0 percent in 1994.

Soon after the grain deregulation, the urban grain price rose sharply,[33] jeopardising social stability in urban China. It forced the central government to resume monopsony over grain, leading to the third round of policy changes. Predictably, the grain monopsony returned, as too did the pressure on government finance. Then, in 1995 the State Council tightened the grain procurement budget.[34] The central government also commissioned the Agricultural Development Bank of China to manage its grain procurement budget.[35] But the government grain-cum-deficits kept increasing over the five consecutive years from 1994 to 1998 (Figure 4).[36] According to State Council

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[31] This is known as the "inversed urban-rural prices for grain" (*chengxiang liangshi gouxiao jiage daogua*), in which the rural procurement price was higher than the urban sale price.

[32] See Chapter 4 "Agriculture Product Circulation" in the *1993 Agriculture Law*.

[33] Compared with the previous year, the 1993 and 1994 CPI increased by 14.7 percent and 24.1 percent, respectively.

[34] In 1995, the State Council divided government grain bureaus' duties into two parts – "commercial transactions" (*jingying xing yewu*) and "policy-based transactions" (*zhengce xing yewu*), and made clear that commercial transactions should not use grain procurement budgets.

[35] According to the grain budget management rules established by Ministry of Finance 139 (1996), all "special funds for purchasing grain" (*gouliang zhuankuan*) must be jointly managed by the Agricultural Development Bank of China and the State Ministry of Finance.

[36] According to Liu *et al* (2004), the grain-cum-deficits in the grain bureaus had rapidly increased to 120 billion yuan by 1998, or 100 million yuan per day; see Liu, Bin, Zhaogang Zhang and Gong Huo, *Zhongguo Sannong Wenti Baogao* (*Report on China's Farming, Countryside and Peasantry Issues*) (Beijing: China's Development Press, 2004).

Document No.15 (1998), the cost of grain overwhelmed the government finance.[37]

Against this backdrop, a new round of reforms were kick started.[38] From 1998, as part of the marketisation reforms the state-owned grain bureaus were made financially independent.[39] Meanwhile, the State Council's Decree No. 244 (1998) imposed a new principle of "selling grain at a favourable price" (*shunjia xiaoshou*) to recoup the monopsonic procurement cost. This could only mean a price drop in government procurement prices for farmers. It ushered in China's largest trough in food output from 1999 until 2003, which forced the central policy-maker to abandon grain monopsony after 2004.

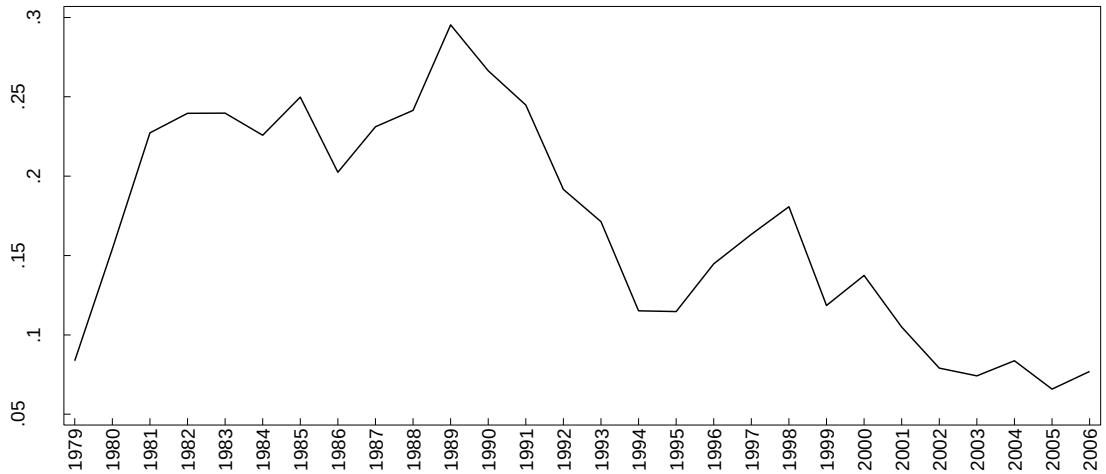
In a nutshell, in the process of re-establishing the market for agriculture, a high government procurement price warranted more food output and hence better food security; and a low food price helped the urban consumers with their living standards. The Gerschenkron state had to strike a balance between the two sectors and gradually introduced the market to both sectors. The state gradually and successfully exited from the food market. Figure 5 illustrates the general trend.

Figure 5. Reduction of Government Involvement to Give Way to the Market

[37] The major focus of the State Council of People's Republic of China Document No. 15 (1998) (hereafter SCPRC 15 (1998)) was on how to control grain bureaus' deficits. For the first time the state asked all grain bureaus to conduct independent accounting. The central finance was no longer willing to pay the deficits. SCPRC 15 (1998).

[38] First, in 1997 the state announced a new guideline for grain bureaus as "cost plus slim profit" (*baoben weili*). This principle signalled that the government selling price should bring back a profit.

[39] SCPRC 15 (1998) separated grain procurement and storage enterprises from grain bureaus to better control deficits. SCPRC 15 (1998).



Source: The same as Figure 2.

IV. Conceptual Framework for Policy Choices

To understand the policy-maker's choices, firstly, we assume that farmers always respond to the price signal regardless of whether it is a market price or government monopsonic price, and hence:

$$Y = Y(P),$$

Where Y is positively related to the price level, i.e. $Y'(P) > 0$.

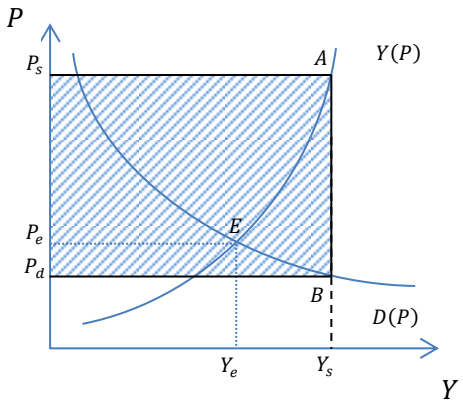
Secondly, the leading price is the state monopsonic price P_s, determined by the central government's fiscal affordability:

$$P_s = P_e + P_g.$$

Where P_e represents the market equilibrium price; and P_g is the overpriced portion caused by the government output-promotion monopsonic price during the period when food shortage looms large. Both P_e and P_s satisfy $P_e > 0$, $P_s > 0$. When the government procurement price is not the same as the equilibrium level, $P_s \neq P_e$, $P_g \neq 0$, the market clearance level under the government influence becomes $Y_s = Y(P_e + P_g)$, where Y_s differs from the market equilibrium level Y_e, which is free from government influence.

Figure 6 presents the situation when the grain economy is under strict state monopsony. In order to keep the market at clearance levels, the government has to pay for the difference between the urban subsidised price P_d and the monopsonic price P_s. The distortion of the market can be measured by the grain output Y_s at a market clearance price P_d. The total grain subsidies equal to sY_s (ABP_dP_s), in which the rate of subsidies s is the difference between the procurement price and the market clearance price, i.e. $s = P_s - P_d$.

Figure 6. Grain Production under State Monopsony



From the viewpoint of the central government operation, the total expenditure on grain G is confined within the limit of $G \leq \bar{G}$. More specifically, G is determined by (1) the grain procurement cost (known also as the "grain procurement fund") $R = rP_sY$, where r denotes the interest rate in grain purchasing; (2) the urban price subsidies sY_s, and (3) the monopsony management cost $M(Y) = mY$. The government expenditure on grain can be presented as:

$$G = R + sY + M.$$

By the same token, to simulate central policy-making on food security, we assume that policy-makers have to solve a utility function with budget constraint:

$max\, U = \{min\, G, max\, Y\}$, subjected to $G \leq \bar{G}$.

The causality between government fiscal capacity and food production can be shown in two scenarios (see Appendix A). Scenario 1: fiscal expenditure does not cause output if G is not capped. When $\bar{G}$ is removed from decision-making, $max\, Y$ is no longer constrained. Then, policy-makers' target is simplified to solve a utility function with a minimal expenditure on grain:

$$max\, U = min\, G = min\{rPY + sY + mY\}.$$

Here, when the government fiscal capacity can afford all grain monopsony costs and at the same time delivers the desirable total output Y at any level, the government policy is simplified to the point of an increase in efficiency of the grain procurement fund and grain bureaus by reducing r and m, because, in reality, both r and m are irrelevant to grain output, only dependent on the governance quality of the grain regulator.

