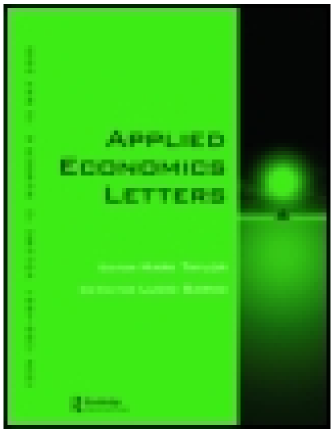

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Road to success? The effects of road toll on economic growth in China

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Road to success? The effects of road toll on economic growth in China

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This article examines the effects of road tolls on economic growth in China. Using a provincial panel data and pool mean group method, we find that a 1% rise in road tolls leads to 0.005% and 0.03% reduction in GDP growth and GDP per capita, respectively. Moreover, it shows that although more road tolls may contribute to financing local transportation networks, they hinder inter-regional trade thus result in more serious market segmentation.

Keywords: toll roads; economic growth; pool mean group method; China

JEL Classification: H23; H41; D61

I. Introduction

The contribution of transportation infrastructure to economic growth has been emphasized in a large body of literature (e.g., Michaels, 2008; Atack *et al.*, 2010; Banerjee *et al.*, 2012), showing that well-developed transport networks may lead to better market accessibility and lower trade costs, promoting economic growth. China's recent experience seems to be a good example of rapid growth in GDP per capita (more than 9% annually) corresponding with unprecedented expansion of the nation's transport networks (World Bank, 2013). By 2012, China's express roads had reached 90 620 km in length, the world's longest network (World Bank, 2013). A growing body of empirical evidence indicates that China's economic boom over the last several decades was promoted by the growing provision of transportation infrastructure (Démurger, 2001; Lin and Song, 2002; Banerjee *et al.*, 2012; Faber, 2014). However, that causation is worthy of being rethought.

If one closely looks at China's government expenditures and its investment in roads, 80% of the road construction seems to have been financed by bank loans as of 2010 (Ministry of Transport of China, 2011). To repay the loans, Chinese local governments have resorted to imposing charges on a large proportion of public roads. Specifically, 95% of expressways, 61% of first-class and 42% of second-class highways are now toll roads (Ministry of Finance of China, 2012). The toll revenues are a part of governments' extraordinary budgets, a proportion which rose sharply from 1% in 1990 to 45.5% in 2010 (Ministry of Finance of China, 2012). This situation motivates us to study the influence of nationwide road tolls on economic growth in an emerging economy like China, a subject which rarely receives scholarly examination. This detailed

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study has shown that a negative impact of road tolls on economic growth in China: an increase in tolls by 1% corresponds with 0.005% slower growth in GDP and 0.03% lower GDP per capita. In the long run, growth in road tolls seems to impede inter-regional trade and to lead to greater market segmentation. These findings raise questions about emerging countries' development patterns and plans for road construction.

The remaining of the article is organized as follows: Section II discusses the data and methodology, Section III presents the results and Section IV concludes.

II. Data and Method

Chinese provincial data covering the period 1995 to 2010 were analysed. The main dependent variables were GDP growth rate and GDP per capita. We explore the potential mechanism of effects of road tolls on economic growth by the four dimensions: length of each province's roads (a variable labelled 'infrastructure') (Atack *et al.*, 2010), domestic trade volume (Baier and Bergstrand, 2001; Limao and Venables, 2001), a market segmentation index (MSI, where a larger value implies greater market segmentation) (Young, 2000) and relative prices index (inflation) (Kormendi and Meguire, 1985; Barro, 1991). In economic growth accounting model, we control investment as a fraction of GDP, the number of primary and secondary students per 10 000 populations and the population growth rate (Levine and Renelt, 1992). Level of industrialization, total population, trade openness, government size and relative employment size of state-owned enterprises (SOEs) were also controlled for in the channel analysis (Chen *et al.*, 2007; Wu and Liu, 2009; He and Fan, 2011) (Table 1).

