Journal of Applied Economics

ISSN: 1514-0326 (Print) 1667-6726 (Online) Journal homepage: https://www.tandfonline.com/loi/recs20

Can strengthening the local content requirements meet a government's need to raise industrial productivity and production?

Shiue-Hung Lin & Yungho Weng

To cite this article: Shiue-Hung Lin & Yungho Weng (2020) Can strengthening the local content requirements meet a government's need to raise industrial productivity and production?, Journal of Applied Economics, 23:1, 316-328, DOI: 10.1080/15140326.2020.1753468

To link to this article: https://doi.org/10.1080/15140326.2020.1753468

Published online: 05 May 2020.

JOURNAL OF APPLIED ECONOMICS
2020, VOL. 23, NO. 1, 316–328
https://doi.org/10.1080/15140326.2020.1753468

Routledge
Taylor & Francis Group

Can strengthening the local content requirements meet a government's need to raise industrial productivity and production?

Shiue-Hung Lin[a] and Yungho Weng[b]

[a]Business School, NanFang College of Sun Yat-Sen University, Guangzhou, China; [b]Department of Economics, National Chengchi University, Taipei, Taiwan

ABSTRACT

By taking firm heterogeneity in productivity into account in a monopolistic competition market in a general-equilibrium model setting, this paper investigates whether a stricter local content requirements (LCRs) can increase both productivity and production in the domestic intermediate-goods industry. The result shows that stricter LCRs policy cannot simultaneously increase both. The initial level of LCRs plays an important role in policy effectiveness. If it is below a critical level, a stricter LCRs can increase production but decrease productivity; however, production decreases but productivity increases if the initial LCRs are higher than the critical level.

ARTICLE HISTORY
Received 3 December 2019
Accepted 30 March 2020

KEYWORDS
Local content requirements; industrial productivity; industry production; firm heterogeneity

1. Introduction

The local content requirements (LCRs) are an industrial policy that require a given percentage of domestic value-added or domestic intermediate products be embodied in specific final goods (Grossman, 1981). It is widely adopted by developing countries to achieve industrialization by raising industrial productivity and production in domestic intermediate-goods industries. This policy was imposed on the television and refrigerator industries in Taiwan (Grossman, 1981), on the auto industry in Brazil, South Africa, and Turkey (Carbaugh, 1983), and on the wind energy industry in Brazil and South Africa (Rennkamp & Westin, 2013).

Although LCRs policy enforcement has been widespread in developing countries for more than five decades, related studies are still sparse and results are inconclusive.[1] Grossman (1981), the first and the most influential study, constructed a small open-economy model in which the final-goods firms use domestic and/or foreign intermediate goods to produce homogeneous non-tradable final goods. Under the assumption that both intermediates are perfect substitutes and foreign firms' technology is superior to domestic technology,[2] Grossman (1981) showed that, other things remaining the same, the LCRs policy directly increases domestic intermediate-goods production. However, due to the interaction of intermediate-goods and final-goods markets and the higher price of domestic intermediate goods, this policy raises the domestic final-goods price,

CONTACT Shiue-Hung Lin 98258507@nccu.edu.tw
[1]An excellent literature survey can be seen in Veloso (2006).
[2]This implies that the foreign firm's production cost per unit is lower than that of the domestic firm.

and hence the demand for the final good and the domestic intermediate good decrease. The effects of LCRs policy on the domestic intermediate-goods production, therefore, become ambiguous, depending on how responsive the final-goods production is to the change in the price of the intermediate good, and on how responsive the intermediate-goods production is to the change in the price of the final goods.

Research after Grossman (1981) becomes multidirectional in terms of issues focused on and market structure settings. The issues that previous studies have highlighted include the policy effects on intermediate- and final-goods production (Hollander, 1987; Richardson, 1991), policy equivalences (Carbaugh & Wassink, 1985; Vousden, 1987), and welfare (Davidson, Matusz, & Kreinin, 1985; Findlay & Wellisz, 1986; Hollander, 1987). The market structure settings include the perfect competition market (Fung, 1994; Mussa, 1984), the monopoly market (Beghin & Sumner, 1992; Hollander, 1987) and the duopoly market (Belderbos & Sleuwaegen, 1997; Krishna & Itoh, 1988). Results obtained from prior research are equivocal, relying on the definition of the LCRs (physical, valued added, production, or sales), the relationship between domestic and foreign intermediate goods (substitutes or complements), the degree of elasticity of substitution, and market structure types.