Moreover, when the total output is given exogenous $Y = Y_s$, the difference between the grain procurement price and the market clearance price s is also exogenous, as $s = P(Y_s) - P_d$. The central government has no impact on Y; and there is no causality from the central fiscal expenditure to food production when G is not capped:

$$max\, U = min\, G(r, m).$$

Scenario 2: fiscal expenditure causes output if it has an upper limit $G \leq \bar{G}$. If the grain procurement fund $R = rPY$ and administrative cost of monopsony $M(Y) = mY$ both satisfy $R'' > 0$ and $M'' > 0$, then $G''(Y) > 0$. Further, we assume central government's fiscal preference is linear or quasi-linear on increasing marginal cost, which means that the marginal grain output does not cause extra utility to the central government. Then we have:

$$max\, U = \{min\, G(Y), max\, Y\}, \text{ where } \quad G''(Y) > 0 \ \ and \ \ \ G \leq \bar{G}.$$

This means any increase in output potential, such as technical progress and demand changes, will increase government expenditure. If the central

government grain expenditure is bound to a fiscal capacity which is insufficient to fund grain monopsony, to maintain its overall utility the central government either depresses output Y, or reduces subsidy s and abandons $max\, Y$:

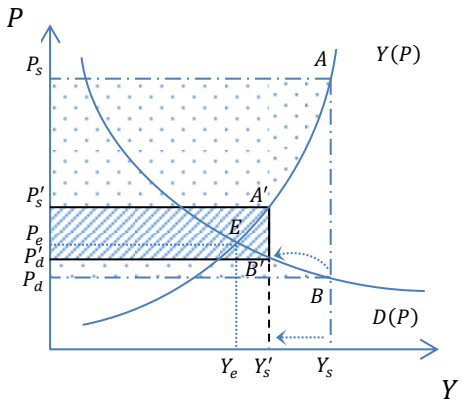
$max\, U = min\, G(s, P)$, where $G''(Y) > 0$ and $G \leq \bar{G}$.

As there exists a long-run unidirectional causal relationship from the central fiscal expenditure to the grain production (see Section II), it is reasonable to believe that China's food policy-making resembles Scenario 2. This *de facto* causality corroborates upper bounds $\bar{G}$ in the central government's fiscal load on grain monopsony to limit policy-maker's decision making, $G \leq \bar{G}$ (Proposition 1). Also, with the monopsony of grain, all government food policies eventually take effect through affecting the final grain output and supply Y_s (Proposition 2).

This framework captures the mechanisms of changes in policies and food output. Amongst all three major reasons for fiscal crises, grain procurement reforms are linked to procurement prices P_s, urban subsidies sY, grain procurement fund rPY and the power of grain bureaus $m(Y)$. This framework also explains why government policy reforms were not random but dictated by costs incurred by some specific choices.

Figure 7 demonstrates the mechanisms of changes. The policy-makers increased urban food price (1991) from P_d to P_d'. They then employed "one price for food" (1992), which reduced the rural procurement price P_s to P_s'. Both choices reduced the grain market clearance level. The result of capping grain subsidies capped grain output as well: when subsidies were narrowed from ABP_dP_s to $A'B'P_d'P_s'$, grain output declined from Y_s to Y_s'. But the urban selling price increased to P_d' with contractions in consumer's surplus and producer's surplus $BB'P_d'P_d$ and $AA'P_s'P_s$, respectively. The urban sector was finally ready for a full market price for food without hardships (the early 1990s,). The urban food subsidies were swiftly abandoned as a result.

Figure 7. Ending of Food Subsidies



With the abolition of the urban subsidy, the fiscal pressure was so greatly eased that the government had the resources to increase grain procurement funds and invest in grain bureaus. But when grain output reached historical heights in the mid-1990s, pressure on the government budget rocketed. At this point, the government expenditure function became $G = rPY + mY$, retaining only the grain procurement fund and cost of grain bureaus.

Figure 8. Grain Bureau Reforms

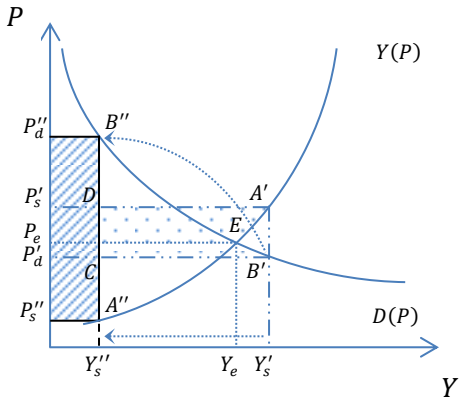


Figure 8 demonstrates a welfare loss to both the urban consumers and the rural producer due to grain bureaus' arbitrage. With arbitrage, urban grain price leaps to P_d'' plus a depressed grain procurement price P_s''. Grain bureaus make profit $A''B''P_d''P_s''$, which comes from the consumer's surplus and producer's surplus. Meanwhile, the grain output drops to Y_s''. A part of social welfare $A'EB'CD$ becomes the deadweight loss. This policy was not efficient during the 1994-2003 reforms. In 2003 the government terminated state grain monopsony

and arbitrage. The government-free market finally returned to China's food sector.

V. Conclusion

By establishing the causality from government fiscal capacity in Beijing to grain production in villages, this article reveals the mechanisms in which a "Gerschenkron state" acted as a proxy for the market by creating and sending the peasantry artificial price signals under a state monopsony on behalf of the demand side to generate food output from the supply side composed of more or less autonomous producers for a market.

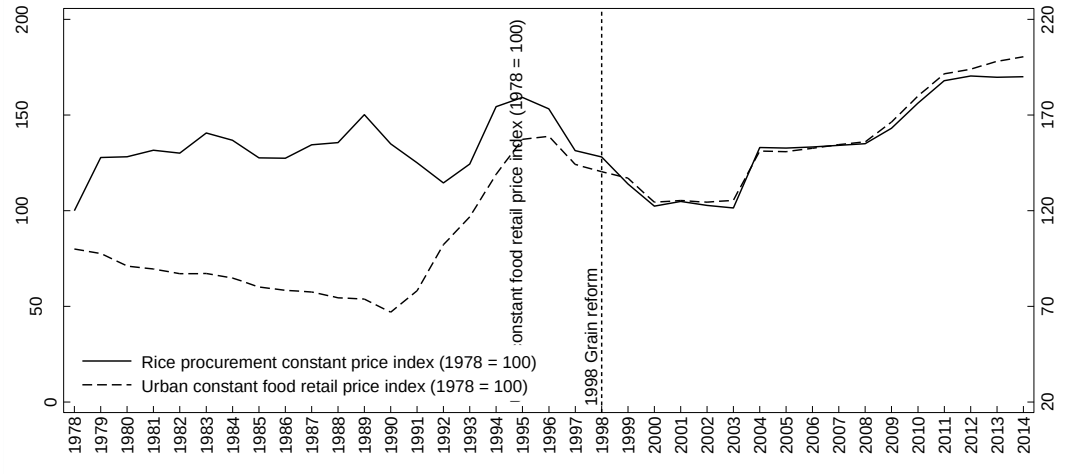
In particular, China's Gerschenkronian policies aimed to re-establish the market economy for food after 1979. But there was no market economy yet. The Gerschenkronian prices (either government procurement prices for the rural sector or government subsidised prices for the urban sector) served as a learning process for the economy to get used to resource allocation in a non-planned economy; a step towards revival of the market that was eliminated by the state after 1949. The challenge to the reformist state was how to get food prices right so that enough food was produced by the peasantry during the first stage of the post-Mao reforms when a functional market was long absent due to the Soviet system adopted by Maoist China.

The Gerschenkronian price signals were received positively by the rural producers. High procurement prices encouraged food supply in the next food production cycle and hence improved China's food security. But a low food price suited the urban sector that lived on government subsidies. The result was dual prices for the same food. The price gap had to be bridged by government fiscal capacity.

This nurturing and tutoring of the market by the state was largely a process of trial and error which in turn determined inevitable frequent changes to get the food prices "right" (meaning that the food market clears itself). Operationally, the state food monopsony caused policy swings, sometimes on a massive scale. Meanwhile, the new price-responsive food outputs fluctuated accordingly, which sometimes threatened China's food security in the short run.

Even so, the purpose was clear: to strike a balance between government grain procurement for the rural producers and affordable food for urban residents. In the end, the Gerschenkron state did succeed in getting the prices right; China's agriculture was successfully marketised. This is shown in Figure 9: After 1998, the government procurement price for rice was the same as the market price; and the urban food retail price was practically identical with the market price for rice as well. The "Gerschenkron mission" was accomplished.

Figure 9. Food Price Conversion during the Reforms



Source: National Bureau of Statistics of China, National Data, <http://data.stats.gov.cn/english/>, accessed 29 January 2016; National Bureau of Statistics, *Zhongguo Tongji Nianjian (China Statistical Yearbook)* (Beijing: China's Statistics Press, 1981–2007).

Our findings also show that for China's food production physical inputs were necessary but not the only sufficient factors. Institutions and policies played a significant role. This point differs from the traditional view on China's post-reform agricultural performance. State intervention and monopsony helped government achieve reform goals, but the Gerschenkron state had to struggle with its fiscal limits. Even so, in the end, the state did get the price right for food on behalf of the market, an important deed that we should not underestimate or take for granted.

Appendix A

Causal Relationship between Government Fiscal Capacity and Food Production

This appendix aims to establish a long-run causal relationship between the central government fiscal ability and food production by focusing on four time series, namely, the national grain output, the national rice output, government fiscal expenditure, and the inflation rate.

