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Global Value Chain Embeddedness and Latecomer's Productivity: Examining the Springboard Perspective

Abstract: Participating in global value chains (GVCs) can potentially raise the level of productivity of latecomer firms in developing countries. We investigate this hypothesis using a large Chinese firm-level dataset with 208,078 firm-year observations for the period from 2000 to 2006. We find an inverted U-shaped relationship between GVC embeddedness and the Chinese firms' productivity. The productivity gain also depends on the nature of the GVC embeddedness: indigenous Chinese firms, firms that focused on the high-end of a value chain, independent manufacturers, and firms that targeted the markets of developed countries experienced greater productivity improvements from participating in GVCs. Our results bear upon public policies that are aimed at helping developing country firms to capture and maximize the productivity benefits of GVC embeddedness.

Keywords: Global Value Chain; Productivity; Springboard Perspective

1. Introduction

In the past two decades of globalization, both large multinational enterprises (MNEs) from developed countries and the latecomer firms from developing countries are aggressively building and participating global value chain (GVC) (Gereffi et al., 2005; Gereffi and Memedovic, 2003; Humphrey and Schmitz, 2002). Luo and Tung (2007) suggest that internationalization pattern of firms from developing countries are different from their counterparts from developed economies. The formal firms are more likely use the internationalization as the springboard to improve their capability and overcome the latecomer disadvantage. Can these latecomers benefit from GVC participation in productivity improvement? What kind of factors can they leverage to jump from the springboard?

There is an emerging literature on GVC (Beugelsdijk et al., 2009; Gereffi et al., 2005; Gereffi and Memedovic, 2003), although few of researches especially focus on the latecomer from developing countries, or the peripheral area of GVC (Prithwiraj et al., 2012; Santangelo, 2009). Mudambi and Puck (2016) criticize that the "regional strategy" perspective only counts the activities of Fortune Global 500 but widely ignore the other participators of GVC, especially from the latecomer firm in developing countries. From the latecomer's perspective, on the one hand, participating in the international division of labor allows firms to have access to larger international market, enlarge economies of scale; to purchase cheaper, more diverse materials, even import foreign intermediate inputs with higher-quality and high-tech, and improving the level of technology and innovation capacity (Morrison et al., 2008); also to strengthen the competitive pressure effect on domestic firms, in order to force the firms' transformation and upgrading, and technological innovation (Baldwin and Yan, 2014; Kelly, 2004;. Chiarvesi et al,

2010). On the other hand, developing countries have a little domestic value added (Bonaglia and Goldstein, 2007), and because of long-term dependence on imports of high-tech components from developed countries, they were locked at the low-end of GVC and even fell into " value captured" (Lepak et al., 2007). Thus, participating in GVC may also cause diminishing marginal effect, or the "inverted" U-shaped relationship which we propose in this study.

Researches about effects of GVC embeddedness on productivity mainly focused on empirical evidence from developed countries (such as Baldwin and Yan, 2014; Brancatia et al, 2014.). In the last two decades, Chinese firms fast improve their productivity and competitiveness. One notable feature is their deep embeddedness in GVC. World Trade Report find that Chinese firms are actively engaging GVC and increase its participation level from 25% in 1995 up to 50% in 2014 (WTO, 2014). With a large dataset from the Chinese Industrial Firm Database, China Customs Import and Export Database and the World Input Output Database, we collect the data of 208,078 firm-year observations and take an in-depth analysis from the firm level to find out how global value chain could affect the total factor productivity, a key measure for firm competition and country economic growth (Krugman, 1991).

We try to make these contributions: (1) We develop a new measure GVC embeddedness and examine the springboard perspective (Luo and Tung, 2007) -- the influence of GVC embeddedness on firm's total factor productivity. We find the inverted U-shaped relationship between GVC embeddedness and productivity. It indicates that engaging GVC could be a springboard for the latecomer firms from developing countries, but over-embeddedness of GVC could reduce the positive effect on productivity; (2) We find that different engagement configurations in GVC could moderate the positive effect of GVC participation on productivity

improvement. For example, the independent manufacturers benefit more from participating GVC than the original equipment manufacturers. Original equipment manufacturers lack of production autonomy and independent development goals, resulting poorer knowledge obtaining and 'learning effect' from GVC; (3) We further find the mechanism of GVC in the periphery area. To be specific, we examine the impacts of different variables such as the firm's type, position in GVC, and targeting markets on the relationship between GVC embeddedness and productivity improvement. Our findings enrich the literature on the core-periphery relationship in GVC and carry some policy implications.

2. Literature Review and Hypothesis Development

2.1 Research Gap in the GVC Literature

How can participation in global value chains affect total factor productivity? It has been explained clearly in theory, but the experimental research progress is very slow, due to how to measure the level of the firms' GVC embeddedness. Brancatia et al. (2014) use a two-stage system GMM method to run an empirical studies on Italian firms, which shows that GVC participation will significantly affect corporate productivity and profits, and the impact on profits is greater than the impact on productivity. This effect is most prominent in those final product producers and high quality products supplier who import cheap foreign intermediate goods. Furthermore, Baldwin and Yan (2014) collect the propensity score matching method to analyze the impact of Canada's manufacturing firms to participate in global value chains on productivity, who find that those companies carried out economic and trade relationship with high-income countries promote faster growth in productivity by access to larger markets and more advanced technology. Furthermore, Wang et al. (2014) collect 23 industrial industry panel data from 1999 to 2012, analyze the technological progress effect of the global value chain embeddedness, and find that embedded into GVC can promote technological progress, but due to the presence of

inhibition effect, GVC embeddedness and technological advances have an inverted U-shaped relationship. However, global value chain, served as the global trade organization and governance forces at the same time, makes China's foreign trade collaboratively blockaded

by producer-driven and buyer-driven value chain, and fell into imports into trapping network that imports and exports induce each other, technology and market double catch up with each other. This suppresses domestic firms' industrial upgrading (Morrison et al., 2008).

At present, productivity effects studies of GVC are mainly focus on the national and industry levels. But such researches cannot identify the heterogeneous effects of firm's strategy in value chain, even within the same industry. It is difficult to give a strategic guidance for the firms. Based on strategy choice theory (Child, 1972), different firms within the same industry may have various position, configuration, and development of GVC embeddedness. Especially when considering the firm heterogeneity, which emphasis on the allocation of resources within the industry among firms, it is necessary to analyze the impacts of GVC on specific firm's economic activity at the firm level. Recently, the increasing firm-level researches though of a small amount provide empirical evidence for in-depth understanding of heterogeneous firms' productivity effect in the global value chain.

