Journal of International Economics 103 (2016) 166–183

Contents lists available at ScienceDirect

Journal of International Economics

journal homepage: www.elsevier.com/locate/jie

Intermediate input imports and innovations: Evidence from Chinese firms' patent filings

Qing Liu[a], Larry D. Qiu[b,*]

[a] School of International Trade and Economics, University of International Business and Economics, China
[b] Faculty of Business and Economics, The University of Hong Kong, Hong Kong

ARTICLE INFO

Article history:
Received 26 May 2015
Received in revised form 21 September 2016
Accepted 27 September 2016
Available online 5 October 2016

JEL classification:
F13
F15
O14
O31

Keywords:
Trade liberalization
Intermediate input
Innovation
Patent

ABSTRACT

Innovation plays a key role in economic growth. In this paper, we investigate the effects of intermediate input tariff reduction on the innovation activities of domestic firms. Input tariff reduction has two opposite effects on the innovation decision of a firm: it may promote innovation because the cost of innovation activities decreases, but it may also result in a decrease in innovation because foreign technologies become cheaper. We use Chinese firm-level data from 1998 to 2007, which features a drastic input tariff cut in 2002 because of China's WTO accession, and find that input tariff cut results in *less* innovation undertaken by Chinese firms. The findings are obtained using the difference-in-differences technique and are robust to various specifications checks of the model. We also provide a theoretical framework to generate insights to the empirical findings.

1. Introduction

Innovation and technological progress are key determinants of economic growth. In his 2014 State of the Union Address, US President Barack Obama claimed that "the nation that goes all-in on innovation today will own the global economy tomorrow". The past few decades have witnessed the race for innovation and deepening globalization worldwide. How does trade liberalization influence the incentive of firms to engage in innovation activities? This important question has been addressed by a large body of literature. Most existing studies are based on final goods trade and confirm that trade is one of the most important factors that drive innovation (Kiriyama, 2012). In contrast, this paper examines the effects of intermediate input tariff liberalization on firm innovation activities. Our study is based on Chinese firm-level data.

A growing share of international trade is in capital goods and intermediate inputs. At the global level, the share of capital goods in total trade increased from 21.0% in 1970 to 26.5% in 2006 while the share of intermediate goods in total trade increased from 7.5% to 13.0% (Onodera, 2009). From 2000 to 2006, the total value of China's capital and intermediate input imports increased by 151% and 256%, respectively. Another notable change is China's growing innovations. For example, China's share of global research and development (R&D) jumped from 2.2% in 2000 to 14.5% in 2011.[1] In 2011, China's patent office received the highest number of applications worldwide.[2] Thus, China is a good case for analyzing the effects of intermediate input imports on innovations. Drastic trade liberalization in China also makes the country a good case for valid empirical investigation of such an issue. On the one hand, the average input tariff rate in China dropped from 13.74% in 1998 to 8.13% in 2007, with the greatest cuts after 2001 when the country became a member of the WTO. On the other hand, the degrees of input tariff liberalization differ tremendously across industries. By utilizing these two features, namely, large and sudden tariff cuts due to the WTO accession and cross-industry variations of the cuts, we are

* Corresponding author.
E-mail addresses: qliu1997@gmail.com (Q. Liu), larryqiu@hku.hk (L. Qiu).

[1] *Foreign Policy*, "It's official: China is becoming a new innovation powerhouse", Feb. 6th, 2014.
[2] *The Economist*, "How innovative is China? Valuing patents", Jan. 5th, 2013.

http://dx.doi.org/10.1016/j.jinteco.2016.09.009
0022-1996/

able to use the difference-in-differences (DID) technique to assess empirically the effects of input tariff cuts on the innovation activities of domestic firms.

Against backdrop, our analysis shows that China's input tariff liberalization *reduces* innovation activities of firms as measured by patent filings. This negative effect is both statistically significant and economically important: a one-percentage point cut in input tariff rate results in about 0.15% to 0.28% drop in innovations. This finding is robust to different model specifications and concerns of the model. This finding is also interesting because it is neither obvious nor expected.

A cut in intermediate input tariffs could have positive and negative incentives to innovation activities. On the one hand, input tariff reduction enables a firm to purchase a larger quantity of input with more varieties and higher quality. This capability lowers a firm's incentive to undertake innovation because the firm can raise its production productivity or output quality through a cheaper channel (i.e., importing intermediate inputs). On the other hand, a firm may undertake R&D by using intermediate inputs, and its innovation activities may benefit from the technology embedded in imported inputs. As a result, the cost of undertaking R&D decreases or the effectiveness increases, and hence, a firm's incentive to do R&D increases. Our empirical finding implies that the innovation-reducing effect dominates the innovation-raising effect in China.[3] We introduce a simple theoretical model to understand the mechanism at work, and find that under some very plausible conditions, a firm imports higher quality inputs in response to a tariff cut in intermediate input, which results in a reduction in innovation.