1. Data Description and Model Specification

Yearly data for the four time series come from *Zhongguo Tongji Nianjian* (*China's Statistical Yearbooks*), *Zhongguo Caizheng Nianjian* (*Finance Yearbooks of China*), and *Zhongguo Jiage Tongji Nianjian* (*China's Price Statistical Yearbooks*). Our observation period is set from 1979 to 2006, covering the whole transition from monopsony to the government-free market. Variables and data used in the test are denoted as follows:

Y_t^g: Change rate of grain output
Y_t^r: Change rate of rice output
G_t: Change rate of central government expenditure index
eG_t: Change rate of real (deflated) central government expenditure index

We use the year-on-year change rate of central government expenditure G_t to denote the state's fiscal capacity. We also include the deflated term eG_t measured by nominal central expenditure divided by the inflation rate.

Food security is measured by the change rate of food output Y_t^k. We mainly use grain output data Y_t^g for estimation, which according to *China's Statistical Yearbooks*, grain output includes cereals, potato and beans. However, food security usually refers to cereals of which rice is always very important for China. Thus rice output Y_t^r is also taken as a reliable proxy for food output. By examining grain and rice we are more likely to establish an unbiased relationship between Chinese government fiscal capacity and the country's food security.

For the simple fact that the actual causal relationship between government fiscal capacity and food security is unknown prior to reforming China, we begin our empirical analysis by specifying two bivariate regression equations.

$$eG_t = \varphi_{10} + \varphi_{11} Y_t^k + \varepsilon_{1t} \qquad (A-1)$$

$$Y_t^k = \varphi_{20} + \varphi_{21} eG_t + \varepsilon_{2t} \qquad (A-2)$$

In the above long-run regression functions, G_t is the year-on-year percentage change in the government fiscal capacity, Y_t^k is the food output growth rate, and φ_{ki} denotes the associated regression coefficients. In detecting the asymmetric interrelations between the observed time series variables, we employ the Granger causality method which requires information on the past growth rate of both variables.[40] This can be represented by the following equation:

$$\begin{pmatrix} eG_t \\ Y_t^k \end{pmatrix} = c + \begin{cases} \sum_{m=1}^{p} \alpha_{1m} eG_{t-m} + \sum_{m=1}^{p} \beta_{1m} Y_{t-m}^k + \varepsilon_{1t} \\ \sum_{m=1}^{p} \alpha_{2m} Y_{t-m}^k + \sum_{m=1}^{p} \beta_{2m} eG_{t-m} + \varepsilon_{2t} \end{cases} \qquad (A-3)$$

Where α_{km} denotes the coefficients of lagged term of dependent variables and β_{km} for the independent variables.

The meaning of the above system equation is stated as follows: eG_t (Y_t^k) is expected to Granger-cause Y_t^k (eG_t), if Y_t^k (eG_t) can be better predicted by the histories of both Y_t^k and eG_t than that of Y_t^k (eG_t) alone. The F-tests are applied on the null hypotheses of Granger non-causality, $H_0: \beta_{km} = 0$. If the computed F-statistics surpass the upper bound critical values, one rejects the null hypothesis of Granger non-causality and a causal relationship between government fiscal capacity and food production exists, and vice versa.

[40] Granger, Clive, "Investigating Causal Relationship by Econometric Models and Cross-spectral Methods," *Econometrica*, 37/3 (1969): 424-38.

Because the testing of the Granger causality involves time series data, the presence of any stochastic trend must be tested. In this paper we follow the augmented Dickey-Fuller (ADF) regression to test the unit root hypothesis:

$$\begin{pmatrix}\Delta eG_t \\ \Delta Y_t^k\end{pmatrix} = c + \begin{cases}\rho_1 TR + \gamma_1 eG_{t-1} + \sum_{i=1}^{q} \theta_{1i}\Delta eG_{t-i} + e_{1t} \\ \rho_2 TR + \gamma_2 Y_{t-1}^k + \sum_{i=1}^{q} \theta_{2i}\Delta Y_{t-i}^k + e_{2t}\end{cases} \qquad (\mathrm{A}-4)$$

Where TR stands for the time trend. The unit root test is then carried out under the null hypothesis $\mathrm{H}_0: \gamma_k = 0$ against the alternative hypothesis $\mathrm{H}_1: \gamma_k < 0$. The results of the ADF test indicate that if γ_k is greater than the critical value, then the time series for eG_t or Y_t are not stationary. In order to achieve a better test result, all three models with (1) constant c only, (2) with constant c and time trend TR, and (3) with no constant or trend are included in the next part of testing specification. The appropriate lag length is chosen based on the rule of Schwarz criterion (SC).

2. Granger Causality Test

The ADF unit root tests perform with three models for all the series. The results of tests for $(\mathrm{A}-4)$ listed in Table A1 are in favour of the level of the data; and the unit root null hypothesis is rejected at the five percent level and above. Thus, our four time series are all stationary at level with 95 percent level of confidence.

Table A1. Results of ADF unit root tests

Variables	$I(0)$		
	Model (1)	Model (2)	Model (3)
Y_t^g	–5.4190***	–5.3955***	–5.0166***
Y_t^r	–4.8945***	–5.0372***	–4.8166***
G_t	–3.6336**	–4.2956**	–2.3982**
eG_t	–3.1390**	–3.8819**	–2.9279***

Note: All three models with (1) constant only, (2) with constant and time trend, and (3) with no constant or trend are included in the model specification; the lag order is chosen based on the rule of SC, 5 lag

lengths for all four series; *** indicates 1 percent significance level; and ** indicates 5 percent significance level.

The selection of lag order of variables included in the $(\mathrm{A}-4)$ test equation follows with SC rule, which implies that farmer's production incentives are based on their knowledge of previous year's government procurement price and quantity. The results of ADF unit root tests indicate that the Granger causality test for the statistical significance of lagged level terms in $(\mathrm{A}-3)$ can reveal the long-run causal relationship between government fiscal capacity and food security.

The results of the Granger causality tests for $(\mathrm{A}-3)$ are reported in Table A2, where the computed F -statistics of $\mathrm{H}_0: \beta_{km}=0$ demonstrate significant unidirectional non-causality from the former to the latter variables. The p-value indicates the level of significance of the null hypothesis.

Table A2. Results of Granger Causality Tests

Null hypothesis	Obs	*F*-statistic	*p*-value
Result of Granger causality test (Y_t^g, G_t)			
G_t *does not cause* Y_t^g	27	6.03998	0.0216
Y_t^g *does not cause* G_t		0.36452	0.5517
Result of Granger causality test (Y_t^g, eG_t)			
eG_t *does not cause* Y_t^g	27	10.1025	0.0040
Y_t^g *does not cause* eG_t		0.23862	0.6296
Result of Granger causality test (Y_t^r, G_t)			
G_t *does not cause* Y_t^r	27	5.20024	0.0318
Y_t^r *does not cause* G_t		0.01838	0.8933
Result of Granger causality test (Y_t^r, eG_t)			
eG_t *does not cause* Y_t^r	27	9.41964	0.0053
Y_t^r *does not cause* eG_t		0.16961	0.6841

The testing results of G_t, eG_t to Y_t^g, Y_t^r are all significant at the five percent level above. As the empirical tests suggest, the Granger causality test indicates a long-run stable causal relationship from government fiscal capacity to the national food security during the period in question.

Moreover, all four test results demonstrate that the causality is unidirectional from real/nominal central government expenditure to grain/rice output. This relationship is

also significant from the real central government expenditure to the next year's rice output. This makes sense as rice was under more restrict control than other foods by the state. This is the reason why Section III focuses on rice-related policies.

The results also confirm that there is no causality from food production to government expenditures, which means that farmers had no influence on government fiscal capacity. We also argue that reforms were generated within the government sector due to the costs of policies: high cost policies gave way to low cost ones.

The results in Appendix A show a long-run unidirectional causal relationship from the state's fiscal capacity to grain production in China. The current year's government food expenditure directly determined the future grain output. The test results are particularly significant for real government fiscal capacity and food production. In Appendix B and Section III, we will discuss the mechanism through which this causality functions.

Appendix B

Joint-Causality and Impulse-Response Analysis in the Production-Input-Policy Unrestricted VAR

To take our investigation further, the unrestricted VAR model is chosen here to detect long-run association between different categories of food policies and food production. To achieve that, we follow the results of Table 3 and add three additional policy variables to basic physical inputs into our analysis: (1) grain procurement price index, (2) grain, cotton and edible oil subsidies for the urban sector, and (3) grain procurement fund index.

