The Cursed Virtue: Government Infrastructural Investment and Household Consumption in Chinese Provinces[*]

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Abstract: Using Chinese provincial panel data for the period 1978-2006, this paper studies the relationship between government infrastructural investment and household consumption. In our baseline reduced-form regression, we find that a one percentage point increase of infrastructural investment in the government budget leads to a 0.31 percentage point reduction of the share of household consumption in GDP. This result holds qualitatively in a variety of specifications and under different estimation methods. In contrast, private investment is not found to have any significant impact on the share of household consumption. Our structural estimations establish two channels for government investment's negative effects, one by encouraging the development of the secondary sector that is more capital intensive than agriculture and services, and the other by increasing profits in the industrial sector.

Keywords: infrastructure, consumption, economic imbalances

JEL codes: E21; F32; O16

The lack of domestic consumption is believed to be one of the major causes for China's external imbalance problem. Between 2000 and 2008, the share of consumption in GDP declined from 62 percent to 48 percent; in the meantime, the share of net export in GDP increased from 2 percent to 8 percent (NBS, 2009). Table 1 compares China with several major countries in terms of the shares of consumption and capital formation in 2008. China's share of final consumption in GDP was not only much lower than those in OECD countries including Japan and Korea with similar cultures of China's, but also much lower than those in India and Brazil, two large developing countries. Meanwhile, China's share of gross capital formation in GDP was 44 percent, much higher than in other countries. It is hard to imagine that this already high investment rate could be made even higher to reduce China's large current account surplus. That is, the main driving force of China's external imbalances is likely to be low domestic consumption rather than insufficient investment.

Table 1: Shares of consumption and investment in GDP of major countries in 2008

Country	U.S.	U.K.	Germany	Japan	Korea	India	Brazil	China
Final consumption (% of GDP)	88	86	75	76	70	71	80	48
Gross capital formation (% of GDP)	17	17	18	24	31	35	20	44

Sources: World Development Indicator (WDI): http://data.worldbank.org/indicator/NE.CON.TETC.ZS, and http://data.worldbank.org/indicator/NE.GDI.TOTL.ZS.

In this paper, we propose and test a proposition that relates government infrastructural investment to China's low shares of domestic consumption. Government infrastructural investment has two effects on household consumption. One is a direct crowding-out effect. That is, when it invests more, the government reduces its transfer to households

and cuts spending on social security, both leading to lower household consumption. The other is an indirect effect. That is, government infrastructural investment alters industrial structure and creates biases against household consumption. Our main task is to test the indirect effect while controlling the direct effect using China's provincial data for the period 1978-2006. We identify and test two channels for the indirect effect to exert impacts on household consumption. Our story goes like the follows.

Fiscal decentralization induces local governments to compete for capital (Xu, 2008). To attract more private investment, they invest in roads, utilities, and other infrastructural facilities, and offer concessions to investors when land prices are negotiated. Some of those investments (such as roads) complement firm production, and others (such as utilities) are direct subsidies to capital. Here we would like to emphasize one key difference between government infrastructural investment and private infrastructural investment. That is, infrastructural investment is cheap for the government because its money either comes from taxes or comes from cheap bank credits. As a result, government infrastructural investment can be larger than what the society desires under the current relative prices. Firms in the secondary sector (manufacturing, construction and transportation) benefit the most from infrastructural investment and are the main targets for competition among local governments because they are more mobile and provide more taxes than firms in the tertiary sector.[1] As a result, the secondary sector grows faster than agriculture and services, just like the Rybcszynski theorem would predict. In the meantime, the secondary sector is more capital-intensive than the other

[1] Xu, Wang, and Shu (2007) and Yao and Zhang (2011) find that change of leaders has significantly positive effects on the secondary sector but not on the whole local economy, indicating that cross-regional competition is mainly on that sector.

two sectors. Consequently the share of labor income in GDP declines, and so does the share of consumption. This is the first channel that we will test. The second channel is related to the asymmetric effects of government investment in industry. Much of the government's infrastructural investment implies direct subsidies to firms. This is more evident in government-sponsored industrial parks. We found in our fieldwork in Xiangtan city of Hunan province in the spring of 2010 that land prices in government-sponsored industrial parks were half of the cost the government incurred to prepare the land. Other researchers found that factor price distortions including low land prices imply large subsidies to producers (e.g., Huang and Tao, 2010; Zhang and Cheng, 2010). As a result, firms' profits increase. This would lower the share of labor income in the industrial sector. Because capital owners have lower propensities to consume than ordinary people, the share of consumption in GDP further declines.

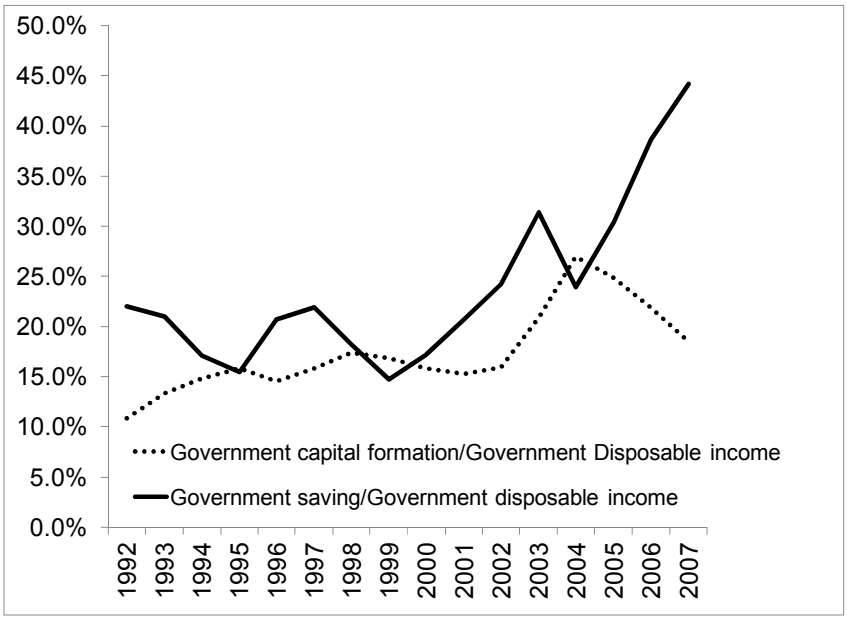
In the literature, several explanations have been proposed to explain China's high household saving rates. Some of them rely on traditional theories such as the life-cycle hypothesis (Modigliani and Cao, 2004; Wei and Zhang, 2009), liquidity constraints (Kujis, 2005), and precautionary savings (Meng, 2003; Blanchard and Giavazzi, 2005; Giles and Yoo, 2007; Chamon and Prasad, 2008).[2] Recently, researchers have begun to study the role of household income on household consumption. They argue that the rapid declining share of household income in GDP is the main reason for low consumption in China (Aziz and Cui, 2007; Bai and Qian, 2009a, 2009b). In contrast, Li, Liu, and Wang (2009) emphasize the role of structural change in causing China's declining share of

