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Road investments and inventory reduction: Firm level evidence from China

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ABSTRACT

This study presents new evidence on the causal impact of transport infrastructure on the economy. In China, inventory has declined over recent decades, while the country's road infrastructure has expanded rapidly. Building on the existing literature, we introduce new approaches, including a quasi-experiment based on differential demand for distant suppliers, to identify the causal relationship between road investments and inventory decline. Examining a large panel data set of Chinese manufacturers from 1998 to 2007, we find one dollar of road spending saves around two cents of inventory costs. This effect is non-trivial but less than that in the United States in the 1970s. Moreover, our estimates also suggest spillover effect from road investments to firms in neighboring provinces.

1. Introduction

China has made large scale road infrastructure investments since 1990s. According to China Statistical Yearbooks, the total length of roads in China has more than doubled since 1990, reaching 2.6 million kilometers by 2008. The total length of expressways has increased from 147 km in 1988 to over 50,000 km in 2007, ranking second only to the United States. At the same time, China's GDP grew by about 9% per year, while GDP per capita increased by 8% annually. There is a common view that the infrastructure investments have played an important role in sustaining the rapid economic growth of China.

However, empirical evidence on the productivity of road infrastructure investments in China is rare, and the investment efficiency has been frequently questioned. Using province-level data, Demurger (2001) finds that the differences in infrastructure development can explain the observed differences in firm productivity across provinces. In contrast, Fleisher and Chen (1997) find that China's transportation infrastructure had no significant effect on its economic growth and firm productivity during 1979–1993. Huang (2008) also argues that China's infrastructure spending has been inefficient because the investment decision was biased by government officials' incentive to pursue short-term GDP growth through physical investments. A typical criticism to these studies using aggregate data has been the reverse causality between infrastructure and aggregate output: although infrastructure investment may facilitate production, economic growth could also create demand for infrastructure, which would cause a bias in estimated returns to infrastructure (Shatz et al., 2011).[1] Without a clear identification of the causal effect, it is difficult to estimate the investment efficiency due the endogeneity bias.

One possible way to circumvent this endogeneity problem is to study micro-channels through which infrastructure affects the aggregate productivity of the economy (Gramlich, 1994). In this study, we examine the impact of road infrastructure investments on inventory costs in China. From 1998 to 2007, the inventory-sales ratio of median and large manufacturers in China decreased steadily from 22% to 13%, a level comparable to that of developed countries.[2] In theory, road investments in China could have contributed to this decline of raw materials inventories, as faster and more predictable delivery can reduce firms' materials inventory as a safety buffer (Meyer et al., 1959). Hence, with a more reliable

[1] Beginning with Aschauer (1989), a large body of literature estimates efficiency of road infrastructure investment. Shatz et al. (2011) did an excellent survey of literature. In specific, most of these studies find significant and positive associations between infrastructure investments and outputs at aggregated level: Aschauer (1989), Holtz-Eakin (1988), Munnell (1990), Rubin (1991), and Morrison and Schwartz (1996). In contrast, Hulten and Schwab (1991), Tatom (1991, 1993) and Munnell (1992) report insignificant results.

[2] There are several possible explanations for inventory decline in emerging markets, such as improved management efficiency and technical change (Cuthbertson and Gasparro, 1993). Market integration may also play an important role (Louri, 1996).

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transportation network, firms are able to save on inventory holding costs by cutting their inventory stock, leading to improvement in individual firms' productivity (Shirley and Winston, 2004).[3] This efficiency gain may be particularly significant for developing economies where inventory levels are typically twice or three times as large as in developed countries (Guasch and Kogan, 2001).

To identify the causal effect of road investments on firms' input inventories, we introduce two approaches to address the endogeneity issue. This issue can arise from omitted variables, such as unobserved capital costs, inventory management technology, and business cycle.[4] In one approach, we show that the bias due to the omitted variables can be reduced if we add final goods inventory of firms to the regressions. This is because the final goods inventory serves as a proxy control of many of the omitted variables. As long as road investment does not increase final good inventory, a lower-bound estimate of the impact of road investments on input inventory can be obtained. In an alternative approach, we split firms into treatment and control groups according to the location of their suppliers. Control group, such as ready-to-mix concrete firms, rely heavily on local suppliers; treatment group, such as electronics firms, often have distant suppliers. If road investment does affect firms' input inventory, then the effect of road investment in other provinces should affect only the treatment group, but not the control group. This is the hypothesis to test in the second approach. Although both approaches have limitations, together they should strengthen our empirical evidence.