1. Data Description and Model Specification

Our annual data come from *Zhongguo Tongji Nianjian* (*China's Statistical Yearbooks*), *Zhongguo Caizheng Nianjian* (*Finance Yearbooks of China*), and *Zhongguo Jiage Tongji Nianjian* (*China's Price Statistical Yearbooks*). Our sample period is again set from 1979 to 2006. All variables are listed as below:[41]

Y_t^g: Change rate of grain output
L_t: Change rate of labour in farming, forestry and animal husbandry
K_t: Change rate of effective irrigated area
F_t: Change rate of chemical fertilizers
T_t: Change rate of power of machinery
eP_t: Change rate of real procurement price index (excludes CPI)
eS_t: Change rate of real urban subsidies on grain, cotton and edible oil index (excludes CPI)
eR_t: Change rate of real procurement fund index (excludes CPI)

Following the finding of Appendix A, for our purpose we only establish the equation of Y_t^g as a dependent variable in this appendix to look into the interrelations

[41] Procurement price index and grain procurement fund index are calculated from the rice data which are most detailed.

between the government food policies and food security for reforming China. We begin our empirical analysis with the following production functions:

$$Y = f(INP) \qquad (B-1)$$

$$Y = f(INP, POL) \qquad (B-2)$$

Where INP stands for physical inputs (L_t, K_t, F_t, T_t) and POL for policy variables (eP_t, eS_t, eR_t). $(B-1)$ describes the traditional production function based on major physical inputs, while $(B-2)$ includes our analysis of policy impact on China's food production. Accordingly, our long-run equilibrium regression functions between Y and INP, POL can be expressed as follows:

$$Y_t^g = \varphi_1 + \varphi_2 L_t + \varphi_3 K_t + \varphi_4 F_t + \varphi_5 T_t + e_{1t} \qquad (B-3)$$

$$Y_t^g = \varphi_1 + \varphi_2 L_t + \varphi_3 K_t + \varphi_4 F_t + \varphi_5 T_t + \varphi_6 eP_t + \varphi_7 eS_t + \varphi_8 eR_t + e_{2t} \qquad (B-4)$$

In the above long-run regression functions, Y_t^g is the year-on-year percentage change in food output, L_t, K_t, F_t, T_t denotes the change rates of physical inputs, eP_t, eS_t, eR_t for policy changes. The parameters φ_{ki} denote the associated regression coefficients of above independent variables. In detecting the interrelations between the observed time series variables, we employ the unrestricted VAR which requires information on the past growth rate of all variables. This can be represented by the following equation $(B-5)$:

$$Y_t^g = c + \begin{cases} \sum_{m=1}^{p} \alpha_{1m} Y_{t-m}^g + \sum_{m=1}^{p} \beta_{11m} L_{t-m} + \sum_{m=1}^{p} \beta_{12m} K_{t-m} + \sum_{m=1}^{p} \beta_{13m} F_{t-m} + \sum_{m=1}^{p} \beta_{14m} T_{t-m} + \varepsilon_{1t} \\ \sum_{m=1}^{p} \alpha_{2m} Y_{t-m}^g + \sum_{m=1}^{p} \beta_{21m} L_{t-m} + \sum_{m=1}^{p} \beta_{22m} K_{t-m} + \sum_{m=1}^{p} \beta_{23m} F_{t-m} + \sum_{m=1}^{p} \beta_{24m} T_{t-m} + \sum_{m=1}^{p} \gamma_{21m} eP_{t-m} + \sum_{m=1}^{p} \gamma_{22m} eS_{t-m} + \sum_{m=1}^{p} \gamma_{23m} eP_{t-m} + \varepsilon_{2t} \end{cases} \qquad (B-5)$$

Where α_{km} denotes the coefficients of lagged term of dependent variables and β_{km} for the independent physical input variables and γ_{km} for independent policy variables. The meaning of such a system equation can be stated as: eP_t, eS_t, eR_t is expected to individually and/or jointly impact on Y_t^g, if Y_t^g can be better predicted by the histories of physical inputs and policy variables than that of physical inputs alone. The t-statistics are applied to test the significance of individual variables, and χ^2 are

applied on the null hypotheses of joint non-causality, $H_0: \gamma_{km} = 0$. If the computed statistics surpass the upper bound critical values, we then reject the null hypothesis and a joint causal relationship between policy swings and food production exists, and vice versa.

In addition, we use the impulse-response analysis to identify the responsiveness of food production Y_t^g in the VAR when a shock is put to the error term. This is noted as the following VAR system:

$$Y_t^g = c + \alpha_i Y_{t-i}^g + \theta_i X_{t-i} + e_{3t} \qquad (B-6)$$

Where X_t denotes both INP $(Y_t^g, L_t, K_t, F_t, T_t)$ and POL (eP_t, eS_t, eR_t). The parameter α_i indicates the coefficients of the lagged term of Y_{t-i}^g and θ_i for all inputs. Impulse-response equation $(B-6)$ implies a change in the residual e_{3t} will bring a change in Y_t^g, and also causes a change in both Y_t^g and X_t during the subsequent periods. With a shock to the residual in $(B-6)$, this test will allow us to understand further how it affects the whole VAR system $(B-4)$. In reality it reveals individual physical input and policy variable's impact to food production in China.

Due to the testing of the unrestricted VAR involving time series data, we firstly test the presence of any stochastic trend. In this appendix we again follow the augmented Dickey-Fuller (ADF) regression to test the unit root hypothesis:

$$\Delta X_t = c + \rho TR + \gamma X_{t-1} + \sum_{i=1}^{q} \theta_i \Delta X_{t-i} + e_{4t} \qquad (B-7)$$

Where X_t denotes both INP $(Y_t^g, L_t, K_t, F_t, T_t)$ and POL (eP_t, eS_t, eR_t); TR stands for the time trend. The unit root test is then carried out under the null hypothesis $H_0: \gamma = 0$ against the alternative hypothesis of $H_1: \gamma < 0$. The results of the ADF test indicate that if calculated statistics of γ is greater than the critical value, the time series for X_t are not stationary. We include constant c and time trend TR in all models with (1), and then exclude constant or tend in (2) in the tests. The appropriate lag length is chosen based on the rule of SC.

2. Unrestricted VAR and Impulse-Response Analysis

Our empirical analysis in Table 3 shows that the state's food policies are highly associated with the level of food security in China, and that various food policies may have individually and/or jointly affected output. Our VAR on associationship between specific food policies and grain output from 1979 to 2006 shows the possibility of little to less influence of individual food policies on food production if they were temporary measures. A Wald test is therefore employed to see if all these specific policies jointly as a package cause the long-run grain production to change.

Change rates of variables ($Y_t^g, L_t, K_t, F_t, T_t, eP_t, eS_t, eR_t$) are used as estimators in the unrestricted VAR model; and all of them are stationary at levels in ADF unit root test (Table B1).[42]

Table B1. ADF Unit Root Test

	$I(0)$	
	Model (1)	Model (2)
Y_t^g	-5.3955***	-5.0166***
L_t	-4.6411***	-2.3735**
K_t	-3.7394**	-2.8248***
F_t	-4.8723***	-2.7877***
T_t	-3.5701*	-2.6017**
eP_t	-4.9062***	-5.1806***
eS_t	-13.8175***	-15.776***
eR_t	-5.2562***	-5.4600***

Note: We test two models with (i) with constant and trend, and (ii) with no constant or trend in the model specification; the optimal lag lengths are chosen based on the rule of Schwartz criterion (SC); ***, ** and * indicates 1%, 5% and 10% significance levels, respectively.

Following the rule of Akaike information criterion (AIC), we choose two leg lengths for the VAR system in $(B-5)$. We first run the regression without policy variables to test input-led output changes. Our results are reported in Column (1), Table B2. Secondly, we include three policy variables to the VAR model and run the tests respectively with Ordinary Least Square (OLS) and Weighted Least Square

[42] L_t has a unit root at level in the model with a constant, but is still stationary at level with a 99% confidence interval for the other two models. We consider this variable stationary at level.

(WLS).[43] Our results are listed in Columns (2) and (4) of Table B2. Column (4) of Table B2 contains the results of WLS in VAR. The new test results support our conclusion with an enhanced level of significance to most variables. Finally we test the joint-causality of policy variables with the results of OLS and WLS, respectively. The results are reported in Columns (3) and (5) of Tables B2 (the same as Table 4).

Table B2. Unrestricted VAR of Grain Output on Inputs and Policy Variables, 1979–2006

	OLS			WLS	
			Grain output		Grain output
	Grain output	Grain output	Wald test (Chi-square)	Grain output	Wald test (Chi-square)
Variables	(1)	(2)	(3)	(4)	(5)
Grain output (–1) (Y^g_{t-1})	–0.29 (1.01)	–1.22 (-3.82) ***		-1.21 (-6.50) ***	
Grain output (–2) (Y^g_{t-2})	0.12 (0.43)	–0.70 (-1.82)		-0.70 (-3.10) **	
Labour (–1) (L_{t-1})	1.25 (1.42)	1.80 (2.36) **		1.80 (4.01) ***	
Labour (–2) (L_{t-2})	–0.26 (-0.33)	–1.20 (-1.54)		-1.19 (-2.62) **	
Land (–1) (K_{t-1})	–1.05 (-1.17)	–1.75 (2.42) **		-1.75 (-4.12) ***	
Land (–2) (K_{t-2})	–2.61 (-2.34) **	–2.14 (-2.31) **		-2.14 (-3.92) ***	
Fertilizer (–1) (F_{t-1})	0.29 (0.81)	0.26 (0.87)		0.26 (1.47)	
Fertilizer (–2) (F_{t-2})	–0.05 (-0.15)	0.18 (0.67)		0.18 (1.13)	
Machine(–1) (T_{t-1})	–0.72 (-1.16)	–1.21 (1.94) *		-1.21 (-3.30) ***	
Machine (–2) (T_{t-2})	–0.23 (-0.47)	–0.33 (0.63)		-0.33 (-1.06)	
Procurement price (–1) (eP_{t-1})		–0.70 (-2.30) **		-0.70 (-3.91) ***	
Procurement price (–2) (eP_{t-2})		–1.36 (-3.87) ***		-1.35 (-6.59) ***	
Urban subsidy (–1) (eS_{t-1})		0.02 (0.18)		0.01 (0.30)	
Urban subsidy (–2) (eS_{t-2})		–0.00 (-0.22)	22.21***	-0.00 (-0.37)	64.17***
Grain procurement fund (–1) (eR_{t-1})		0.80 (2.91) **		0.80 (4.95) ***	
Grain procurement fund (–2) (eR_{t-2})		1.24 (3.90) ***		1.24 (6.63) ***	
Constant	9.95 (2.17) **	13.38 (2.70) **		13.38 (4.60) ***	
Observations	26	26		26	
R^2	0.52	0.86		0.86	
Serial correlation [a]		0.90 [0.45]			
Heteroscedasticity [b]		0.23 [0.64]			
Normality [c]		0.38 [0.83]			
Stability [d]		Stable			

Notes: [a] Breusch-Godfrey serial correlation LM test; [b] Auto-regressive conditional heteroscedasticity (ARCH) test; [c] Jacque-Bera normality test; [d] Cumulative sum of recursive residuals (CUSUM) test; The *t*-statistics for variables are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels respectively.