2.2 The Inverted U-shaped Relationship between the GVC Embeddedness and Firm's Productivity

We summarize the existing literature and find that integration into global value chains improve the productivity of firms through three channels: Firstly, entering a larger market can make firms

to develop economies of scale, learn new techniques and products, and become more productive. Baldwin and Yan (2014) use the propensity score matching method to analyze the impacts of Canada's manufacturing firms' participating in global value chains on productivity, and found out that participating GVC can help promoting productivity, especially those firms have economic and trade relationship with high-income countries get more "learning effect" to promote faster growth in productivity by having access to larger markets and more advanced technology (Morrison et al., 2008). Secondly, firms have much easier access to cheaper intermediate goods, broader product or high-quality foreign investment, which can reduce costs and improve productivity. Kelly (2004) points out that imports of intermediate products is the main channel for technology spillovers, embedding GVC is equivalent to more easily obtaining foreign high-tech products and intermediate inputs, thereby improving productivity levels. Brancatia et al. (2014) use a two-stage system GMM method to run an empirical study on Italian enterprises, which show that GVC participation will significantly affect productivity and profits, and the impact on profits is greater than the impact on productivity. This effect is most prominent in final product producers and high quality products supplier which import cheap foreign intermediate goods. Thirdly, participating GVC have to face competitive pressure from the international market, which may encourage firms to improve productivity in order to cope with intense international competition (Amighini and Rabellotti, 2006; Chiarvesio and Di Maria, 2009;Chiarvesio,Di Maria and Micelli,2010). Based on the above analysis, we propose the first hypothesis of this article:

H1a: The Chinese firm will gradually improve total factor productivity when firm is embedded into the GVC.

However, some scholars put forward the opposite view. UNCTAD (2013) considered that because there is a certain gap between cutting edge of technology and innovation systems in developing countries and developed countries, domestic firms in developing countries could only based on competitive advantages such as labor and natural resources, and be engaged in low value-added high-energy processing assembly sector while embedding into GVC. This led to dependence on imports of high-tech parts from the developed countries. Developed countries have indirectly spillover effect on developing countries by outputting technology and knowledge to meet their import demand of high-quality and environmentally friendly products through the value chain when the developing countries are still in the early stages of the value chain. These enabled developing countries achieve the productivity improvement through the "learning effect" of the value chain (Evenson, 1995). However, developing countries mainly export technology-mature or labor-intensive products with low-cost advantage. Such model can easily be "captured" by dominated international buyers and multinationals, especially when developing countries are climbing from the low-end segments to the high-end segments. During this progress, it may be subject to double strike and control by international buyers or multinationals in developed countries, and then locked in low value-added, meager-profit low-end manufacturing sectors (Humphrey, 2002; Gereffi, 2001). In this case, GVC participation can also result in diminishing marginal effect or the "inverted U-shape" relationship. Wang et al. (2014) use industrial panel data of 23 industries from 1999 to 2012 and analyze the technological progress effect of the global value chain embeddedness, found that embedded into GVC can promote technological progress, but due to the presence of inhibition effect, GVC embeddedness and technological advances have an inverted U-shaped relationship. Depending on the

perspective of diminishing marginal efficiency improvement, we put forward our second hypothesis:

H1b: The Chinese firm will reduce total factor productivity when firm is over-embedded into GVC. In other words, there is the inverted U-shaped non-linear relationship between the GVC embeddedness and the Chinese firms' total factor productivity.

2.3 The Heterogeneous Relationships between the GVC Embeddedness and Firm's productivity among Different Firms

Are all firms can benefit from the productivity process? Which firm benefits more? A key reason for discrepancies between firms is the different types of ownership. GVC participation is an act of firms to join into the global market competition. By learning and improving at the international level, the domestic firms can not only improve the productivity and domestic mechanism through competition, but can also learn new technology from international peers, upstream and downstream suppliers. As Gereffi (2001) points out that within buyer-driven production chain, domestic firms of developing countries have rapid escalation space in the technology upgrading and product upgrading stages. With the low production cost manufacturing capacity due to specific lower factor endowments, domestic firms of developing countries which have knowledge gaps with the international forefront can achieve more substantial productivity improvement and intense learning effect in the GVC dominated by the foreign firms from developed countries. Based on this mechanism, we propose the following hypothesis.

H2: The domestic Chinese firm will benefit more total factor productivity improvement from GVC embeddedness than the foreign invested firm in China.

Once the contract manufacturing systems of developing countries is upgrading and entering the high-end of the value chain, the developed countries will introduce more stringent standards (such as entry barriers on quality, safety, and environmental protection and rapid changes in product upgrading requirements) and make use of substitutability between developing countries or other means to impede and control the upgrading process,

"lock" the contract manufacturing systems of developing countries in the low-end of GVC. At present, there are two main business model of Chinese trade firms, one is mixed firms which undertake the entire design production and sales process as an independent company and participate in the GVC. The other is processing trade firms based on contract manufacturing. Therefore, processing trade firms which only undertake specific tasks are much easier to be "captured" by developed countries and more difficult to improve their productivity (Levy xx). Therefore, we propose:

> *H3: The Chinese independent manufacturers will benefit more total factor productivity improvement from GVC embeddedness than the Chinese original equipment manufacturers.*

The impacts of GVC embeddedness on the firms' productivity are more likely to be reflected in the heterogeneity of value chain itself, namely firms at different GVC stages may enjoy different productivity improvement. Firms at high-end may have more access to the upstream production and processing sectors of core components, and have more opportunities to obtain the "learning effect", while firms at the low-end of the value chain are relatively closer to the consumer, thus facing with more substitutability and competition (Sun et al., 2010). Therefore, we expect a reverse result of the GVC embeddedness on the productivity improvement of firms at different GVC stages.

H4: The Chinese firms focused the high-end position of value chain will benefit more total factor productivity improvement from GVC embeddedness than the Chinese firms focused the low-end position of value chain.

In the past two decades, MNEs in developed countries continue to configure GVC and move different parts to the efficient locations, making it more specialized and advanced (Beugelsdijk et al., 2009). Baldwin and Yan (2014) argue that GVC exposure to different foreign markets allows firms to gain different economies of scale, learning different technology, and improve different capability in research and innovation. At the same time, companies can more easily purchase foreign intermediate inputs with high quality and improve productivity and competitiveness. Based on the possibility of this mechanism, we have to carefully examine the subject effects of the firms in developed countries, therefore make the corresponding hypothesis as follows:

H5: The Chinese firms targeted the markets of developed countries will benefit more total factor productivity improvement from GVC embeddedness than the Chinese firms targeted the markets of developing countries.