[2] Wei and Zhang (2009) provide an innovative and controversial explanation based on China's high sex ratios. Their idea is that high sex ratios increase the competition among men in the marriage market and force them to save more. Their empirical study based on provincial data seems to confirm their hypothesis.

consumption. In the early stage of economic development, structural change brings labor out of agriculture, which is the most labor-intensive sector in the economy, and reallocates them to the secondary sector, which is the most capital intensive in the economy. Subsequent structural change, however, will increase the share of the more labor-intensive service sector. As a result, the share of consumption would exhibit a U curve when a country moves from a low-income economy to a high-income economy. Li et al. (2009)'s cross-country panel study has confirmed this U curve.

Our study partly builds on Li et al. (2009)'s premise that the secondary sector has a lower share of labor income as compared with the other two sectors. Different from the existing literature, we introduce a political economy explanation for China's imbalances problem. Overall, governments play a significant role in capital formation in China. As shown in Figure 1, the share of savings and capital formation in government budget increased in most years since 1992, and by 2007 savings accounted for 44 percent of total government budget. That is, governments had higher saving rates than the household saving rate, which was 37.5 percent in 2007 (NBS, 2009). Our study helps understanding how the government's extraordinary savings have contributed to China's imbalance problem.

Figure 1. Government savings and capital formation in China[3]



Source: NBS (2009).

In the literature on infrastructure, most studies have focused on the role of infrastructure in promoting economic growth (e.g., Aschauer, 1989; Munnell, 1992; Morrison and Schwartz, 1996; Esfahani and Ramirez, 2003). Some studies explore the economic returns on specific infrastructural investments such as road (Fernald, 1999), telecommunication (Roller and Waverman, 2001), etc. For infrastructural investment in China, D´emurger (2001) provides empirical evidence on the links between infrastructure investment and economic growth. Compared with the rich literature on infrastructure's contribution to economic growth, very few studies have focused on the relationship between infrastructural investment and income distribution. Calderon and Servén (2004)

[3] Government disposable income is defined as total (government revenue - net current transfer); government saving is defined as (government disposable income - government consumption); government capital formation is defined as (government saving - government capital transfer - government net financial investment - other non-financial assets acquisition). All the data are available in the NBS' *Flow of Funds Accounts*.

is an exception. They have studied the relationship between infrastructural investment and income distribution based on cross-country panel data. However, their main interest is the income distribution among household. On contrast, we study the distribution between labor income and capital income. In addition, instead of studying overall infrastructural investment, we focus on infrastructural investment made by the government.

The rest of the paper is arranged as the follows. In Section I, we provide descriptive statistics to show how government infrastructural investment leads to lower shares of household consumption. In Section II, we conduct a reduced-form econometric analysis on the relationship between infrastructural investment and household consumption. In Section III, we move to structural estimations on the two channels for infrastructural investment to induce lower shares of household consumption, one by encouraging the development of the secondary sector, and the other by increasing capital returns in the industrial sector. Section IV concludes the paper with a discussion of the implications of our results.

I. Descriptive Analysis

Our data cover the period 1978-2006 for 28 Chinese provinces and regions.[4] They are obtained from published official sources. The National Bureau of Statistics (NBS) provides detail information on government expenditures. One category of government expenditures recorded by NBS is capital construction expenditure (*jiben jianshe zhichu*) which includes expenditures in three areas: (a) investment in railways, roads,

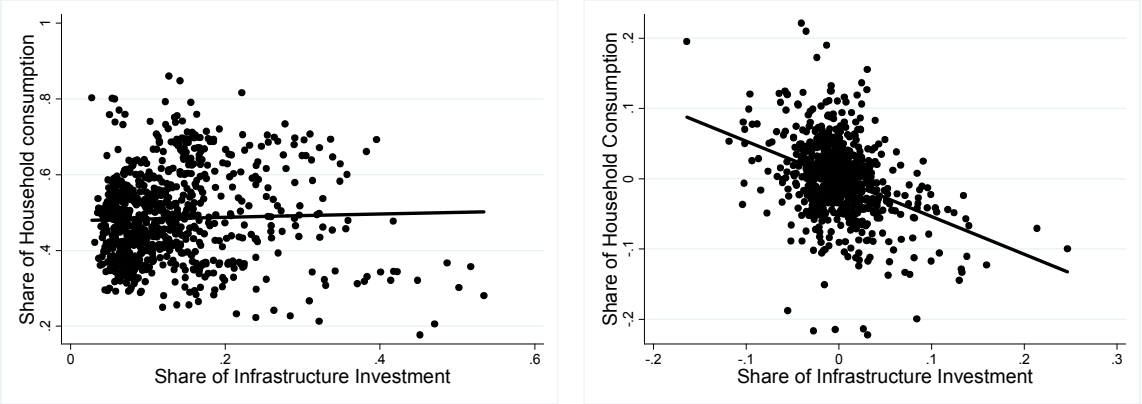
[4] Chongqing, Sichuan and Tibet are excluded. Chongqing was separated from Sichuan in the mid-1990s creating inconsistencies in their statistics. Tibet is an outlier because the majority of its government budget comes from the central government. Our data end at 2006 because the National Bureau of Statistics changed its sub-categories of government expenditure, and no longer provides the data of government investment starting in that year.

communications, power, water facilities, agriculture, forestry and municipal infrastructural constructions; (b) capital construction in national defense, education, science, culture, healthcare, law and other social welfare areas; and (c) other investment expenditures (Ministry of Finance, 1999). From this definition, it is clear that most sub-categories of capital construction are infrastructural investment. Therefore, we use capital construction expenditures as a measure for the government infrastructural investment in our paper.[5] The Appendix provides a description of the data and data sources used in this paper.

In this section, we provide descriptive evidence for our hypotheses. Figure 2 shows the relationship between the ratio of infrastructural investment in provincial government spending and the ratio of household consumption in the provincial GDP. The left panel plots the pooled data and the right panel plots the residuals after controlling provincial and year fixed effects. There is no definitive relationship between infrastructural investment and household consumption in the left panel, but there is a clear and negative relationship in the right panel. That is, increases in the share of infrastructural investment within a province reduce the share of household consumption in that province after common macroeconomic factors are controlled for.