[43] The reason for the use of WLS is because the diagnostic check of residuals based on system equation $(B-5)$ passes all diagnostic checks, but Breusch-Pagan-Godfrey test for heteroskedasticity shows significant at 1 percent. To make sure of the power of our regression, we use the WLS to further correct the heteroskedasticity. After correction, our model is healthy and we can accept the findings derived from this model.

After the introduction of three policy variables, the fitness of regression R^2 increases from 0.52 to 0.86, conforming that when policy changed the significance of physical inputs in food production enhanced in the long run.[44] So, food policies remain persuasive in explaining changes in grain production.

The results of eP_t and eR_t are significant, at the five percent level or higher. The VAR test indicates that there exists a long-run equilibrium relationship between food production and the grain procurement price and grain procurement fund in the preceding year. Although urban subsidy eS_t is not individually significant, eP_t, eS_t and eR_t jointly influence the future grain output with an enhanced confidence interval at 99 percent level in both OLS and WLS.

Our impulse-responses results based on $(\mathrm{B}-6)$ confirm the findings of policy variables in the VAR regression. The shocks from grain procurement price and grain purchase fund can cause a long-time instability to food production respectively. But the response to food subsidy shock is weak. This confirms further our empirical findings regarding China's food coupon system which ended in 1993. Interestingly, different from the regression result, food production shows a very quick adjustment to restore equilibrium. It indicates that agricultural technology developed, although gradually, to make food production stable again after a shock to physical inputs. But compared with physical inputs, food production in China was more vulnerable and sensitive to policy changes.

In all, these empirical results are reasonable since all three new variables played a major part in government fiscal expenditure for grain procurement between 1979 and 2006. The largest component of urban subsidy – the grain coupons – was in place from 1979 to 1993. The Wald joint causality test and impulse-response empirical results also confirm food policy intensity in Table 3.

[44] Fan (2000).

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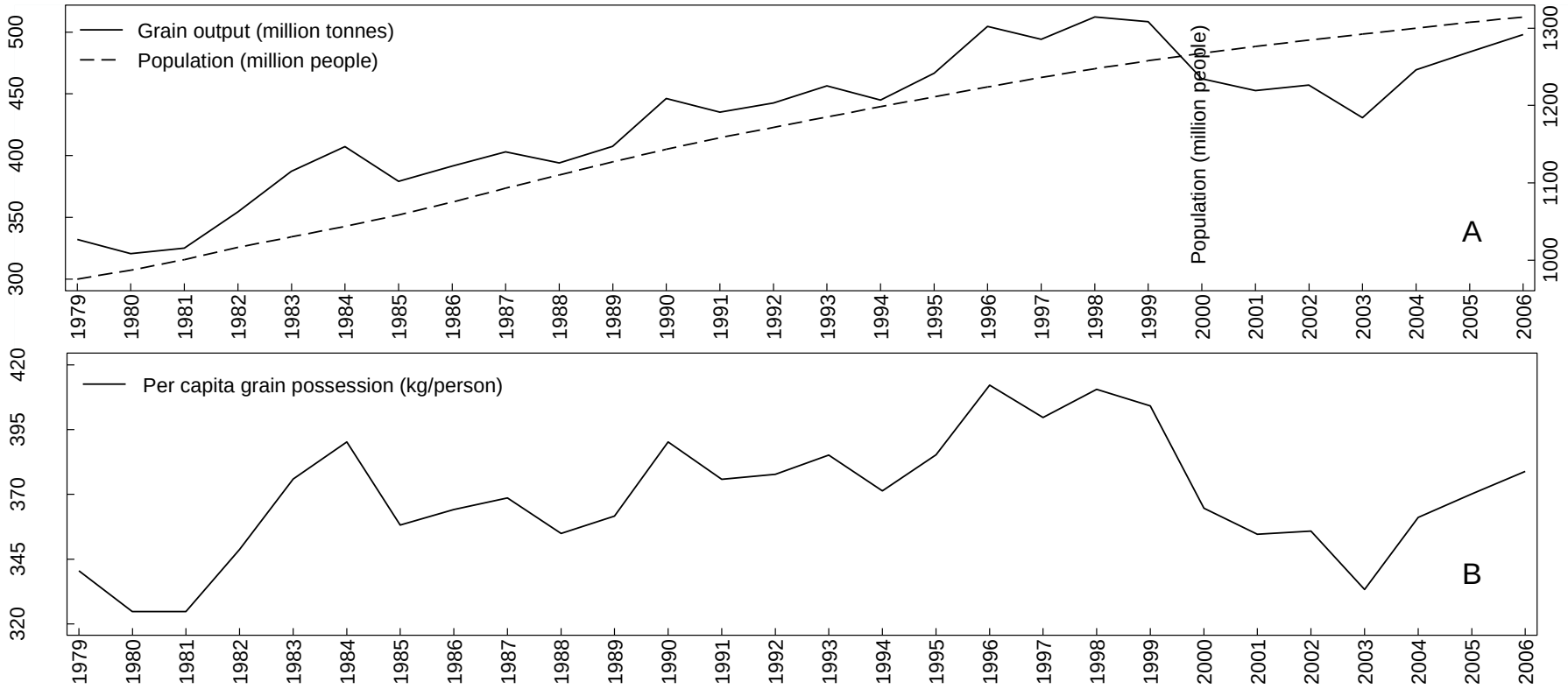
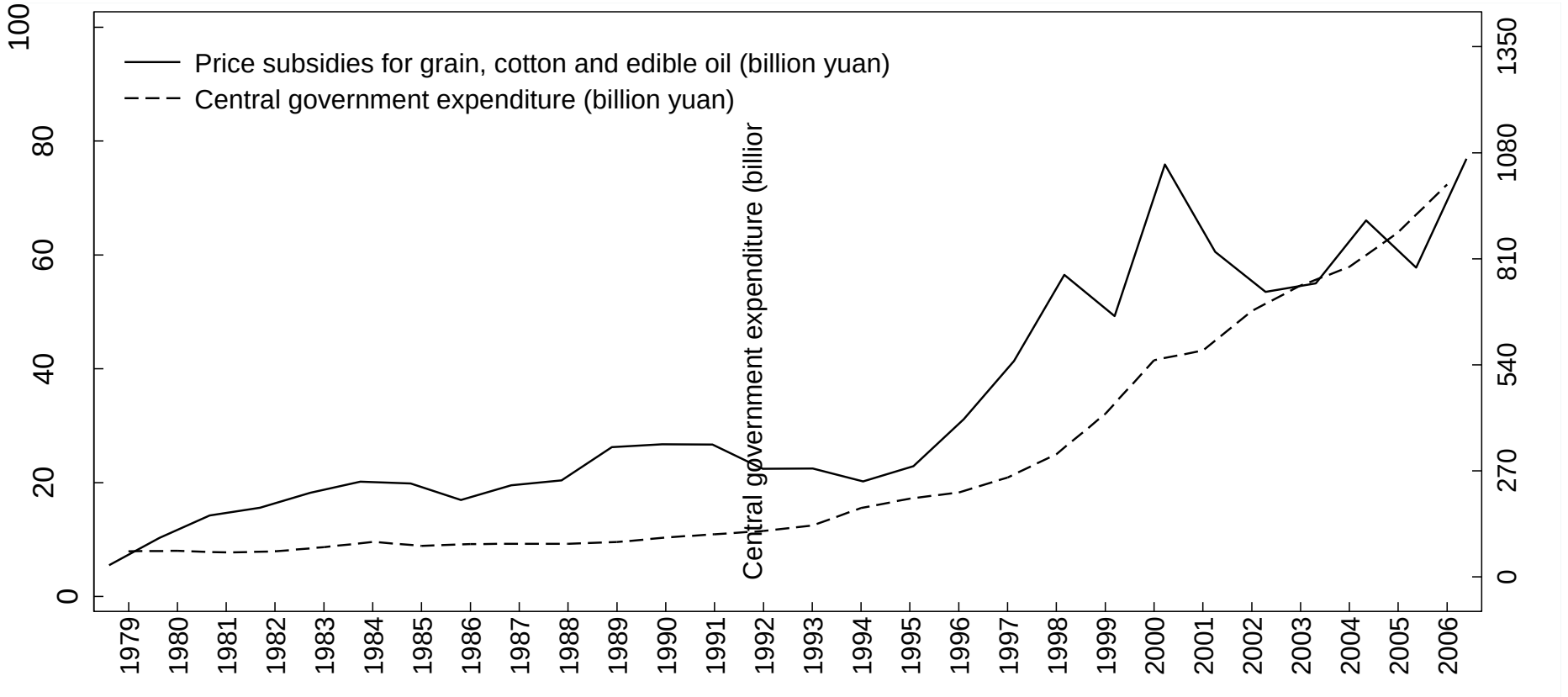
Figure 1. Fluctuations in Food Output and Per Capita Food Stock, 1979–2006