3. Data, Variables, and Econometric Model

3.1 Sample

We combine data from the "Chinese industrial firm database"[1] and "China customs import and export database"[2]. We match the original firm data from these two database with no elimination

[1]Since the "China Industrial Firm Database" has the problem of deficiency and abnormity of indicators, we filter the data as follows: delete the observations lacking total industrial output, and annual average balance of net fixed assets; delete samples does not meet the accounting principles, namely when current assets exceeds total assets, annual average balance of net fixed assets exceeds total assets, or current period depreciation exceeds accumulated depreciation; delete samples that cannot meet the acquirement of "over the scale", that is employees less than 30 people, the main business income less than 5 million, or an annual average balance of net fixed assets less than 10 million Yuan. Further, in order to better achieve convergence with various databases, our research focuses on the manufacturing firms.

[2] The data and Kee & Tang (2015, AER) data consistency, is currently the most effective data of the micro enterprise computing export behavior and economic performance, which customs import and export database 2000--2006 years, the most complete rich, is currently available the minimum micro data set; and data of industrial enterprises in 2008 after lack of intermediate inputs relevant data items, and adjust the definition of above-scale enterprises in 2010, less sample variation, so using 2007 data before the international trade circle the general consensus; data used herein for seven years. Consistent with the relevant study sample, the conclusion can be said to be reasonable. The current study using the updated consolidated customs micro data and enterprise

referring to the Upward et al. (2013) in two steps .Firstly, the paper matches the data according to the firms' name and age, because, the same firm might change its name and the new entering firm may use other firms' former name. Secondly, merge the data that has not been matched in the first step using the zip code and the last seven figures of telephone numbers. We assume that firms have the same phone number in the same zip code area. However, number of digits may be diverse in different areas, such as some cities put one more digit in front of the original 9 digit numbers. Therefore, taking into account that the difference mainly occurs in the first place, we use the last seven figures of telephone numbers. On the whole, this paper 189,380 successfully matched data which is very close to results of Upward et al. (2013)[3].

3.2 Measurement

3.2.1. Dependent Variable: Firm Productivity

We adopt Levinsohn and Petrin (2003)'s method to estimate the Total Factor Productivity (the LP methodology) as the firm productivity by adopting a semi-parametric methodology to correct the simultaneity bias from reverse causality and selection bias from firms' exits, and solve the Olley and Pakes (1996, referred to as the OP methodology) method problem of "zero investment" phenomenon caused sample truncation problems. We use the intermediate inputs as proxy variables of external shocks (because intermediate goods inputs are easier to meet the monotonous return assumption and can fully reflect the impact of external productivity) to have a two steps estimation. In addition, in the actual calculation, the paper estimates the production function parameters for each four-code industry and adjusts inflation by using the annual

data research work is still very small, the relevant update data is currently difficult to obtain in the academic community. We look forward to the relevant scholars can use the updated data in the future will continue to deepen or revise the relevant conclusions.

[3] Upward et al. (2013) 11965 final match of samples, but it excluded the industrial sectors of some industries, resulting in less data than matched our matches.

producer price index for manufacturing sectors from the "China Statistical Yearbook". Furthermore, the paper uses OP Methodology to alternate LP Methodology in robustness analysis, and also considers a depreciation rate of 9% and 15% of both cases, in order to ensure the robustness.

3.2.2. Independent Variable: GVC Embeddedness

Upward et al. (2013) estimate foreign value added of Chinese firms through Chinese customs data and industry consolidation data. This method assumes that all imports are used as intermediate inputs, that is, processing trade imports are all used as intermediate inputs of processing trade exports, and general trade imports are put into domestic sales and general trade exports with the same proportion. The formula of foreign value added rate of firms' exports can be described as follows:

$$FVAR = \frac{V_F}{X} = \frac{M^p + X^o\left[M^o/\left(D + X^o\right)\right]}{X} \qquad (6)$$

Where, FVAR represents foreign value added rate of firms export; the corresponding represents foreign value added of firms export; M, X and D, respectively stands for imports, exports and domestic sales of firms; superscript p and represent processing trade or general trade. In the specific calculation process, import and export data comes from customs statistics detailed; domestic sales data is from industrial firms census data, by subtracting the export delivery value from the firm sales value[4]. For those companies who have less sales value than export delivery

[4] This approach and Upward et al. (2013) is consistent, it will cause some enterprises and domestic sales and exports of the total output value and sales are not equal. An alternative approach is to use the difference between the sales of processing trade exports

value, we assume the foreign value added of firms export equals to the sum of processing trade imports (M^p) and the general trade imports (M^o)[5].

However, this calculation method still has some defects. We try to improve it in the following three ways: (1) It is necessary to convert HS Code into Broad Economic Categories (BEC) Product Code 6 to distinguish which imported products to be used as intermediate inputs (M), which should be considered consumer goods (C) or capital goods (K). In this regard, we will replace the M^o by M_m^o in Formula 6, represents intermediate product under BEC Categories, which does not include consumer goods (C) and capital goods (K). (2) We further adjust foreign value added (V_F), processing trade imports (M^p) and general trade import (M^o) in Formula 6 into V_{AF}, M_A^p and M_{Am}^o ,which represent the real foreign value-added, processing trade imports and general trade imports of intermediate inputs (see Equation 8 and Equation 9). (3) Domestic raw materials used by firms may also contain a share of foreign products, which could between 5% and 10% according to Koopman et al. (2012). This may because the indirect imports by intermediary firms or normal traders as stated above. More likely, the domestic intermediate inputs include foreign value-added. Therefore, it is necessary to peel off this part of the value. Eventually, after making necessary adjustments to calculation of export foreign value-added rate based on the existing literature, we obtain the following expression as the firms' GVC embeddedness level index:

instead of domestic sales and exports of general trade plus total. In theory, both algorithms should get the same result, but because companies may indirect exports through trading companies, solid in the actual data gaps often. Even so, the analysis in this paper, the two formulas give the same conclusion.

[5] When the foreign value added exceeds total exports during calculation, we will set domestic value added rate as zero, foreign value added ratio as 1.

[6] UN website provides BEC and HS customs code conversion table, http://unstats.un.org/unsd/cr/registry/regdnld.asp?Lg=1.

$$v_F' = \frac{V_{AF}}{X} = \frac{\left\{M_A^p + X^o\left[M_{Am}^o / \left(D + X^o\right)\right]\right\} + 0.05\left\{M^T - M_A^p - M_{Am}^o\right\}}{X} \quad (7)$$

Wherein M^T represents the amount of intermediate inputs. The above formula assumes that there is 5% of foreign value added within domestic intermediate inputs.