5 We have confirmed the definition of government capital construction and infrastructural investment with the NBS staff and some local MOF (Ministry of Finance) staff. From conversations with them, we learned that most government capital construction expenditure flows to infrastructural investment. The most important areas of government capital construction are railways, roads, communications, power and water facilities, which all fall into the category of infrastructure.

Figure 2. Infrastructural investment and household consumption



The next several figures, all using pooled data, show the first indirect channel for government infrastructural spending to lower the share of household consumption by promoting the development of the secondary sector. Figure 3 establishes a positive relationship between infrastructural investment and the share of the secondary sector with the pooled data. Figure 4 then presents a negative relationship between the share of the secondary sector in GDP and the share of labor income in GDP. Finally, Figure 5 provides a significantly positive relationship between labor income and household consumption.

Figure 3. Infrastructural investment and the share of the secondary sector

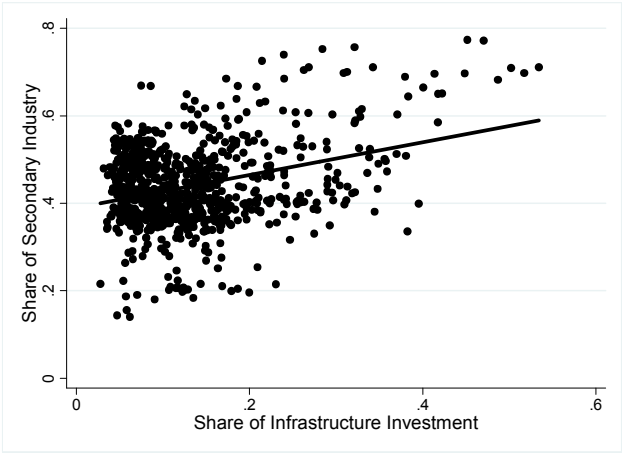


Figure 4. The secondary sector and share of labor income

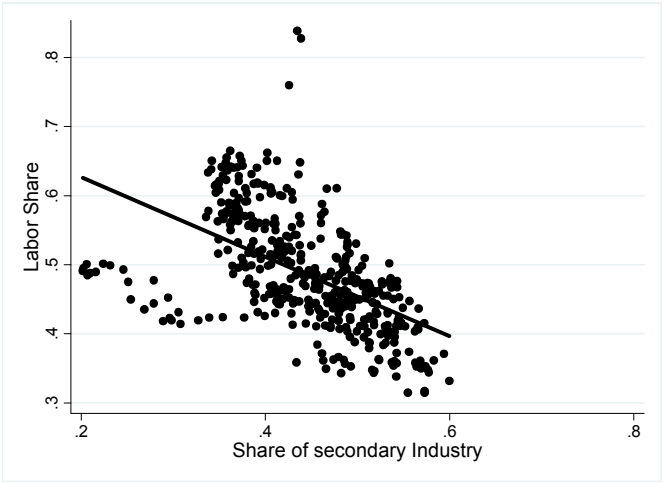
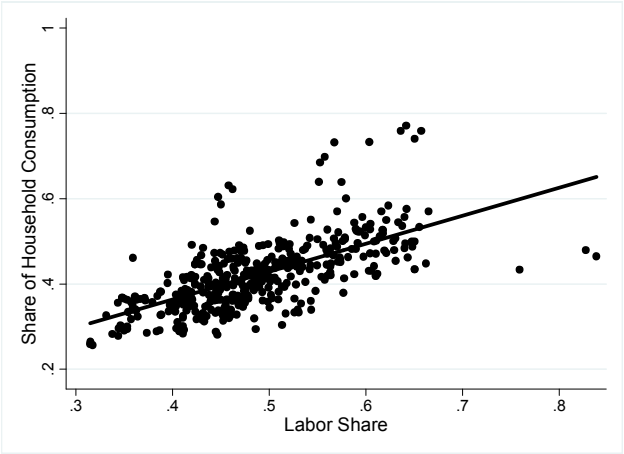


Figure 5. Share of labor income and share of household consumption



Then, Figures 6 – 8 try to establish the other channel for infrastructural investment to lower household consumption, namely, by increasing the profits in the industrial sector. Figure 6 shows that industrial profit rates are higher when provinces increase infrastructural investment in their budgets. Figure 7 shows that higher industrial profit rates are correlated with lower labor shares in the industrial sector. Figure 8 then establishes a positive relationship between the labor share in the industrial sector and the share of household consumption.

There could be a reverse causality against our two hypotheses. That is, a larger secondary sector and higher returns to capital increase government tax revenues so local governments can afford to spend more on infrastructure. This issue will be dealt with in our econometric analysis by controlling government revenues.

Figure 6. Infrastructural investment and industrial profit rates

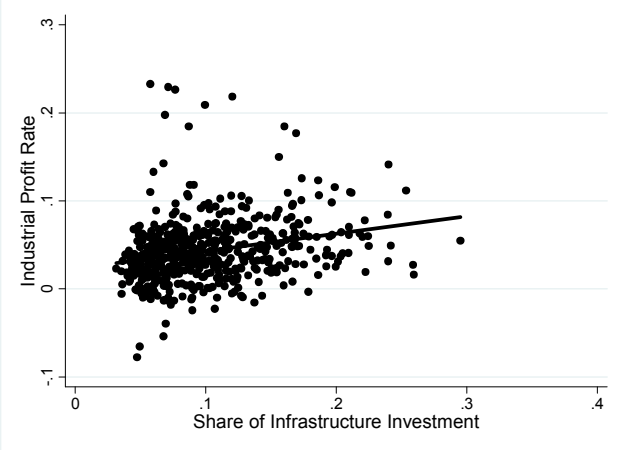


Figure 7. Industrial profit rates and labor shares in the industrial sector

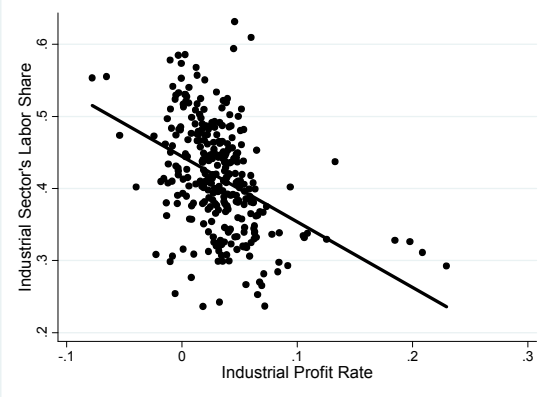
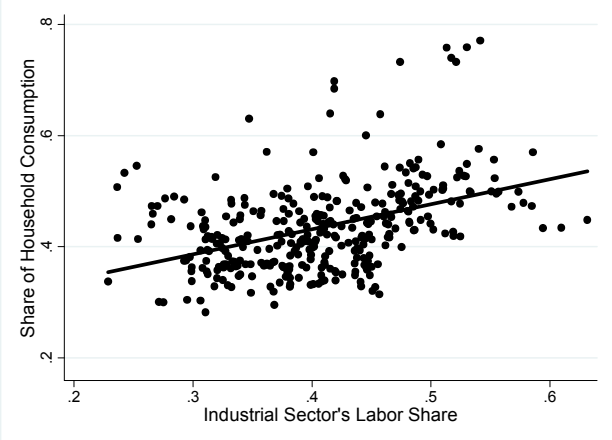