The initial model is:

$$Y_{it} = \alpha_1 toll_{it} + X_{it}'\beta_1 + \mu_i + \mu_t + \varepsilon_{it} \tag{1}$$

where *I* and *t* denote province and year, respectively. Y_{it} is the dependent variable of interest. $toll_{it}$ represents the logarithm of the total road tolls. X_{it}' is a vector of covariates. μ_i and μ_t are province and year fixed effects. ε_{it} is an i.i.d error term.

It is reasonable to assume that the dependent and independent variables are persistently affected by lagged effects, so a dynamic panel approach was employed and Equation 1 was rewritten as an autoregressive distributed lag ([*p*,*q*]) model:

Table 1. Summary statistics

Variables	Obs.	Mean	SD
Independent variable			
Road tolls (¥/ton-km)	387	0.105	0.129
Dependent variables			
GDP growth rate (%)	387	10.090	16.943
GDP per capita (thousands of 1990 ¥)	387	14.25	13.12
Length of roads (m/person)	387	1.743	4.410
Total road freight (tonnes/100 km)	387	9671.235	10 236.864
Market segmentation index	387	0.055	0.061
Relative prices	387	1581.325	291.802
Control variables			
Investment/GDP (%)	387	5.467	1.523
Human capital (primary and secondary students per 10 000 persons)	387	1570.055	278.850
Population growth (‰)	387	6.580	3.472
Industrialization (secondary and primary/GDP, %)	387	57.239	6.149
Total population (10 000 persons)	387	4838.812	2292.142
Openness (total trade/GDP, %)	387	32.067	41.123
Government size (government spending/GDP)	387	14.167	6.095
Size of SOE employment (employees of SOEs/total employees, %)	387	18.217	17.201

Source: Statistical Yearbook of China (NBS, 2013).
Notes: For details of the construction of the MSI and values for the period 1990 of 2007, see Lu and Chen (2009). The same method was used to extend this index through 2010. There were 387 observations for each variable.

$$Y_{it} = \sum\nolimits_{d=1}^{p} \delta_2 Y_{i,t-d} + \sum\nolimits_{d=0}^{q} \alpha_2 toll_{it} + X'_{it}\beta_2 + \mu_i + \mu_t + \varepsilon_{it} \quad (2)$$

where p and q denote lags. If all variables in Equation 2 satisfy I (1), then for each province ε is an I (0) process. Reparameterizing Equation 2 yields an error-correction model as follows:

$$\Delta Y_{it} = \theta_i\left(Y_{i,t-1} - \pi_i toll_{it}\right) + \sum\nolimits_{d=1}^{p-1} \delta_3 \Delta Y_{i,t-d} + \sum\nolimits_{d=1}^{q-1} \alpha_3 \Delta toll_{it} + X'_{it}\beta_2 + \mu_i + \mu_t + \varepsilon_{it} \quad (3)$$

where $\theta_i = -(1 - \delta_2)$ indicates the coefficient of error correction and is expected to be negative in the long run. $\pi_i = \frac{\Sigma\alpha_2}{1-\delta_2}$ denotes the long-run overall relationship between road tolls and Y_{it}, which is the key parameter of interest in this study.

The pool mean group (PMG) approach developed by Pesaran *et al.* (1999) allows the short-run intercepts, slope coefficients and error variances to vary in estimating the coefficients of Equation 3. This feature isolates the short-run dynamics and the heterogeneous attributes of different Chinese provinces, which a traditional fixed-effects model cannot do.

III. Results

Table 2 presents the relationship between road tolls and GDP growth (column (1)) and the logarithm of GDP per capita (columns (2) and (3)). The error-correction coefficients in all columns are significantly negative, which is consistent to the expectation that θ is negative in the long run. Importantly, a higher level of road tolls correlates significantly with lower GDP growth and lower GDP per capita, implying that higher tolls impede local economic development. Column (3) includes a squared road tollsterm and the coefficients show a greater burden of higher tolls on economic performance. In sum, a 1% rise in the level of road tolls correlates with 0.005% less GDP growth (column (1)) and a 0.03% lower GDP per capita (column (3)).