Because indirect imports through intermediary firms cannot be directly observed, we use the method of Ahn et al. (2010). First, identify the intermediary firms which names contain "Import and Export", "Economy and Trade", "Trade", "Technology Trade" or "International Economy"; Then calculate the m^i ,cumulative import share by intermediary firms of total imports of specific products (6 HS Code). In this way, $\left(1 - m^i\right)$ represents direct imports through the Customs;

Finally, estimate the real processing trade imports and real general trade imports of intermediate inputs by the following formulas.

$$M_A^p = \sum_i \frac{M^p}{1 - m^i} \quad (8)$$

In this formula, i represents products imported through processing trade.

$$M_{Am}^o = \sum_i \frac{M_m^o}{1 - m^i} \quad (9)$$

In this formula, i represents intermediate inputs imported through general trade.

3.2.3. Moderators

Foreign Firms. We divides firms into two types- domestic firms (including state-owned and private enterprises) and foreign invested firms (including Hong Kong, Macao and Taiwan and foreign invested firms). The firms' types are defined with the proportion of firm's registered investment capital (≥50%). Guariglia et al. (2011) suggest that this classification method is more

reliable and accurate than the one simply based on the firm' registration types. We code foreign invested firm dummy as 1 if firm's registered investment capital is larger than 50% (included), otherwise 0.

Independent Manufacturers. Some Chinese processing trade firms are engaged in processing activity in an "large scale import and export, both supplier and customer are abroad" way, and they would purchase intermediate inputs such as raw materials and components domestically. We treat them as original equipment manufacturers, since they operate within a relatively short parts in the value chain and are largely dependent on foreign buyer. Therefore, we code this kind of firm with value of 0 as original equipment manufacturers; other firms are coded with value of 1 as independent manufacturers.

High-end Position in Value Chain. We follow Wang et al. (2013)'s method to distinguish firms between high-end or low-end in the value chain in terms of foreign value added level in intermediate products[7]. High-end firms are defined as 1, otherwise 0. Firms at high-end may have more access to the upstream production and processing sectors of core components, and have more opportunities to obtain the "learning effect", while firms at the low-end of the value chain are relatively closer to the consumer, thus facing with more substitutability and competition.

[7] We use the world input-output data (WIOD) to examine the foreign value-added of intermediate goods and final goods referring Wang et al.(2013) . We chose data from 1995 to 2011 in WIOD which includes 13 manufacturing industries. However, because customs microscopic sample database only has data from 2000 to 2006, so we chose the latter interval to match the years.

Targeting Markets of Developed Countries (Developed Countries). Based on the latest standards published by the World Bank, we observe that there are 90,918 firms export to the developed countries and 117,159 exports to developing countries. Therefore, we define those target the market to developed countries as 1, otherwise 0.

3.2.4. Control Variables

Capital per person. Composition and using ratio production factors will affect the production mode, thus affecting the participation patterns and competitiveness in global value chains. Therefore, this paper introduces Capital per person control variable to examine the impact of GVC participation on the total factor productivity. We take the logarithm of ratio between firm's annual average balance of net fixed assets and firm's employees number to measure the factor intensity, where the average balance of net fixed assets using deflator of 2000 fixed assets investment price index as the base.

Firm Size. Compared to domestic trade, participate in global value chains need to pay additional fixed costs, such as long-distance communication and shipping costs, customs fees, more demanding of quality by foreign consumers, barriers to entry in safety and high construction and maintenance costs of the terminal market sales overseas, and high uncertainty risks and political risk (such as protectionism in developed country)in international markets . Whereby only those large-scale firms, by using economies of scale inherent in "home market", can possibly cover the marginal cost of these additional products and create a competitive advantage (Bonaccorsi,

1992). Thus, the larger companies may be more competitive in global value chains. This paper selects the number of employees as a proxy indicator of firm size[8].

Firm Age. More experienced firms which has longer establish ages and more mature production and management methods ,generally have better export performance(Roberts and Tybout,1997). Since the "Chinese industrial firms database" report the Start-up Year rather than firm age, this paper calculates the firm age as follows: Firm Age = Focal Year - Start-up Year +1. We also put in the squared firm age into the empirical analysis in order to test whether there is an U-shaped relationship between the firm age and the firm productivity.

Financing Constraints. Based on Cleary (1999) and Musso and Schiavo (2008), we measure the firm financing conditions by using financial constraints comprehensive index, for different indicators cannot fully reflect the whole picture of the firms' financial situation. Specifically, we construct a comprehensive index to measure the financial constraints, including 11 sub-indicators: firm size, sales margin, cash inventory accounting, return on assets, the ratio of commercial credit, solvency, solvency ratios, liquidity ratios and liquidity constraints. We also use principal component analysis of these indicators to conduct a comprehensive analysis to better assess the contribution and influence of various indicators the financial constraints comprehensive index. In this case, we don't have to choose weighted average or use median method and the subjective weighted selection problems can be avoided as a result. Higher

[8] To deal with the endogeneity problem between the scale and efficiency of the variables as possible, we also lag size made the necessary controls in GMM analysis.

financing constraints comprehensive index indicates that firms suffer serious financial constraints[9].

Inventory. Inventories can affect participation mode and turnover flexibility of firms in the GVC to some extent. During the financial crisis, higher stock-scale firms can better deal with the impact of the crisis, which ensuring the smooth conduct of international operations (Alessandria et al., 2010). Specifically, this paper selects a logarithmic inventory of firms as a control variable.

Industry output tariff rates (Tariff). By concentrating products tariffs under HS6 Code into 2-digit industry level, we obtain the final product tariff rate in this article. It should be noted: First, there are different data sources of each year import tariffs. Among them, the 2000 HS coding data is from the World Bank WITS database, and the data from 2001 to 2006 come from the WTO Tariff Download Facility database. Second, coordination code versions under HS6 are not consistent. This paper compares the HS1996 version provided by the United Nations Statistics Division (corresponding to 2000 and 2001 tariff rates) and HS2002 version (corresponding to 2002 - 2006 tariff rates), unifies an HS2002 version. Import tariffs will not only have a direct impact on the country's imports, but will also have an important impact on export as well as the value chain embeddedness. Tariff concessions will lead to a lot of the same or similar foreign products into the domestic market, thus the fierce market competition will encourage domestic firms to do research and innovation for "surviving" and (Aghion et al., 2001), and the firms' productivity will be enhanced as a result.

[9] Another common approach is to take an assignment of all indicators and choosing the median as the financial constraints comprehensive index.

3.2.5 Econometric Model

The article uses the constant elasticity of substitution production function to analyze the effect of global value chain embeddedness on firm productivity. The function is:

$$Y_i = A_i \bar{K}_i^{\alpha} \bar{L}_i^{1-\alpha} \qquad (1)$$

Among them, A_i represents the technical level, α and $1-\alpha$ represent the distribution coefficient of capital and labor, $\bar{K}_i$ and $\bar{L}_i$ are effective capital and effective labor on the foregoing documents that GVC participation may affect firm productivity through three main ways: We assume that $\bar{K}_i = \alpha_K(GVC_i)K_i$, $\bar{L}_i = \alpha_L(GVC_i)L_i$, $\alpha_K(GVC_i)$ is the measurement of capital productivity, $\alpha_L(GVC_i)$ represents measured value of the labor productivity.