Figure 8. Industrial labor share and share of household consumption



II. Reduced-Form Analyses

2.1 Baseline results

In this section, we conduct reduced-form analyses on the relationship between government infrastructural investment and household consumption. The baseline model we estimate is the following two-way fixed-effect specification:

(1) $\text{hhcon\_ratio}_{it} = \alpha_0 + \alpha_1 \text{ infras\_ratio}_{it} + \beta X_{it} + v_i + v_t + u_{it}$,

where hhcon_ratio_{it} is the share of household consumption in GDP of province i in year t; infras_ratio_{it} is the share of government infrastructual investment expenditure in total government expenditure of province i in year t; X_{it} is a set of control variables, including the share of government revenue in GDP, per-capita GDP (10,000 yuan) and its square, share of employment of the state-owned enterprises (SOEs), and the trade dependency ratio (trade volume/GDP); v_i and v_t are respectively the provincial and year fixed effect; u_{it} is an i.i.d error term; and finally, α_0, α_1 and β are parameters to be estimated. Naturally, we expect α_1 to be negative if government infrastructural investment reduces the share of household consumption.

Some discussions of the control variables are in order. The share of government revenue in GDP is meant to control the direct crowding-out effect of government infrastructural investmen on household consumption. This can be understood in the GDP expenditure identity

(2) $C/Y + G/Y + I/Y + (X - M)/Y = 1$

where Y is GDP, C is household consumption, G is government expenditure of which government infrastructural investment is a part, I is private investment, and X – M is net export. By controlling G/Y, α_1 in our baseline equation (1) then measures the indirect

effect of infrastructural investment on consumption, which is what we are concerned with. However, accounting equation (2) is only satisfied at the country level, but not the provincial level. In China, a significant part of local government expenditure is from central government transfer. For example, the total local government expenditure in 2008 was 4.92 trillion yuan while the total local government revenue was only 2.86 trillion yuan (NBS, 2009). The gap was filled mostly by central government transfers. If central government transfers were disproportionally spent on non-capital items, such as social security and medical care, household consumption would increase in a province. Because local government revenue is more tied to the local economy, it matters more than local government spending when it comes to the crowding-out effect. That is why we control government revenue/GDP instead of government expenditure/GDP. An added benefit is that we are able to control the possible reverse causality running from a larger secondary sector and higher capital returns to more infrastructural investment, as we discussed at the end of the last section. Nevertheless, we will check the robustness of our baseline results using government expenditure/GDP.

Per-capita GDP and its square are included to capture the kind of structural change found by Li, Liu, and Wang (2009), i.e., the labor share exhibits a U curve as a country's income increases. A larger share of SOE employment can mean two things that conflict with each other. On the one hand, SOEs tend to be more capital intensive than private firms (Lin, 2003), so a larger share of SOEs may surpress the labor share in the whole economy. On the other hand, SOEs tend to pay their workers more than private firms, so within the industrial sector, more SOEs may increase the labor share. Indeed, Bai, Qian, and Wu (2008) find that privatization of SOEs is one of the factors leading to the

declining share of labor in the industrial sector. Later, our structural estimations allow us to distinguish between those two contradicting effects. Finally, a more trade-dependent province may have more labor-intensive enterprises because most of China's exports are labor-intensive products. The trade dependency ratio is meant to capture this effect.

There may be an endogeneity problem with some of the control variables. However, reverse causality or simultaneity is unlikely an issue for the share of SOE employment and the trade dependency ratio because those two variables are measures for a province's economic structure that should have little to do with household consumption. There may be an omitted variable issue, though. That is, household consumption and those two variables can all be correlated with some variables not controlled in our regressions. We hope that our provincial and year fixed effects will take care of this issue.

There may be a simultaneity problem with per-capita GDP and government revenue, though, like the GDP expenditure identity (2) shows. We make two arguments that this is not a serious problem. First, household consumption is determined by household income, so treating income as a predetermined variable for consumption is a reasonable approach, just like most studies on consumption do. On the other hand, the amount of government revenue is related to GDP and the tax rates which, like GDP, are also predetermined for consumption. Second, there may be a persistent component in GDP and government revenue that is correlated with consumption, but it should be controlled by the provincial and year fixed effects.

Since infrastructural investment comes from the government budget, our arguments for government revenues also apply to infrastructural investment. The remaining problem is the omitted variable issue. Our strategy is to take care of this issue by the provincial

and year fixed effects. In addition, we will check the robustness of our baseline results by lagging all the explanatory variables for one year and three years, repectively, running a regression of five-year averages, and perform the GMM estimation in a dynamic model.

The first column of Table 2 presents the results of the baseline two-way fixed-effect model defined by equation (1). All the estimates are highly statistically significant and intuitive to interpret. The result of government infrastructural investment confirms our expectation. If its share in government expenditure increases by one percentage point, the share of household consumption in GDP decreases by 0.31 percentage points. This is a large effect. If the share of infrastructural investment increases by one standard deviation, or eight percentage points (see the Appendix), household consumption drops by 2.48 percentage points. As expected, more government revenue is a significantly detrimental factor for household consumption. If the share of government revenues in GDP increases one percentage point, the share of household consumption declines by 0.69 percentage points. This effect is less than unit, implying that there are channels compensating household consumption, such as government transfers and a higher household consumption propensity due to a smaller disposable income. Notice that the negative effect for government infrastructural investment is obtained on top of the negative effect of government budget itself. That is, we have proven the indirect effect on top of the direct effect of government investment.