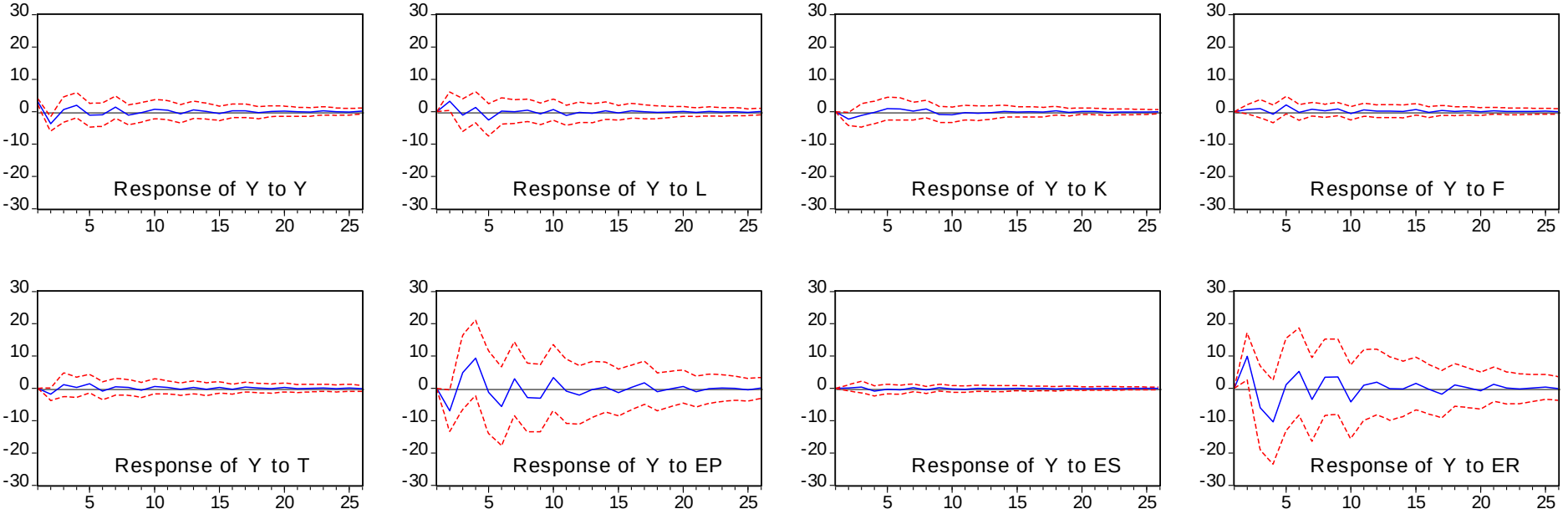
Source: National Bureau of Statistics, *Zhongguo Tongji Nianjian* (*China Statistical Yearbook*) (Beijing: China's Statistics Press, 1981–2007).

Figure 2. Urban Food Price Subsidies and Government Food Expenditure



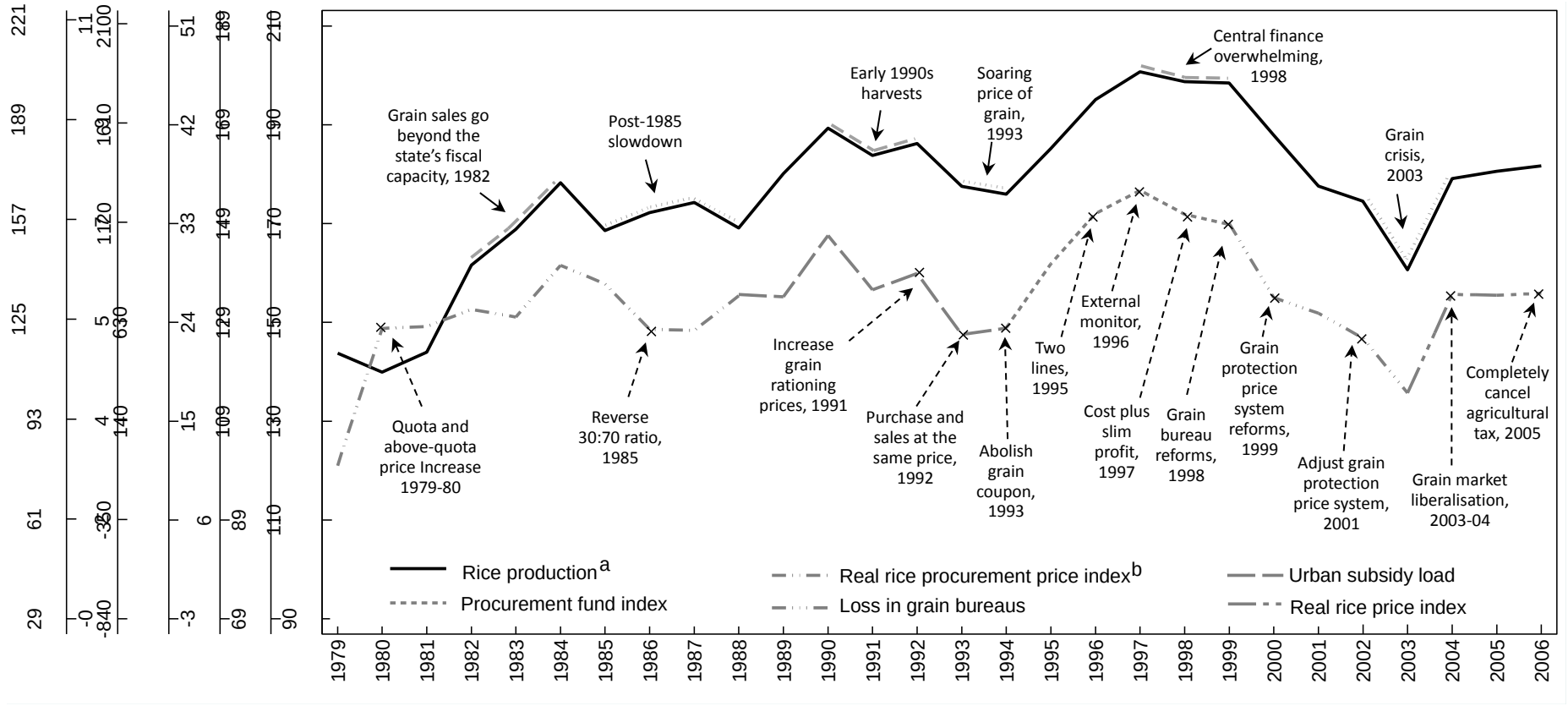
Source: Ministry of Finance, *Zhongguo Caizheng Nianjian* (*Finance Yearbook of China*) (Beijing: China's Finance Magazine, 1991–2007).

Figure 3. Impulse Responses in the Production-Inputs-Policy VAR



Note: The shock corresponds to one standard deviation of the residual in each variable.