In order to describe the impact of firms participating in value chains on effective capital, effective labor and technical level, we assume $\alpha_K(GVC_i)=\exp(\beta_K GVC_i)$, $\alpha_L(GVC_i)=\exp(\beta_L GVC_i)$, $A_i=\bar{A}\exp(\eta+\xi GVC_i)$, into (1), we get:

$$Y_i = \mathrm{A}_i \exp\left\{\left[\alpha\beta_K + (1-\alpha)\beta_L\right]GVC_i\right\} K_i^{\alpha} L_i^{1-\alpha} \qquad (2)$$

Dividing L and take the log of both sides of the formula simultaneously, we have the following model:

$$ln(Y_{it}/L_{it}) = lnA_i + \left[\alpha\beta_K + (1-\alpha)\beta_L\right]GVC_{it} + (1-\alpha)ln(K_{it}/L_{it}) \qquad (3)$$

On the basis of previous studies, we construct the following econometric model:

$$lnTFP_{it} = \beta_0 + \beta_1 GVC_{it} + \beta_2 ln(K_{it}/L_{it}) + \beta_3 X_{it} + \mu_j + \eta_k + \nu_t + \varepsilon_{it} \qquad (4)$$

The subscript i, j, k and t represent firms, industries, the provinces and years. GVC stands for the firms' participation in global value chains, TFP is the total factor productivity of firms, K / L is the per capital stock, X is other control variables, including financial constraints, firm size, firm age, industry concentration, corporate R & D . μ_i is the industries fixed effects, η_k is the provinces fixed effects, ν_t represents the time fixed effects, ε_{it} is random disturbance. In order to avoid synchronization bias between GVC embeddedness and firm growth caused by regional advantages and industry-specific growth, we have respectively control the industry fixed effects and provincial fixed effects in different measurement models. We also control the fixed effects of firms in core regression and relevant regression of mechanisms analysis. We focus on dynamic effects of related factors and try to adopt relevant strategies to find a causal relationship that may exist between GVC embeddedness and firm growth.

Furthermore, because productivity improvement effect of GVC embeddedness is in stages, significant inhibitory effects may occur when productivity improvement of individual firms reached certain "threshold" (Gereffi ,2001); Schmitz ,2004),.To test this procedure and potentially existence of inverted U-shaped relationship, we added GVC^2 as squared revalidation of value chain embeddedness into our econometric model. The econometric model set as follows:

$$lnTFP_{it} = \beta_0 + \beta_1 GVC_{it} + \beta_2 GVC_{it}^{\ 2} + \beta_3 ln(K_{it} / L_{it}) + \beta_4 X_{it} + \mu_j + \eta_k + \nu_t + \varepsilon_{it} \quad (5)$$

4. Findings

4.1 The Basic Regression Result

Table 1 shows the basic regression result. We find that there is a significant positive correlation between value chain embeddedness and firms ‘efficiency. This provides preliminary statistical support for our subsequent empirical tests.

[Table 1]

This paper runs the basic regression according to Model (5). To find out the possible existence of inverted U-shaped effect, we added quadratic term of embeddedness of firms’ into GVC in subsequent analysis, while gradually controlling the possible factors, taking into account the influence of different measurement methods, and try to use lagged variable and GMM estimation to control endogenous problems. In order to investigate the robustness of the basic conclusion and to further discuss of the specific effects channels of value chain embeddedness on firm productivity, we conduct sub-sample analysis on different types of ownership, trade modes and target markets.

The basic results are shown in Table 2, this part is tests fundamental influence of basic model in terms of different variables and fixed effects. In Table 2, columns 1-5 are regression results of pooled 1-2), fixed effect 3-4) and GMM model(5). Column 1 is results controlling the time, provinces, industry fixed effects and control variables. We find that there is a significant positive relationship between firm size, capital per person, inventories and firm productivity, while Financial Constraint, tariffs, foreign firms have a significant negative effect on firm productivity. At the same time, the positive effect of firm age on productivity increase before reaching certain threshold, after this the effect began to decrease . Column2 showed that the value chain embeddedness has a significant positive effect on firm productivity with the passing of 1%

significance test, namely if the firm' participation in GVC increases one standard deviation, the productivity level will increase by 6%.

[Table 2]

The above results reflect the reasonability of the control variables, nevertheless, OLS methodology has its limitation due to the strong dependence assumptions, and it cannot rule out differences in firm heterogeneity. Therefore, we report results using fixed firm effects in column 3 and 4. From column 3 we can see that even after controlling the invariant features of firms, the results can be significant. Column 4 shows that by participating in global value chains, productivity improvement may experience an upgrade firstly then descend latter tendency. At the very beginning, firms productivity increased a lot, however, when it reaches a relatively high level the marginal return will be relatively limited. It should be noted that the GVC embeddedness variables (Upwards et al., 2013) are ratio ranges from 0 to 1. From column (1) we can see that even when embeddedness level reaches the maximum, its embeddedness elasticity to improvement is a positive 0.069. But for the lower levels the elasticity is approaching 0.243. Further, we estimate the critical value of quadratic term between value chain embeddedness and productivity (0.698).We also calculate the mean of the embeddedness value (0.283).According to the sample, the level of China's participation in GVC is still in the productivity interval, and has specified a distance from the critical value (0.283 <0.698). At the same time, we draw a kernel density chart of all firms' GVC embeddedness, and find out that the vast majority of firms are on the left side of the "inverted U-shaped curve" (less than 0.698), namely within the productivity interval. But there is nearly a quarter of high level embeddedness firms locate in inhibition interval of productivity. Therefore, as a whole, firms in the low-end can possibly obtain higher

level of return by increasing embeddedness level. As to China, the level of embeddedness effects (from the average to the extreme) on firm productivity is still in the promotion-effect interval.

[Figure 1]

To further test the robustness of the regression results while considering the possible endogeneity problem between firm productivity and the choice of embedding into the GVC, this paper uses GMM estimation which relaxes the hypothesis that independent and dependent variables are independent. Furthermore, this paper takes the lag phase of the firm's participation level in industry value chain as an instrumental variable, and gets a more consistent result which are reported in colume5 Table 1. The results show that through embedding into the GVC, firms can effectively improve their productivity This kind of relationship is stable, no matter depend on which measurement method, control variables, data generation assumptions and endogenous factors.