Table 2. Government infrastructural investment and household consumption: reduced-form analysis

Variables	FE	Expl. variables lagged 1 year	Expl. variables lagged 3 years	Five-year averages	Province-specific time trends as controls	Gov't exp. as control	Private investment
Infras_ratio	-0.310***	-0.318***	-0.275***	-0.498***	-0.219***	-0.555***	
	[0.042]	[0.044]	[0.043]	[0.114]	[0.033]	[0.044]	
Private inv. ratio							-0.048
							[0.051]
Gov'n revenue /GDP	-0.692***	-0.651***	-0.586***	-0.761***	-0.165***		-0.705***
	[0.050]	[0.051]	[0.050]	[0.099]	[0.064]		[0.052]
Gov'n exp. /GDP						1.042***	
						[0.085]	
Per-capita GDP	-0.125***	-0.110***	-0.099***	-0.186***	-0.053**	-0.044**	-0.152***
	[0.018]	[0.017]	[0.017]	[0.047]	[0.025]	[0.018]	[0.028]
Per-capita GDP^2	0.022***	0.020***	0.021***	0.035***	-0.002	0.014***	0.036***
	[0.003]	[0.003]	[0.003]	[0.007]	[0.003]	[0.003]	[0.007]
Share of SOE	-0.104**	-0.097**	-0.091**	-0.106	-0.172***	-0.136***	-0.039
	[0.043]	[0.042]	[0.042]	[0.103]	[0.048]	[0.046]	[0.050]
Trade/GDP	0.062***	0.051***	0.040***	0.081**	0.054***	0.020	0.072***
	[0.012]	[0.012]	[0.011]	[0.033]	[0.015]	[0.017]	[0.015]
Constant	0.574***	0.880***	0.885***	0.943***	2.602	0.249***	0.714***
	[0.049]	[0.052]	[0.053]	[0.108]	[4.877]	[0.050]	[0.055]
Observations	777	779	753	158	777	777	692
R^2	0.891	0.891	0.894	0.923	0.941	0.883	0.881

Standard errors are in parentheses. ***, ** and * represent the 1%, 5%, and 10% significant level, respectively.

Using the results of the plain FE and the variable means presented in the Appendix, we can calculate the total effect of government infrastructural investment on household consumption. To make it more transparent and comparable, we convert all the numbers into shares of GDP. Then, the indirect effect of infrastructural investment is a reduction of 0.76 percentage points of household consumption in GDP for an increase of one percentage point in the share of infrastructural investment in GDP. The direct effect can be obtained from the estimate for government revenue because the infrastructural investment considered here comes from government revenue. It is 1.22 percentage point reduction in household consumption for one percentage point increase in infrastructural investment. That is, government investment has a negative spillover effect, equivalent to 22 percent of the investment itself, on household consumption, possibly by inducing households to save more to capture higher returns of capital. This is quite different from total government spending which we just found has a compensating effect on household consumption. Adding up the direct and indirect effects, we then get the total effect of government infrastructural spending, which, expressed in elasticity, is 1.98, where the provincial GDP is used as the reference. This is a large effect. Nevertheless, the average share of government infrastructural investment in GDP in our sample is only 1.4 percent. That is, we do not expect a large variation of household consumption arising from the variation of the share of government infrastructural investment in GDP. More meaningful and more significant is the variation of infrastructural investment in the government budget, which we just showed reduces household consumption by 2.48 percentage points relative to GDP for an increase of one standard deviation in it.

Per-capita GDP shows a U curve. This is because income is highly correlated with structural change. When a province still relies heavily on agriculture, its per-capita income is low. But agriculture provides a higher share of labor income. When a province enters a stage of more industrial development, its share of labor income declines. Then when it reaches the next stage of service development (like in Beijing where services account for more than 70 percent of its GDP), the share of labor income increases again. This U curve is consistent with Li et al. (2009)'s finding with cross-country data. A larger share of SOE employment reduces the share of household consumption. This shows that the economy-wide negative effect of SOEs overweighs their possible positive effect in the industrial sector. Openness, measured by the trade dependency ratio, increases the share of household consumption. This finding is consistent with the nature of China's exports that are concentrated in the labor-intensive sectors. The magnitude of the effect, though, seems to be moderate: if trade dependency increases by one percentage point, share of consumption only increases by 0.06 percentage points. However, China's exports are highly concentrated; the nine coastal provinces contribute 90 percent of the total export volumes (NBS, 2010). Other things equal, those coastal provinces then have significantly higher shares of consumption than other inland provinces.

2.2 Robustness checks

The other models in Table 2 are meant to check the robustness and consistency of our baseline results. In Columns 2 and 3, we lag all the explanatory variables by one year and three years, respectively.[6] Those two exercises are meant to accompolish two things. The first is to reduce the possible simultaneity problem arising between the right-hand

[6] The sample size of column 2 is larger than the baseline model because we can use household consumption ratio in 2007 as dependent variable although the data of government infrastructural investment ratio end in 2006.

variables and household consumption. The second is to allow the effects of government infrastructural investment to lag for several years. This consideration makes sense because in our theorectial framework those effects come into place by altering economic structure and increasing capital gains, both of which take time to show up. The results of the two exercises, though, are quite similar to those of the baseline FE model.

Then in Column 4 we run the FE model again by averaging everything by five-year intervals to control potential cyclical macroeconomic movements. We get stronger results for most variables although the neagtive effect of SOEs' employment share becomes insignificant. In particular, the effect of government infrastructural investment increases dramatically. Now we have a reduction of 0.5 percentage points in the share of household consumption for one percentage point increase of the investment share in government spending.

In most Chinese cities, rents are low relative to housing prices. Therefore, it is possible that using imputed rents from owner-occupied homes to account for housing consumption may underestimate household consumption in China. As a result, the declining share of consumption in GDP may be superficial.[7] However, Wang and Wen (2011) show that China's saving rate has still increased since 2000 even if all new housing investment is added back to household consumption. Data limitations prohibit us from conducting a similar exercise using provincial data. The year dummies help us capture the common trend of the real estate market at the country level. To account for regional variations, we include the interation terms between the provincial dummies and the time (t = 1978, 1979, ..., 2006) as additional controls and rerun the baseline regression.

[7] We thank an anonymous referee for pointing out this possibility.

These interaction terms impose separate linear time trends for individiual provinces. Because housing prices have increased almost universally over the years, these province-specific time trends can do a fairly good job to control the discranpacies between imputed rents and housing prices. In addition, they offer a control for other time trends at the provincial levels. The results are reported in column 5 of Table 2. The coefficient of infrastructural investment is still highly significant although its magnitude is smaller than the baseline result.

In Column 6 we substitute government expenditure/GDP for government revenue/GDP. The coefficient of infrastructural investment remains highly significant and its magnitude becomes even larger. However, the coefficient of government expenditure is positive, rather than negative. That is, central government transfers may have indeed boosted local consumption. This shows that government revenue is a more reasonable control for government investment's crowding-out effect on household consumption.