We mainly rely on data from the National Bureau of Statistics of China (NBS) for empirical analysis. In particular, inventory and other firm attributes are from a firm level data set, Annual Survey of Industrial Firms (ASIF). This widely used data set covers the universe of median and large enterprises in China during 1998–2007 and accounts for more than 85% of the industrial outputs of China (Jefferson et al., 2008). This data set has been adopted in a number of high quality researches, including Song et al. (2011), Cai and Liu (2009), and Lu and Tao (2009). Although some variables in this data, such as outputs, may suffer from measurement problem due to the influence of local governments, this is less relevant for inventory due to the lack of incentive for local officials to manipulate this figure. Another challenge of data is the lack of measures for road investment. We address this issue by using provincial road length from China Statistical Yearbooks to approximate road stock. Compared with the value of investments, road length is readily available and should be more reliable due to the simplicity to measure and verify.

We find that road investment in China indeed contributed to inventory decline, although the efficiency appears relatively low. In particular, road infrastructure investments reduced input inventory by about 4% cumulatively from 1998 to 2007. The implied saving in inventory costs per dollar of road spending is around 2 cents, which is about one-third of the estimate in the United States during the 1970s (Shirley and Winston, 2004). Given that China was still in an early stage of infrastructure development, the inventory-saving effect is relatively small. We argue that this small return could be due to the misallocation of public investments by the government and to the inefficiency of SOEs.

Our findings also shed light on the network externalities of road investment and on market integration in China. Other than the effect of road investment on local firms, we find a non-trivial spillover effect of road networks on firms in neighboring provinces, which accounts for around two-thirds of all the inventory reduction due to road investment. This spatial spillover effect is an indication that the goods market in China is integrated to a certain degree, despite the presence of widespread local protectionism (Li et al., 2012, 2013; Naughton, 2003; Bai et al., 2004).

The remainder of this paper is structured as follows. We first summarize stylized facts from China during the sample period. Section 3 presents our model specification and identification strategy. We then describe the data and preliminary patterns in Section 4, followed by estimation results in the succeeding section. We conclude the paper in Section 6.

2. The institutional background

In this section, we summarize relevant stylized facts about the Chinese economy, including the massive infrastructure investments, the rapid decline of inventory, and economic reforms.

2.1. Road infrastructure investments and inventory decline

China increased its infrastructure investments from below 2% of GDP in the early 1980s to around 6% by the early 2000s (Fig. 1), well above the 4% average of developing countries (World Bank, 2005). According to China Statistical Yearbooks, between 1979 and 2008 the total road length almost tripled, reaching 2.6 million kilometers, with most of this increase occurring after 1990.[5] Expressways extended from none in 1988 to over 60,000 km in 2008, and are expected to reach 80,000 km by 2010, approaching the current freeway length in the United States of nearly 90,000 km.

As in many other developing economies, the inventory holdings of Chinese firms were once high (Chikan, 1991; Guasch and Kogan, 2001). Since the early 1980s, the level has decreased dramatically. For example, the inventory-sales ratio for the wholesale and retail industry dropped sharply in China, from 64% in 1982 to 16% in 2007 (Fig. 2). Moreover, the total inventory accumulation, i.e., the annual change in the inventory stock as a share of the change in GNP, declined from 81% to 27% between 1953 and 2008 (column 2 of Table 1). A significant share of this decline may have occurred in the manufacturing sector as it accounted for two-thirds of the inventory accumulation, according to the Bureau of Statistics. To put it in perspective, the inventory-GDP ratios of developed economies are generally low. For example, according to Table 3 of Ramey and West (1999), the ratio for the United States was around 16% in 1995.[6]

Some researchers have offered alternative explanations for sharp inventory decline. For example, Naughton (2007, pp. 148) argues that the high inventory level of Chinese firms at the beginning of the reform might be due to inefficient production processes. Alternatively, Chikan (1991) suggests that expectations of shortages may explain why firms accumulated excess inventory in the Soviet Union. However, few rigorous tests have been conducted.

2.2. Reforms: privatization, opening, and financial reform

Many other changes in the Chinese economy after the mid-1990s may have also affected inventory levels. These include the massive expansion of private enterprises, the opening of the

[3] With lower inventory levels, firms could better utilize their capital to finance production processes and technology development, which enhance productivity. A lower inventory holding also makes it easier to expose and subsequently resolve problems in the production process, leading to higher productivity (Lieberman and Demeester, 1999).

[4] Guasch and Kogan (2001) examine the effect of road investment on inventory using cross-country panel data models. Shirley and Winston (2004) estimate the relationship between firm inventory and state highway investments in the USA, controlling for industry and state fixed effects.

[5] According to China Statistical Yearbooks, the total length of roads does not include roads built to connect villages.

[6] In the USA, the manufacturing sector accounts for almost 50% of total inventory investment (Blinder and Maccini, 1991), and 30% of total stock of inventory (Ramey and West, 1999).