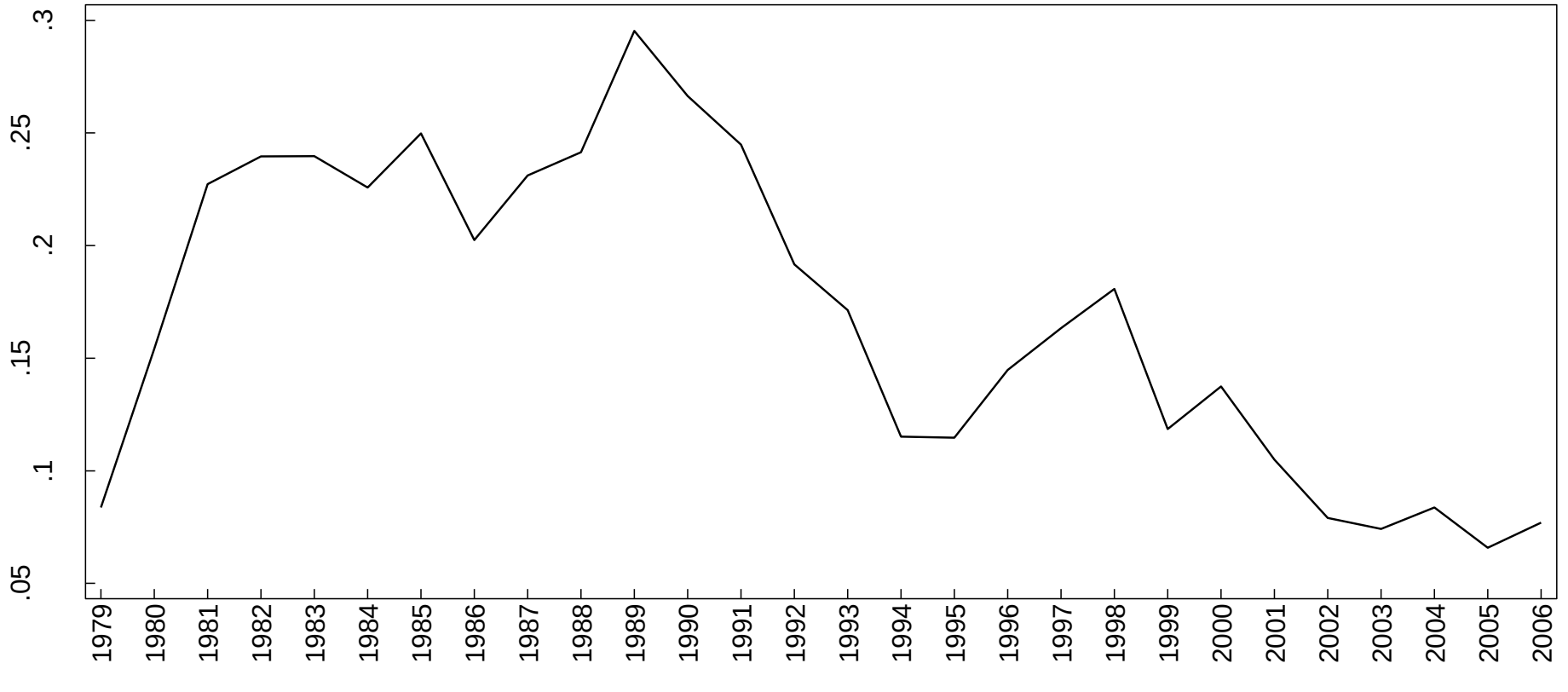
Figure 4. Changes in Policies and Food Security, 1979–2006



Note: [a] [b] The rice procurement price index excludes the weight of the current year's consumer price index.

Source: National Bureau of Statistics, *Zhongguo Tongji Nianjian* (*China Statistical Yearbook*) (Beijing: China's Statistics Press, 1981–2013); Ministry of Finance, *Zhongguo Caizheng Nianjian* (*Finance Yearbook of China*) (Beijing: China's Finance Press, 1991–2013); National Bureau of Statistics, *Zhongguo Jiage Tongji Nianjian* (*China Price Statistical Yearbook*) (Beijing: China's Statistics Press, 1981–2013); Ministry of Agriculture, *Zhongguo Nongye Nianjian* (*China Agriculture Yearbook*) (Beijing: China's Agriculture Press, 1980–2013).

Figure 5. Reduction of Government Involvement to Give Way to the Market



Source: The same as Figure 2.