To the best of our knowledge, the present paper is the first to investigate the *direct* effects of intermediate input imports on innovation based on firm-level data. Two strands of related literature exist.[4] In the first strand, some papers have examined the effects on innovations by trade liberalization in general, but not by intermediate input imports in particular, and thus their conclusions and mechanisms differ considerably from the present paper. Generally speaking, trade affects innovation through various channels, such as transferring embedded technology, increasing market size, changing competition, realizing scale economies, and generating spillovers. Examples in this strand include Baldwin and Gu (2004), de Negri and Turchi (2007), Almeida and Fernandes (2008), Lileeva and Trefler (2010), Aw et al. (2011), Bustos (2011), and Bloom et al. (2016).[5] In particular, Bloom et al. (2016) find that import competition from China leads to more innovations of European firms, but imports from other developed countries have no significant effect. Using firm-level data covering 43 developing countries, Almeida and Fernandes (2008) report that on average 53% of the technological innovations are embodied in new machinery or equipment and transferred from developed to developing countries through exports and multinational firms. In their analysis of 43,595 firms in Brazil and Argentina, de Negri and Turchi (2007) find that national exporters are in general more innovative than non-exporters, with the percentage of innovating firms in these two categories being 48% and 36%, respectively.

The second strand of literature includes the recently emerging empirical studies on the effects of intermediate input imports on firm's performance.[6] Several studies (Halpern et al., 2011 on Hungarian firms; Kasahara and Rodrigue, 2008, on Chilean firms) find that imports of intermediates or declines in input tariffs are conducive to productivity gains. Productivity can increase through three channels via imported intermediate inputs: learning, improved input quality, and increase in input variety. Using Indonesian manufacturing plant-level data, Amiti and Konings (2007) find that a 10% fall in input tariffs leads to a 12% gain in the productivity of importing firms, which is much higher than the productivity gain from reducing output tariffs. Qualitatively similar results are also found by Topalova and Khandelwal (2011) based on Indian data. Goldberg et al. (2010) examine the effects of trade liberalization in India during the 1990s and find that domestic firms increase their product scope because they can access previously unavailable new input varieties. Approximately 31% of the new products are results of lower input tariffs. Using firm-level data from the French agrifood sector, Chevassus-Lozza et al. (2013) discover that lowering input tariffs increases the export sales of high-productivity firms at the expense of low-productivity firms. Bas (2012) shows that Argentine firms in industries experiencing larger input tariff reductions have higher probability of entering the export market. Using French data, Bas and Strauss-Kahn (2014) find that using more varieties of imported input results in higher TFP and export scope. However, not all results are positive. For example, van Biesebroeck (2003) finds that there is no productivity improvement for Columbia firms through the use of input import.[7] Muendler (2004) also finds that the use of foreign inputs plays a minor role in the productivity change of Brazilian firms.

Similar to the present research, several studies have also examined the effects of Chinese input tariff reductions, but with different focuses. Using data on Chinese firms from 2000 to 2006, Yu (2015) finds that both input tariff and output tariff reductions improve firm productivity for both processing-trade and non-processing-trade firms. In particular, the effect of input tariff reduction on productivity is stronger than that of output tariff reduction. Ge et al. (2011) investigate the channels of firm productivity gains from input tariff cut and find supports for the learning, variety, and quality channels. Fan et al. (2015) and Bas and Strauss-Kahn (2015) examine the effect of Chinese input tariff reduction on the change in quality of export goods and find significant quality upgrade. Feng et al. (2016) study the connection between firm imports and exports, based on Chinese firm-level data from 2002 to 2006. They find that firms that expand their intermediate input imports raise the volume of their exports and increase their export scope. All these studies suggest that the channel through which intermediate input imports affect firm performance is the increased technology or quality embedded in imported inputs.[8]

[3] A good example which supports this general empirical finding is Changhong's response to imported technology. Changhong is a large TV maker in China. Through "imitation" the company was able to introduce many new product lines in early 1980s. Beginning in 1986, Japanese TV makers dumped the new generation of color TV production lines and key components to the Chinese market. In response, Changhong stopped its own R&D but just purchased the Japanese technology because of the low cost. The full story can be found in http://news.xinhuanet.com/fortune/2011-05/03/c_121370462.htm.

[4] Grossman and Helpman (1991) provide a very comprehensive study on the relationship between trade and innovation. See Atkeson and Burstein (2010) and Burstein and Melitz (2013) for the recent approaches.

[5] Earlier empirical studies are based on country-level or industry-level data. For example, Coe and Helpman (1995) find strong international R&D spillovers through trade, based on evidence that the productivity growth of a country depends not only on its domestic R&D capital stock but also on the R&D capital stock of its foreign trading partners.

[6] Theoretical studies have painted a clear picture (e.g., Ethier, 1982). Firms' performance can improve from intermediate input imports because of the increased variety of inputs and the utilization of technology embedded in imported inputs.

[7] Zhang (2014) decomposes productivity gains to static and dynamic gains. Dynamic gains come from the increase in knowledge and/or innovation of the importers because of imported intermediate inputs. He uses Columbia data to show that dynamic gains are more important than static gains.

[8] Using new product sales as a measure of innovation, Liu and Buck (2007) show that Chinese firms increase their innovations when they import more technology. Using data from 1965 to 1995 for 86 countries, Connolly (2003) finds that high technology imports from developed countries increase domestic innovations (perhaps through initial imitation), especially for developing countries. He argue that this is perhaps through reversed engineering.