Further analysis using the same model explored potential channels through which road tolls may have impacts on economic growth. Table 3 shows that regardless of the channel the error-correction coefficients are significantly negative, which is consistent with the results presented in Table 2. In the long run, an increase in road tolls will contribute to an expansion of local roads (column (1)) but it will also lead to a larger MSI value (column (3)), indicating increased market segmentation and a decline in road freight, a proxy for inter-provincial trade. Table 3 does not provide any significant evidence that a rise in road tolls correlates with a difference in relative prices. In summary, more tolls mean more local government revenue, which may finance the upgrading of local transportation infrastructure. But heavier tolls may impede trade and become an obstacle to market integration. The adverse effects of road

Table 2. Effects of road tolls on economic growth (PMG estimation)

Dependent variable	GDP growth (%)	Log of GDP per capita	Log of GDP per capita
	(1)	(2)	(3)
Error-correction coefficient (θ)	−0.617*** (0.212)	−0.373*** (0.129)	−0.310*** (0.144)
Long-run coefficient (π) log of road tolls	−0.005** (0.002)	−0.0005** (0.0001)	−0.0004*** (0.0001)
Squared road tolls			−0.0062* (0.0034)
Short-run coefficients log of lagged GDP per capita	−0.130* (0.071)	0.681*** (0.026)	0.533*** (0.039)
Investment/GDP	1.108*** (0.223)	1.349*** (0.313)	1.002*** (0.419)
Log of human capital	0.019*** (0.005)	0.001 (0.003)	0.000 (0.002)
Population growth	−0.0112* (0.566)	−0.001* (0.000)	−0.000** (0.000)
Province fixed effect	YES	YES	YES
Year fixed effect	YES	YES	YES
Number of provinces	26	26	26
Obs.	387	387	387
Log likelihood	2390.11	3978.91	4130.26

Notes: SE's are presented in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 3. Channel analysis (PMG estimation)

Dependent variable	Log of length of roads	Log of road freight	Market segmentation index	Relative price
	(1)	(2)	(3)	(4)
Error-correction coefficient (θ)	− 0.557*** (0.079)	−0.438*** (0.068)	−0.213*** (0.032)	−0.570*** (0.094)
Long-run coefficient (π) log of road tolls	0.0003** (0.000)	−0.014** (0.007)	0.015*** (0.002)	0.013 (0.664)
Short-run coefficients industrialization	0.017*** (0.004)	0.036*** (0.007)		
Log of population	0.032*** (0.009)	0.029** (0.015)		
Openness			0.378*** (0.124)	
Government size			0.711* (0.349)	
Size of SOE employment			0.887*** (0.255)	
Province fixed effect	YES	YES	YES	YES
Year fixed effect	YES	YES	YES	YES
Number of provinces	26	26	26	26
Obs.	387	387	387	387
Log likelihood	2391.82	2078.12	2987.58	2109.76

Notes: SEs are presented in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

tolls on economic development shown in Table 3 have dominated in China in recent years, which echoes the results in Table 2.

The system-GMM approach was also implemented as a robustness check, and all the coefficients of the main variables in Tables 2 and 3 remained similar. Details are available on request.

IV. Conclusion

This study examined whether an increase in road tolls correlates with reduced economic growth in China. Using provincial panel data covering the period 1995 to 2010 and PMG estimations, it found that a 1% increase in road tolls correlates with 0.005% slower GDP growth and 0.03% lower GDP per capita. Higher road tolls may contribute to financing local road networks, but they impede inter-regional trade and thus lead to greater market segmentation. China's expansion of its road network and the heavy burden of road tolls may constitute an example of extraction which has significant adverse impacts on long-run economic performance.

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