Figure 6. Grain Production under State Monopsony

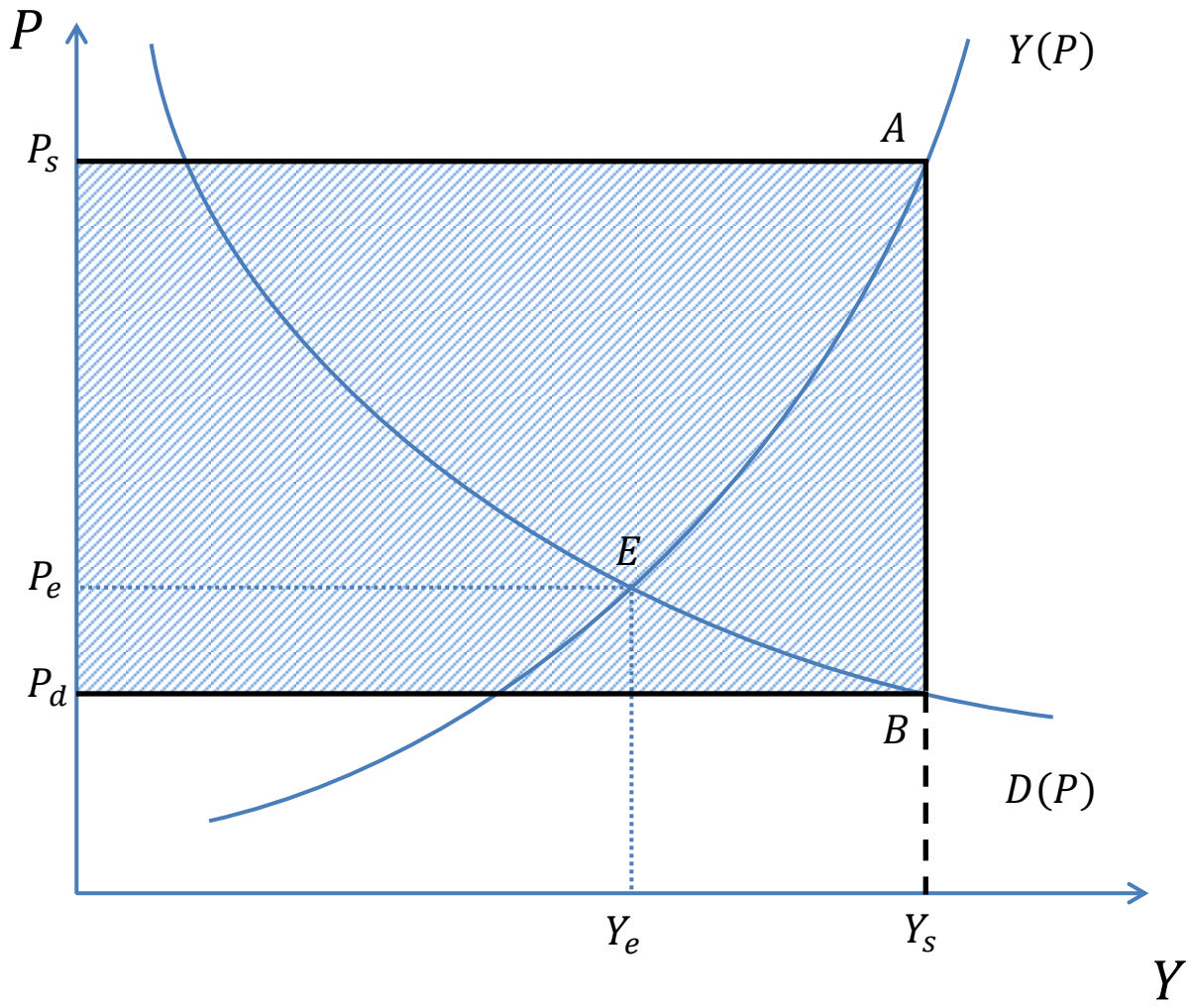


Figure 7. Ending of Food Subsidies

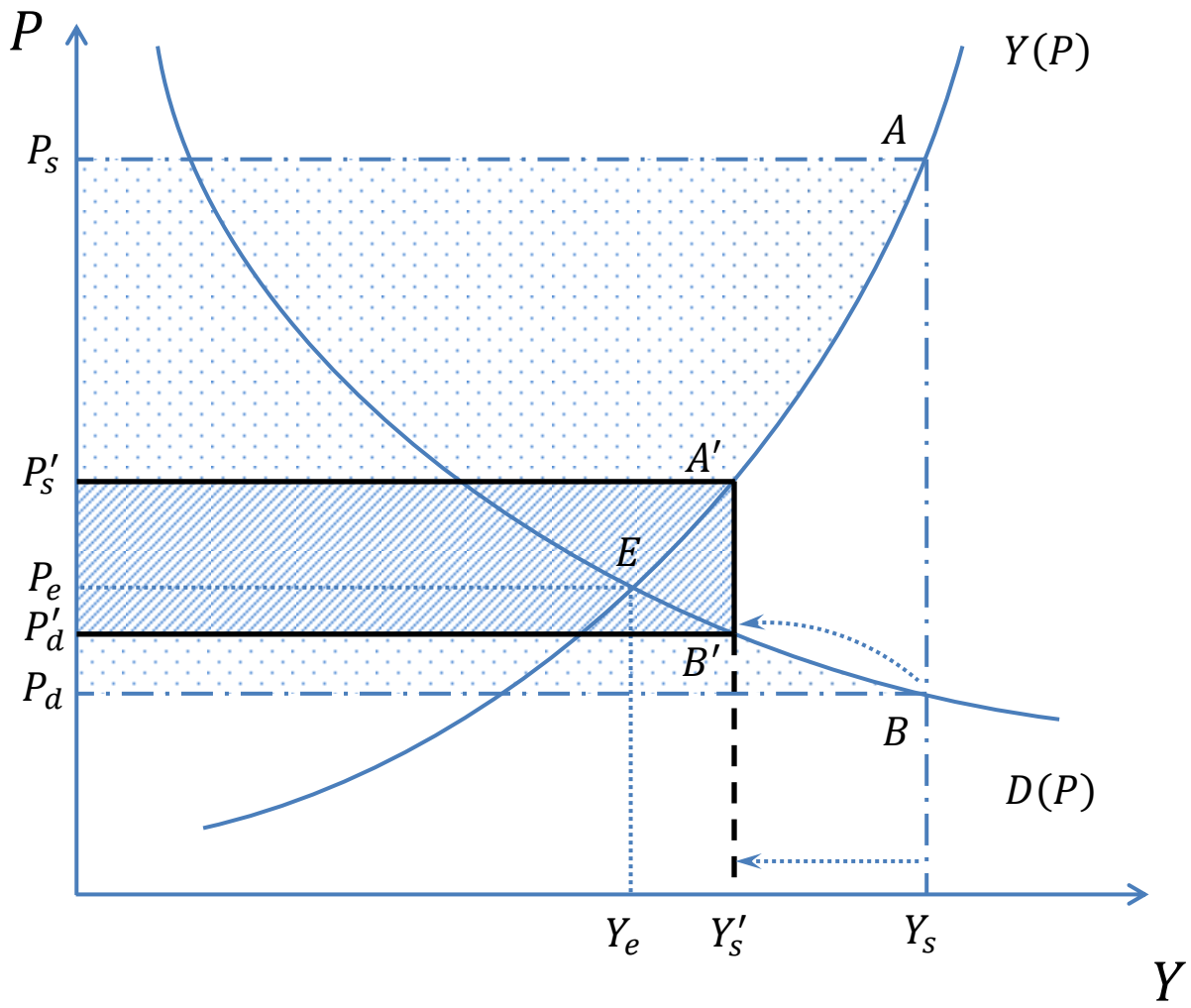


Figure 8. Grain Bureau Reforms

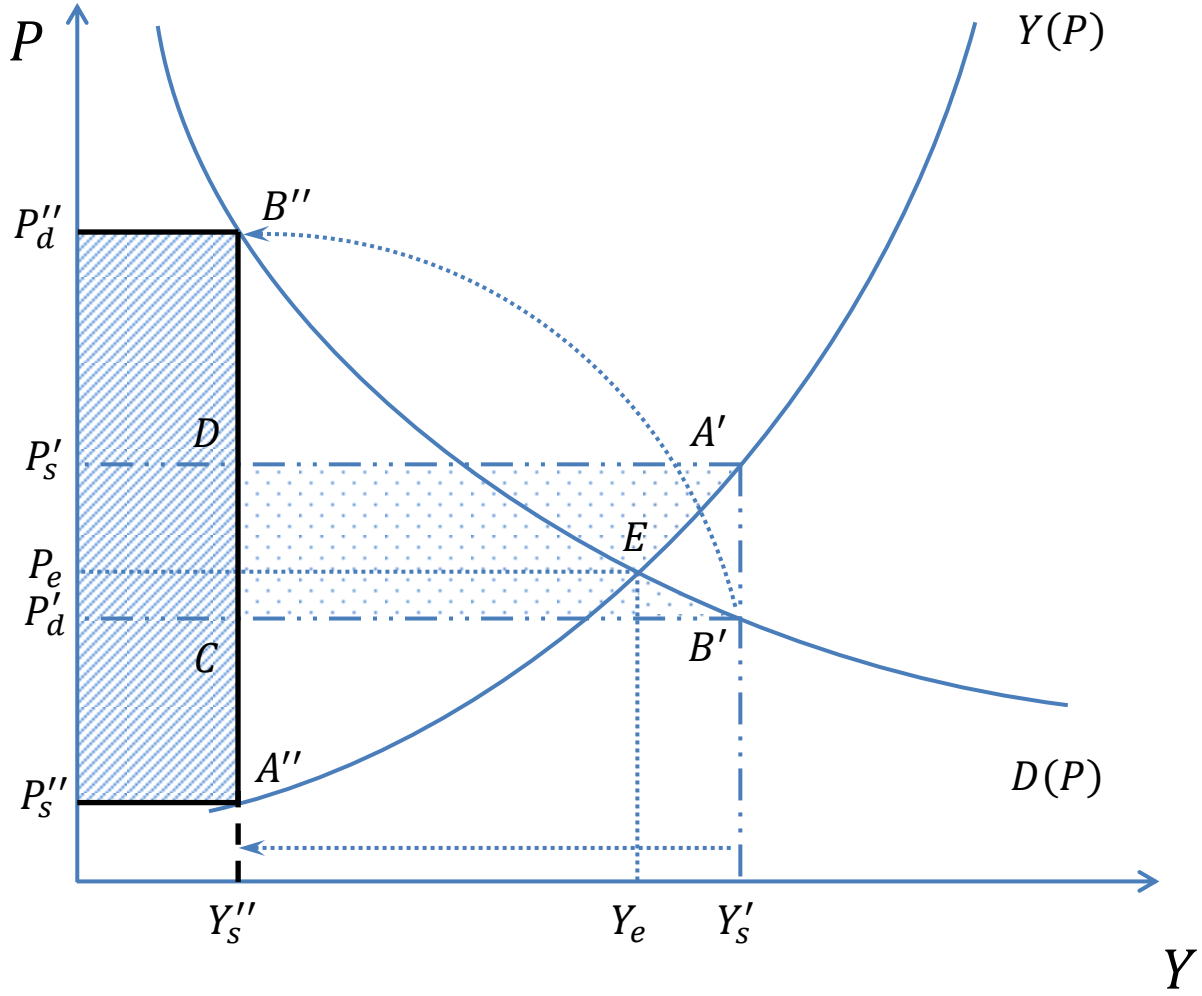
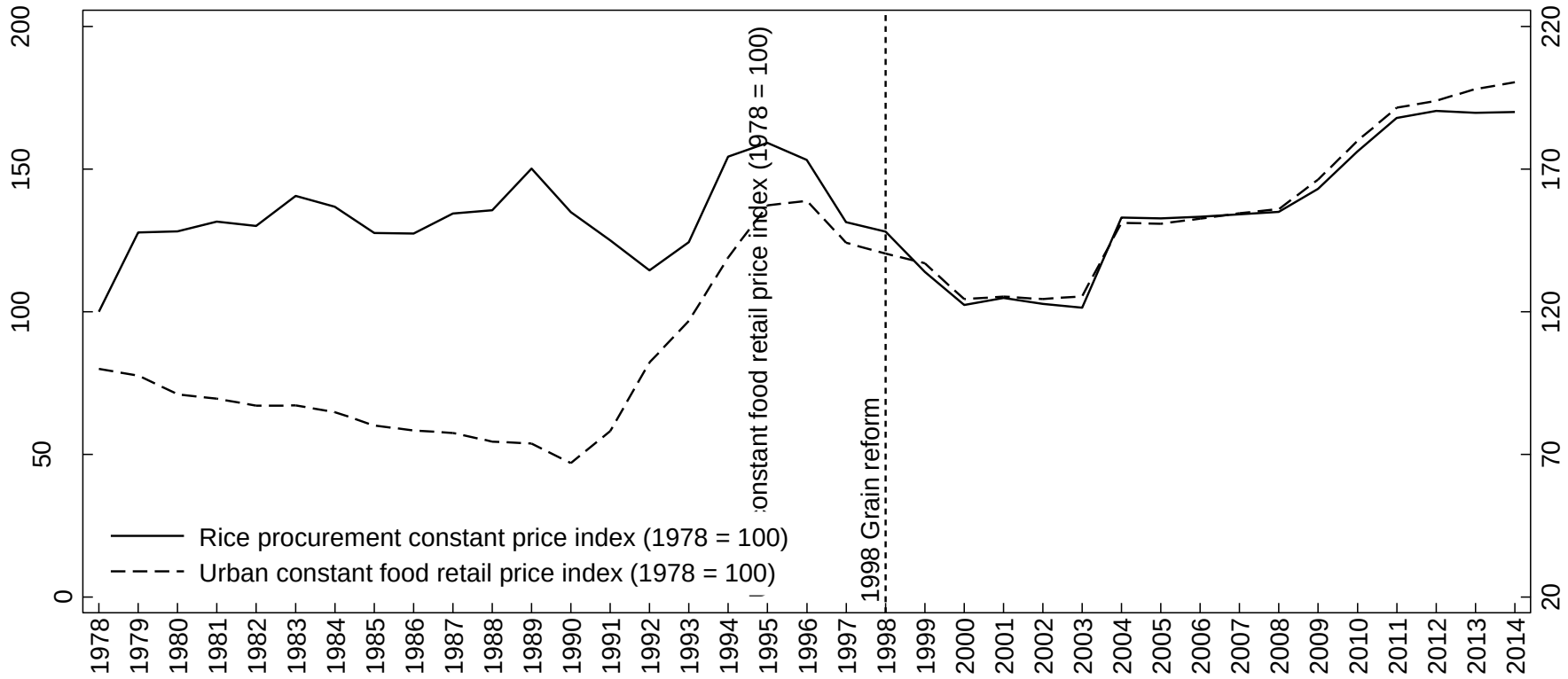


Figure 9. Food Price Conversion during the Reforms



Source: National Bureau of Statistics of China, National Data, <http://data.stats.gov.cn/english/>, accessed 29 January 2016; National Bureau of Statistics, *Zhongguo Tongji Nianjian (China Statistical Yearbook)* (Beijing: China's Statistics Press, 1981–2007).