5. Moderating Effects Analysis

There is heterogeneity of firm productivity effects in the global value chain. It is not only related to the degree of participation, but involves participation patterns to a large extent. In the further analysis, we will discuss productivity effects of different participation patterns separately. Estimation results are shown in Table 3 below.

[Table 3]

Results of Column (1) in Table 3 show that the foreign firms in China have significantly higher FTP than the domestic Chinese firms ($\beta = -.095$; $p < .001$). Therefore, H2 receives strong support.

Results of Column (2) examine H3. The coefficient of GVC Embeddedness×Independent Manufacturers is significantly positive (β = .183; p < .001). It suggests that independent manufacturers have higher FTP than the original equipment manufacturer. Therefore, H3 receives strong support.

Results of Column (3) examine H4 the impact of high-end position in value chain. The coefficient of GVC Embeddedness× High-end position in value chain is significantly positive (β = .160; p < .001). The firms positioned at high-end of value chain can obtain more improvement of productivity both economically and statistically than the firms at the low-end of value chain. H4 thus gains strong support.

Column (4) in Table 3 reports the coefficient of GVC Embeddedness× Export to developed countries is significantly positive (β = .175; p < .001) . This empirical result supports our H4. For those target the market at the developed countries, their net effect of value chain embeddedness will be higher, which indicates that interaction with the developed countries can produce better knowledge returns. Therefore, H5 is supported by the empirical tests.

4.2 Robust Regression Results

Furthermore, we try to find out that whether the alternative indicators for embeddedness or productivity may affect the empirical results. We re-calculate the firm GVC embeddedness using Kee and Tang (2013) to adjust method of Upwards et al. (2013)(See Table 2 column (1-2))[10]. The results indicate that by using these indicators situation, the participation level will have higher effects on productivity improvement as well as higher significance level. Similarly, were put in

[10] The main issues considered intermediate traders and indirect trade, the specific calculation method, see Kee and Tang (2013) instructions.

9% and 15% depreciation rate to estimate the firm productivity(Olley-Pakes, 1995).The results are reported in column (3-6) , which show that no matter depending on what kind of metric form, the effects are significant existed, while significant level is equal or higher than the original model of Levinshon-Petrin.

[Table 4]

4.3 Endogenous Discussion: GPS Estimation

Empirical researches about relations between "GVC and productivity" should focus on the following two aspects: On the one hand, to analyze differences in productivity of GVC firms and non-GVC firms in order to find out whether participating in global value chains can has significantly higher productivity. During which, we focus on testing the "self-selection" effect of GVC firms, namely only firms with high-productivity can choose to participate in global value chains (Lv Yue et al., 2015; Chor et al., 2014); on the other hand, to verify the existence of the "value chain learning effect" through which firms can improve their productivity by participating in global value chains (Bladwin and Yan, 2014; Brancatia et al, 2014.). Therefore, this paper is bound to face a potential endogeneity problem. However, using OLS method may give rise to two kinds of problems: First, the problem of omitted variables, which makes us unable to completely separated other relevant factors which may lead to productivity differences; the second is endogenous problem, which can cause biased OLS estimation. These problems might not be solved even by using panel data model as well as instrumental variables or GMM dynamic panel methods.

A key issue in the study of productivity differences between GVC firms and non-GVC firms is that we can only acquire one of the statuses, the so called typical counterfactual causal inference analysis frame. Rosenbaum and Rubin (1985) presents a sophisticated solution called PSM method, which establishes a treatment group of firms already involved in GVC and a control group with non-GVC firms that have main features of GVC firms as similar as possible. Thus, the control group can furthest analog "counterfactuals" of firms in treatment group, and then we can compare firm productivity differences before and after participation in the GVC.

However, PSM (Propensity Score Matching) method compares the difference of one firm under distinct GVC status. Although it can solve the biased problem caused by OLS method, the regression results can only base on the decision that whether firms has participated in GVC. In view of this, we further use GPS methodology to accurately analyze the TFP changes of firms with different levels of GVC embeddedness. Hirano and Imbens (2004) point out that, although PSM method will not cause the sample selection bias, it only applied to processing variables either 0 or 1. Relaxing this condition can have GPS method which can be applied to continuous processing variables. GPS method is an extension of PSM method, which can not only solve the endogeneity problem, and does not require discretization treatment for continuous variables. This can take full advantage of sample information (Kluve et al., 2012). In addition, GPS can further interpretates heterogeneity effects of processing variables on the result variables, which cannot be achieved by PSM method. PSM method can only get average effect when dealing 0 or 1.

We use a three-step estimation methodology proposed Hirano and Imbens (2004) do the GPS analysis. Based on the first and second steps, we carry out the third step. First, we divide the

value range of GVC embeddedness into multiple intervals, and then estimate the impact of the GVC embeddedness on firms' TFP changes. The dose response function of these two variables is shown in Figure 2 (dashed line is the bound of 95% confidence interval). According to Figure 2, there is a certain interval for "productivity effect". Once the firms exceed the interval, this effect will be transformed into "inhibitory effect". This is consistent with our earlier conclusions of inverted U- shaped relationship.

[Figure 2]

6. Discussions and Conclusion

We make these contributions. First, we examine the springboard perspective (Luo and Tung, 2007)– the influence of GVC embeddedness on firm's total factor productivity. Our results are largely support the springboard perspective. We find that participation in GVCs can improve productivity. This relationship remains stable under circumstances of different measurement methods, GVC embeddedness index, productivity metrics, or controlling the endogenous and sample extreme values. This indicates that China's firms can improve productivity through integration into global value chains. It is worth noting that GVC embeddedness and productivity improvement exists a nonlinear inverted U-shaped relationship. It means although participating in GVC will help the firms increasing their productivity, but there are diminishing marginal effect of this trend. For some firms there might be negative effects afterward. Fortunately, from the perspective of current level of Chinese firms' participation in the global value chain (ranging from average to extreme cases of study), embedding into the value chain to improve the productivity is still in the promotion effect range.

Second, we find that independent manufacturers can boost more productivity than the original equipment manufacturers. This may reflect the fact that during the contracting production process, original equipment manufacturers cannot fully comprehend the production knowledge. Lacking of productive autonomy and independent development goals, they might be limited to update the knowledge and keep the learning effect (Sun and Lee, 2013).

Third, our study provides a latecomer perspective to comprehensively interpret the mechanism of GVC in the periphery area (Lepak et al., 2007; Prithwiraj et al., 2012). We find that domestic Chinese firm can leverage GVC embeddedness to catch up faster than the foreign invested firms in China. Chinese firms can also configure their position in GVC, especially in the high-end product, to maximize the productivity benefit from the global division of labor in GVC. Chinese firms which target developed countries benefit more significantly than the ones trade with developing countries. This finding enriches the literature on the core-periphery in GVC (Benito and Narula, 2007; Prithwiraj et al., 2012).