When we deducted our hypothesis that government infrastructural investment hurts household consumption, we relied on the premise that government infrastructural investment is different from private infrastructural investment in that government investment exceeds the socially desired level and entails subsidies to producers. That is, our hypothesis should not apply to private infrastructural investment. To obtain data for private infrastructural investment, we subtract government capital construction from the total societal capital construction (*quan-shehui jiben jianshe touzi*). NBS provides

provincial data for both kinds of investment for years before 2004.[8] As a result, the time span for our analysis of private infrastructural investment is shorter. In Column 6 of Table 2 we replace government infrastructural investment ratio by the ratio of private capital construction in GDP and rerun the baseline regression defined by equation (1). It turns out that the private investment ratio does not have a significant effect on the share of household consumption although its coefficient is negative. That is, private investment does not have either a direct crowding-out effect or an indirect induced effect on the share of household consumption.

The baseline FE model may suffer from the problem of spurious correlation because the consumption data may contain a strong intertemporally persistent component. To address this issue, we add the lagged dependent variable on the right-hand side of equation (1) to create a dynamic model and estimate it by the GMM estimator derived by Arellano and Bond (1991). Table 3 presents the results. Columns 1 and 2 present the results of the original sample using the first-difference GMM and the system GMM, respectively. Neither model, however, passes the Sargent test although most previous results have been preserved. The failure is caused by the long panel of our data that introduces too many instruments. To make a remedy, Columns 3 and 4 estimate the two models again on five-year averages. There are less significant results than in Table 2, but the negative effect of infrastructural investment is preserved (albeit with a lower significance in the system GMM). In fact, the long-run effects obtained by the two

[8] Before 2004, NBS provided data for four sub-categories of total societal fixed capital investment at: capital construction, innovation, real estate development and other investment. It no longer provides the data of capital construction after 2004 although it continues to provide data for government capital construction.

models, 0.51 and 0.47, are both very close to what we find in Table 2 using the same five-year average sample.

Table 3. Infrastructural investment and household consumption: GMM estimations

	Model 1	Model 2	Model 3	Model 4
$Hhcon\_ratio_{t-1}$	0.823***	0.859***	0.352***	0.446***
	0.025	0.026	0.161	0.092
Infras_ratio	-0.067***	-0.042**	-0.333***	-0.263*
	0.023	0.018	0.106	0.136
Gov'n revenue/GDP	-0.097**	-0.060	-0.451**	-0.257
	0.042	0.044	0.193	0.183
Per-capita GDP	-0.019***	-0.016**	-0.094***	-0.046
	[0.007]	[0.006]	[0.033]	[0.043]
Per-capita GDP^2	0.003***	0.003***	0.009	0.001
	0.001	0.001	0.006	0.004
Share of SOE employment	-0.032	-0.013	-0.118	0.002
	0.023	0.026	0.121	0.139
Trade/GDP	0.007	0.014**	0.100**	0.107**
	0.005	0.006	0.051	0.052
Constant	0.103***	0.066***	0.428***	0.245
	0.021	0.023	0.145	0.150
AR(2) P-Value	0.286	0.269	0.502	0.477
Sargan P-value	0.008	0.014	0.429	0.311
Model	Difference GMM	System GMM	Difference GMM	System GMM
Sample Size	746	775	108	136

Standard errors are in parentheses. ***, ** and * represent the 1%, 5%, and 10% significant level, respectively.

2.3 Levels of consumption and aggregation

Our theory is that government infrastructural investment reduces the share of household consumption by reducing the share of household income. However, our baseline results may have been obtained by households' declincing propensity to consume. This would be possible if the increase of government investment induced

households to save more (possibly because of higher returns to capital as a result of better infrastructure). To check this possibility, we run a regression of households' propensity to consume on government infrastructural investment and the control variables we used before. The results are presented in the first column of Table 4. The coefficient of infras_ratio is positive and insignificant, meaning that government infrastructural investment does not affect households' propensity to consume.

Table 4. Levels of consumption and aggregation

Dependent Variables	Household consumption/ Household income	Per-capita household consumption	Household consumption/ National GDP
Infras_ratio	0.057	-0.028	-0.003*
	[0.036]	[0.035]	[0.0017]
Gov'n revenue /GDP	0.046	-0.031	0.007***
	[0.041]	[0.034]	[0.002]
Per-capita GDP	-0.044***	0.209***	0.002*
	[0.013]	[0.018]	[0.001]
Per-capita GDP2	0.008***	0.030***	-0.000**
	[0.002]	[0.003]	[0.000]
Share of SOE employment	0.011	-0.261***	-0.017***
	[0.042]	[0.052]	[0.002]
Trade/GDP	-0.032***	0.058***	0.005***
	[0.008]	[0.016]	[0.001]
Constant	0.860***	0.321***	0.010***
	[0.043]	[0.053]	[0.003]
Observations	749	777	777
R^2	0.775	0.986	0.967

Standard errors are in parentheses. ***, ** and * represent the 1%, 5%, and 10% significant level, respectively.

It may be argued that since infrastructure is conducive to economic growth, government investment in it can increase the level of household consumption by increasing household income. If that were the case, it would not be too bad for the government to build more infrastructure. We check this possibility by running a

regression for per-capita household consumption and present the results in the second column of Table 4. The coefficient of infras_ratio is negative and highly insignificant. That is, government investment in infrastructure does not help increase the level of consumption.

The above two results provide hints for the channels for government infrastructural investment to reduce the share of household consumption in GDP. Government investment promotes economic growth, but does not affect households' propensity to consume, nor does it affect the level of consumption, so the negative impact of government investment on the share of household consumption has to be caused by the slower growth of household income relative to GDP. In the next section, we will show that government investment does reduce the share of labor income, the largest component of household income, in provincial GDP.

One thing that needs further discussions is whether we can use our results to make inferences for the whole country. That is, we need to consider the aggregation issue. That more infrastructural investment reduces the share of household consumption in a province does not automatically mean that this is true for the whole country. If the provinces with higher shares of household consumption got larger shares of the national GDP when their governments increased investment in infrastructure (which is quite possible because better infrastructure helps economic growth), we would observe that the share of household consumption in GDP at the national level increased as a result of increased total government investment in infrastructure. That is, dynamic between-group variations may make it impossible for us to make inferences for the whole country out of our regressions based on provincial level data. However, our baseline results are robust to

this possibility because the two-way fixed-effect estimation allows us to estimate the within-province effect of government infrastructural investment. The remaining question is whether we can treat the marginal effect we have obtained so far for government infrastructural investment as its marginal effect for the whole country. While a direct answer is impossible, we replace the dependent variable in equation (1) by the share of the ith province's consumption in the national GDP and rerun the FE regression to get a sense of it. The results are presented in the last column of Table 4. The interpretation of the coefficient of infras_ratio is how much a province's investment in infrastracture affects the share of household consumption at the national level, holding other provinces' household consumption constant. It turns out that this effect is negative and significant at the 10% significance level. The point estimate shows that if a provincial government increases infrastructural investment by one percentage point in its budget, that province's household consumption will decline by 0.003 percentage points relative to the national GDP. That is, more government investment in a province reduces its share of consumption relative to the national GDP, and for that matter, reduces the national share of consumption in GDP if the levels of consumption in other provinces are held constant.