Finally, our findings offer significant policy implication especially on how China could further reforms through climbing GVC (Sun et al., 2010). In terms of world economy history, rapid economic growth is a catch-up phenomenon during a particular stage of development. For countries at lower stages of development, due to the lack of technology and productivity, economic growth has the late-mover advantages. They mainly rely on inputs of capital, land and labor; and for countries at higher stages, economic development should count on total factor productivity improvement. Thus, traditional powers which have support China's rapid economic growth for long period now have gradually declined. The current growth momentum of China's

economy under the new normal is to improve the total factor productivity and enlarge its share of economic growth contribution. Therefore, the following questions are worth thinking: how to improve total factor productivity; how to further enhance participation in global value chain deeper and wider; how to promote domestic reform and opening up through deeper participation in the global value chain; how to establish the linkage mechanism between internal reform and catching-up.

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Table 1 Data Description and Correlation

Variable	Mean	Std.Dev.	Min	Max	N
1.Productivity	12.93	1.182	3.406	21.12	208,078
2.GVC Embeddedness	0.285	0.371	0	1	208,077
3.Firm Size	5.418	1.063	3.434	11.45	204,042
4.Firm Age	2.016	0.695	0	4.094	208,078
5.Capital per person	10.41	1.368	0.540	16.68	208,078
6.Financial Constraint	4.760	1.105	1.570	8.926	208,078
7.Tariffs	2.478	0.407	1.083	4.174	205,327
8.Inventory	8.353	2.079	0	16.71	189,380
9.Foreign Firms	0.596	0.491	0	1	208,073

	1	2	3	4	5	6	7	8	9
1.Productivity	1								
2.GVC Embeddedness	0.103	1							
3.Firm Size	0.488	0.068	1						
4.Firm Age	0.137	0.012	0.261	1					
5.Capital per person	0.216	0.200	-0.057	0.0833	1				
6.Financial Constraint	-0.291	-0.080	-0.047	-0.034	-0.129	1			
7.Tariffs	-0.086	-0.006	0.071	-0.019	-0.182	-0.002	1		
8.Inventory	0.452	0.166	0.452	0.220	0.365	-0.0465	-0.126	1	
9.Foreign Firms	-0.044	0.325	-0.077	-0.120	0.009	-0.118	0.105	-0.0254	1

Table 2. GVC Embeddedness on Improvement of firm Productivity

	(1) OLS	(2) OLS	(3) FE	(4) FE	(5) 2SLS
Firm Size	0.471***	0.473***	0.265***	0.263***	0.213***
	(0.004)	(0.004)	(0.009)	(0.009)	(0.011)
Firm Age	0.161***	0.149***	0.300***	0.297***	0.119*
	(0.014)	(0.014)	(0.021)	(0.021)	(0.056)
Age Square	-0.058***	-0.054***	-0.066***	-0.065***	-0.017
	(0.003)	(0.004)	(0.005)	(0.005)	(0.012)
Capital per person	0.092***	0.079***	-0.028***	-0.029***	-0.029***
	(0.003)	(0.003)	(0.005)	(0.005)	(0.007)
Financial Constraints	-0.268***	-0.260***	-0.229***	-0.229***	-0.220***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.005)
Tariffs	-0.103***	-0.099***	-0.051*	-0.051*	-0.016
	(0.019)	(0.020)	(0.020)	(0.020)	(0.031)
Inventories	0.126***	0.119***	0.046***	0.046***	0.039***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Foreign Firms	-0.069***	-0.097***	-0.011	-0.011	-0.011
	(0.006)	(0.006)	(0.011)	(0.011)	(0.017)
GVC Embeddedness (H1a)		0.169***	0.060***	0.260***	0.243***
		(0.009)	(0.013)	(0.041)	(0.064)
GVC Embeddedness Square (H1b)				-0.196***	-0.174**
				(0.039)	(0.060)
Year	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y
Province	Y	Y	Y	Y	Y
Firms			Y	Y	Y
N	201341	183183	183183	183183	55947
R^2	0.474	0.473	0.171	0.171	0.120
F	1074.977	961.197	.	.	128.792

*Note:Standard errors in parentheses + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001*

Table 3. Moderating Effects of GVC Embeddedness on Firms' Productivity

	(1)	(2)	(3)	(4)
GVC Embeddedness	0.241***	0.045***	0.074***	0.060***
	(0.017)	(0.012)	(0.011)	(0.013)
GVC Embeddedness×	-0.095***			
Foreign Firms (H2)	(0.019)			
Foreign Firms	-0.077***			
	(0.007)			
GVC Embeddedness×		0.183***		
Independent		(0.015)		
Manufacturers (H3)				
Independent		-0.010		
Manufacturers		(0.006)		
GVC Embeddedness ×			0.175***	
Developed Countries			(0.016)	
(H5)				
Developed Countries			-0.055***	
			(0.007)	
GVC Embeddedness×				0.160***
High-end Position (H4)				(0.017)
High-end Position				0.080**
				(0.026)
Firm Size	0.472***	0.477***	0.476***	0.477***
	(0.004)	(0.004)	(0.004)	(0.004)
Firm Age	0.154***	0.128***	0.128***	0.130***
	(0.014)	(0.014)	(0.014)	(0.014)
Age Square	-0.055***	-0.047***	-0.047***	-0.047***
	(0.004)	(0.004)	(0.004)	(0.004)
Capital per person	0.079***	0.077***	0.077***	0.078***
	(0.003)	(0.003)	(0.003)	(0.003)
Financial Constraints	-0.260***	-0.255***	-0.256***	-0.257***
	(0.003)	(0.003)	(0.003)	(0.003)
Tariffs	-0.098***	-0.101***	-0.099***	-0.104***
	(0.020)	(0.020)	(0.020)	(0.020)
Inventories	0.119***	0.117***	0.118***	0.118***
	(0.002)	(0.002)	(0.002)	(0.002)
Year	Y	Y	Y	Y
Industry	Y	Y	Y	Y
Province	Y	Y	Y	Y
r2	0.473	0.473	0.472	0.472
F	952.961	950.521	946.783	948.963
N	183183	183183	183183	183183

*Note: Standard errors in parentheses, + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001*

Table 4. Robust Analysis of GVC Embeddedness Effects on Firm Productivity Improvement