III. Structural Estimation to Explore the Channels

In the introduction, we discussed two possible channels for government infrastructural investment to reduce the share of household consumption in addition to its direct crowding-out effect. One is by encouraging the development of the most capital-intensive sector in the economy, the secondary sector, and the other is by increasing capital gains

in the industrial sector. Section I provided descriptive evidence for those two channels. In this section, we conduct structural econometric analyses to formally prove them.

3.1 The secondary sector

For the first channel, we estimate the following recursive equation system:

(3) $\text{Hhcon\_ratio}_{it} = \alpha_{01} + \alpha_{11}\text{Labor\_share}_{it} + v_{1i} + v_{1t} + u_{1it}$,

(4) $\text{Labor\_share}_{it} = \alpha_{02} + \alpha_{12}\text{Sec\_ratio}_{it} + \beta_1 X_{it} + v_{2i} + v_{2t} + u_{2it}$,

(5) $\text{Sec\_ratio}_{it} = \alpha_{03} + \alpha_{13}\text{Infras\_ratio}_{it} + \beta_2 X_{it} + v_{3i} + v_{3t} + u_{3it}$,

to establish the linkage running from more infrastructural investment to a larger secondary sector, and then to a lower share of labor income, which is ultimately linked with a lower share of household consumption. In the equations, labor_ratio_{it} is the labor share (labor compensation/ GDP) of province i in year t; Sec_ratio_{it} is the share of value added of the secondary sector in GDP of province i in year t; the v's are provincial and year fixed effects; the α's are parameters to be estimated; and the u's are i.i.d. error terms distributed by the normal distribution. The control variables in X_{it} are those we used before. We do not include any control variable in the consumption equation because we are primarily interested in how the labor share changes when government investment increases and the further link between the labor share and the consumption share is only indicative. Table 5 presents the results of the SUR and 3SLS estimations for the equation system. Notice that the sample size is much smaller than in the previous regressions. This is because data for labour shares at the provincial level are only available after 1993.

Table 5. Secondary sector and household consumption

Variables	SUR			3SLS		
	Consumption	Labor share	Secondary sector	Consumption	Labor share	Secondary sector
Labor_share	0.749***			0.784***		
	[0.039]			[0.045]		
Sec_ratio		-0.309***			-0.799*	
		[0.097]			[0.481]	
Infras_ratio			0.152***			0.152***
			[0.037]			[0.037]
Gov'n revenue/GDP		0.304*	-0.269***		0.168	-0.268***
		[0.174]	[0.088]		[0.209]	[0.088]
Per-capita GDP		0.008	0.017		0.009	0.018
		[0.024]	[0.013]		[0.024]	[0.013]
Per-capita GDP^2		0.002	-0.011***		-0.003	-0.011***
		[0.004]	[0.002]		[0.006]	[0.002]
Share of SOE employment		0.023	0.095***		0.072	0.095***
		[0.067]	[0.034]		[0.082]	[0.034]
Trade/GDP		0.012	0.037***		0.035	0.037***
		[0.018]	[0.009]		[0.026]	[0.009]
Constant	0.056***	0.371***	0.354***	0.039*	0.640***	0.281***
	[0.020]	[0.081]	[0.037]	[0.023]	[0.155]	[0.034]
Observations	392	392	392	392	392	392
R^2	0.389	0.769	0.941	0.380	0.748	0.941

Standard errors are in parentheses. ***, ** and * represent the 1%, 5%, and 10% significant level, respectively.

Let us first look at the results of the SUR model, starting with equation (5) for the secondary sector. The two results we first notice are that more government spending on infrastructure increases the size of the secondary sector, confirming our theory, whereas the size of the government revenue has a negative impact --- possibly because a larger government budget requires higher tax rates, which discourage industrial development. The positive effect of infrastructure is economically significant: if its share in government budget increases by one percentage point, the secondary sector increases by 0.15 percentage point relative to the provincial GDP. As for other variables, there is a weak

inverse U curve for per-capita GDP, and a larger SOE sector and more international trade are found to be associated with a larger secondary sector. Traditionally, SOEs were more in the manufacturing sector than in the service sector, and there were virtually no SOEs in agriculture. In more recent years, most SOEs have been privatized and those left behind are mostly in the manufacturing sector. On the other hand, it is easy to understand the positive relationship between trade and secondary sector because most of China's trade involves manufacturing goods.

Then in equation (4) for the labor share, a large negative effect is found for the secondary sector: if its share in GDP increases by one percentage point, the labor share declines by 0.36 percentage points. It is interesting to find that government revenue increases the labor share. However, this result is not robust. In the 3SLS regression, it turns highly insignificant although the coefficient remains positive.

Lastly, in equation (3) for the consumption share, we study the whole effect of labor share. A one percentage increase of the labor share is found to increase the share of consumption by 0.75 percentage points. This result is intuitive because labor income consists of more than 90 percent of household income (Bai and Qian, 2009b).

Coming to the 3SLS estimation, we find that it yields qualitatively similar results as those of the SUR estimation for equations of the secondary sector and consumption. However, the results for the labor share equation are different. As pointed above, government revenue becomes insignificant. In addition, the coefficient for the secondary sector becomes substantially larger although its statistical significance drops. This may have something to do with the covariance matrix of the three error terms.

3.2 Profit rates

For the second channel, we estimate the following equation system:

(6) $\text{Hhcon\_ratio}_{it} = \alpha_{01} + \alpha_{11}\text{Labor\_share\_ind}_{it} + u_{1it}$,

(7) $\text{Labor\_share\_ind}_{it} = \alpha_{02} + \alpha_{12}\text{Profit\_indus}_{it} + \beta_1 X_{it} + v_{2i} + v_{2t} + u_{2it}$,

(8) $\text{Profit\_indus}_{it} = \alpha_{03} + \alpha_{13}\text{Infras\_ratio}_{it} + \beta_2 X_{it} + v_{3i} + v_{3t} + u_{3it}$,

to establish the linkage running from infrastructural investment to industrial profits, then to labor share in the industrial sector, and finally to household consumption. In the equations, Profit_indus_{it} is defined as firm profits divided by output in the industrial sector; $\text{Labor\_share\_ind}_{it}$ is defined as labor compensation of the industrial sector divided by industrial value-added. The definitions of the other symbols are the same as previously defined. Table 6 presents the results of the SUR and 3SLS estimations for the equation system. The sample size is again smaller than the baseline regressions because the data of labor share in the industrial sector are only available from 1993 to 2004.

The two sets of results are qualitatively the same except for the industrial profit rate in the labor share equation, which is insignificant in the SUR model, but significant at the 10% significance level in the 3SLS model. For the other variables, government investment in infrastructure increases profits by 0.13 percentage points for one percentage point increase of its own; a higher share of SOEs significantly increases labor share in the industrial sector, consistent with Bai, Qian, and Wu (2008)'s finding that SOE privatization is one of the factors leading to the declining share of labor in the industrial sector; finally, industrial labor share is found to be positively correlated with the share of household consumption in both the SUR and 3SLS models although the

strengths are much smaller than those found for the economy-wide labor share in the equation system (3)-(5), a result intuitively understandable.

Table 6. Industrial profits and household consumption

Variables	SUR			3SLS		
	Consumption	Labor share	Profits	Consumption	Labor share	Profits
Labor_share_ind	0.552***			0.600***		
	[0.056]			[0.066]		
Profit_indus		-0.008			-1.415*	
		[0.110]			[0.809]	
Infras_ratio			0.126***			0.125***
			[0.044]			[0.044]
Gov'n revenue/GDP		-0.047	-0.043		-0.089	-0.043
		[0.197]	[0.101]		[0.234]	[0.101]
Per-capita GDP		0.057	0.042*		0.089	0.042*
		[0.043]	[0.023]		[0.055]	[0.023]
Per-capita GDP^2		-0.001	-0.009**		-0.010	-0.009**
		[0.008]	[0.004]		[0.011]	[0.004]
Share of SOE employment		0.295***	0.037		0.349***	0.037
		[0.094]	[0.048]		[0.117]	[0.048]
Trade/GDP		-0.029	-0.005		-0.030	-0.005
		[0.020]	[0.010]		[0.024]	[0.010]
Constant	0.210***	0.106	-0.008	0.190***	0.153	-0.007
	[0.023]	[0.101]	[0.053]	[0.028]	[0.121]	[0.053]
Observations	308	308	308	308	308	308
R^2	0.154	0.717	0.670	0.142	0.561	0.670

Standard errors are in parentheses. ***, ** and * represent the 1%, 5%, and 10% significant level, respectively.

IV. Conclusions

In this paper, we have found that the share of household consumption in GDP declines with an increase of the share of infrastructural investment in government spending in Chinese provinces. Our results are robust to a variety of specifications and estimation methods. As a contrast, we do not find any significant impacts of private capital investment on household consumption. In addition, we do not find that government infrastructural investment increases either households' consumption propensity or their

levels of consumption, so its negative impacts on the share of household consumption must come from its reduction of household income. We theorize that this reduction emerges because government infrastructural investment is above social optimum and subsidizes industrial production. As evidence for this theory, we have found two channels, in addition to the direct crowding-out effect, for infrastructural investment to reduce the share of household consumption, one by increasing the size of the secondary sector, and the other by increasing capital gains in the manufacturing sector, both reducing the share of labor income.

Our results make a contribution to the literature on infrastructure. While most of the literature studies the impacts of infrastructure on economic growth, an often neglected aspect is that infrastructure's impacts on the economy may vary by sectors. The sectors that use infrastructure more intensively benefit more from it. But those sectors are usually more capital intensive because they tend to use highways more to transport their inputs and consume more electricity and other utilities. Therefore, infrastructure can have an income distribution effect by which capital is favored over labor.

Our results have important implications for China to rebalance its economy. A direct implication is that the government needs to lower its saving rates and shifts more of its spending to the areas, such as education and social security, which complement household consumption. An indirect, but stronger implication is that the current arrangement of fiscal decentralization needs to be scrutinized carefully. Fiscal decentralization has been shown by theoretical and empirical studies to play a significant and positive role promoting economic growth in China (Qian and Roland, 1998; Jin, Qian, and Weingast, 2005). The main mechanism is competition; local governments compete to

offer concessions, mostly in land prices and infrastructural costs, to potential investors in the hope of faster economic growth and more tax revenues. However, the fierce competition inevitably leads to the race-to-the-bottom problem. Our results add another question mark on it, i.e., competition among local governments distorts the economic structure and in the end will likely suffocate economic growth because it will slow down the growth of demand.

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Appendix: Data Description

Variables	Variable Definition	Data Sources	Obs.	Mean	St. dev.
hhcon_ratio	Household consumption/ GDP	*Comprehensive Statistical Data and Materials on 50 years of New China*, and "China Economic Information Network"	853	0.48	0.12
Infras_ratio	Infrastructural investment/ Government Expenditure	*Comprehensive Statistical Data and Materials on 50 years of New China*, and *China Statistics Yearbook* (1999~2009)	811	0.13	0.08
Labor_share	Labor income/ GDP	*Data of Gross Domestic Product of China (1993~2004)* and *China Statistics Yearbook* (2005~2009)	420	0.49	0.08
Labor_share_ind	Industrial labor income/ industrial value-added	*Data of Gross Domestic Product of China* (1993~2004)	336	0.41	0.08
Profit_indus	industrial profit/ industrial output	"China Economic Information Network"	614	0.05	0.04
Per-capita household consumption	Household consumption/ Population	Comprehensive Statistical Data and Materials on 50 years of New China, and "China Economic Information Network"	853	0.25	0.31
Private investment ratio	(Total capital construction- government capital construction) / GDP	Same as above	760	0.12	0.07
Sec_ratio	Secondary industry GDP / GDP	Same as above	868	0.44	0.10
Gov'n revenue/GDP	Government Revenue / GDP	Same as above	868	0.11	0.07
Per-capita GDP	Per capita real GDP (2000 constant price, 10,000)	Same as above	868	0.67	0.76
Per-capita GDP2	Per capita real GDP square	Same as above	868	1.03	2.96
Share of SOE employment	Number of SOE workers/ number of total workers	Same as above	866	0.73	0.12
Trade/GDP	(Import+export) /GDP	Same as above	849	0.22	0.34

Notes: government revenue is budgetary revenue and does not include extra-budgetary revenues such as those coming from land sales. Extra-budgetary data are not available for provinces.

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