	(1) lntfplp	(2) lntfplp	(3) lntfpop9	(4) lntfpop9	(5) lntfpop15	(6) lntfpop15
GVC Embeddedness	0.069*** (0.018)	0.196** (0.061)	0.071** (0.022)	0.217** (0.067)	0.064** (0.021)	0.246*** (0.066)
GVC Embeddedness Square		-0.120* (0.055)		-0.143* (0.062)		-0.179** (0.061)
Firm Size	0.210*** (0.011)	0.209*** (0.011)	-0.398*** (0.012)	-0.398*** (0.012)	-0.397*** (0.012)	-0.398*** (0.012)
Firm Age	0.126* (0.054)	0.124* (0.054)	0.118* (0.058)	0.117* (0.058)	0.132* (0.057)	0.130* (0.057)
Age Square	-0.019 (0.012)	-0.019 (0.012)	-0.015 (0.013)	-0.014 (0.013)	-0.018 (0.013)	-0.018 (0.013)
Capital Per person	-0.029*** (0.007)	-0.029*** (0.007)	-0.314*** (0.007)	-0.314*** (0.007)	-0.319*** (0.007)	-0.319*** (0.007)
Financial Constraints	-0.223*** (0.005)	-0.223*** (0.005)	-0.217*** (0.005)	-0.217*** (0.005)	-0.219*** (0.005)	-0.219*** (0.005)
Tariffs	-0.020 (0.030)	-0.020 (0.030)	0.445*** (0.032)	0.445*** (0.032)	0.619*** (0.032)	0.618*** (0.032)
Inventories	0.040*** (0.003)	0.040*** (0.003)	0.039*** (0.003)	0.039*** (0.003)	0.039*** (0.003)	0.039*** (0.003)
Foreign Firms	-0.012 (0.016)	-0.012 (0.016)	-0.008 (0.017)	-0.008 (0.017)	-0.012 (0.017)	-0.012 (0.017)
Year	Y	Y	Y	Y	Y	Y
Industry	Y	Y	Y	Y	Y	Y
Province	Y	Y	Y	Y	Y	Y
N	58086	58086	55947	55947	55947	55947
R^2	0.121	0.121	0.239	0.240	0.225	0.225
F	137.998	134.760	303.655	296.409	279.775	273.211

*Note: Standard errors in parentheses, + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001*

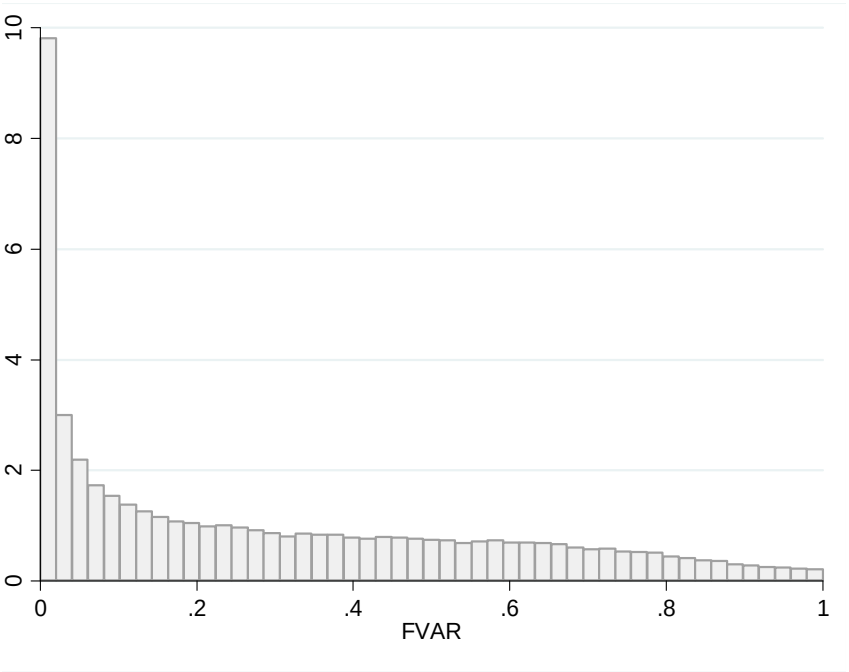

Figure 1. Kernel Density Chart of GVC Embeddedness

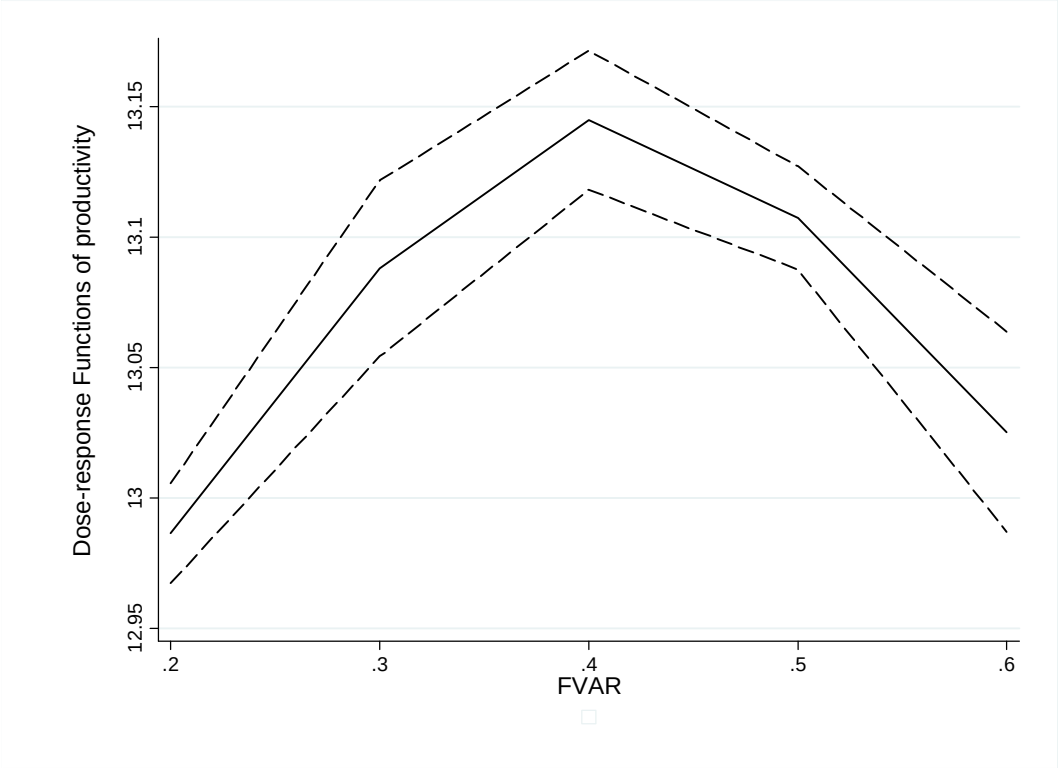

Figure 2. Dose-response Functions between GVC embeddedness and productivity
Note: Dashed lines represents the bound of 95% confidence interval.