Although related studies exist, previous research pays more attention to the effects of LCRs on industrial production than on industrial productivity. Very rare research simultaneously examines the effects on both variables. Besides, policy implementation re-allocates scarce resources (labor in particular under a general-equilibrium setting) among firms, and a firm's productivity plays an important role in the acquisition of the allocated resource (Melitz, 2003); most related research, however, builds on a partial equilibrium model with a homogeneous firm type, and firm heterogeneity has so far not been taken into account. Moreover, the monopolistic competition market, the best-known market structure in reality (Dixit & Stiglitz, 1977), has not been considered in the related literature. Therefore, the purpose of this paper is to examine the effects of strengthening the LCRs by taking a firm's heterogeneous productivity into account in a monopolistic competition market in a general equilibrium model setting. To our best knowledge, no such research yet exists.

The plan for the remainder of the paper is as follows: In Section 2, the actual cases of LCRs are presented. In Section 3, by modifying Grossman's (1981) model, a monopolistic competition market with heterogeneous firms is presented in the domestic intermediate-goods industry. The domestic government imposes an LCRs policy on the domestic final-goods firms. Section 4 is comparative statics analysis. Section 4 evaluates the effects of strengthening LCRs on the productivity and production of the domestic intermediate-goods industry. Concluding remarks are offered in Section 5.

2. The actual cases of LCRs

The OECD Trade Policy Papers No. 180 (2015) states that after the 2008 subprime mortgage crisis, over 58% of the LCRs implemented have been in economies with a GDP of more than 800 billion USD. One of the main reasons is that the rapid increase in the unemployment rate after the crisis. The implementation of LCRs can quickly provide employment opportunities in the short term, although it may be harmful to trade and competitiveness finally. On the other hand, these large economies believe that its domestic

market is sufficient to attract foreign enterprises to change their production methods to develop local enterprises. In addition, the population size and GDP per capita are also important to a government to implement the relevant measures of LCRs. The report indicates that most of the LCRs (54%) are implemented in countries with a population of more than 100 million; countries with GDP per capita between 2 USD,500 and 15 USD,000 have implemented 66% of LCRs, and most of them are applied in the industrial sector.[3] According to the above report, we can summarize three main points: First, after the 2008 crisis, LCRs-related measures are still implemented in different countries or regions, and most of them are not implemented in traditional closed economies or low developing countries. Second, increasing production scale or enterprise productivity is an important factor to affect the implementation of LCRs. Finally, the implementation of LCRs will definitely bring benefits to the countries that implement this policy, but it may cause damage if the trade interaction of both countries is considered simultaneously. Therefore, this article is based on the above actual background of LCRs implementation to investigates whether stricter LCRs can increase both productivity and production in the domestic intermediate-goods industry. The following cases of LCRs implementation are used as important supports for the motive of our study.[4]

2.1. The case of Philippine motor vehicle assembly industry

The LCRs of the Philippine motor vehicle assembly industry are originated in 1949. This is due to the shortage of foreign exchange and the government's foreign exchange control measures. A subsequent foreign exchange crisis and attempts to develop the motor vehicle industry led the Philippine government to implement a ban on built-up (CBU) vehicles imports in 1973 and continue to adopt LCRs. In 1984, the policy was further modified to require companies assembling cars to earn foreign exchange through exports to partially compensate foreign exchange losses for importing related components. In 1986, the new government increased the intensity of LCRs based on existing policies. This includes companies assembling cars must earn a different percentage of foreign exchange on imported related kits for different types of vehicle. The case of the Philippines motor vehicle assembly industry implementing LCRs supports the setting of our study, which is to explore the government's actions to increase the implementation degree of existing LCRs in order to support an industry.

2.2. The case of Russia's automobile investment programs

In order to attract foreign direct investment (FDI) to promote the development of its automobile industry, Russia has proposed a set of investment incentives since 2005 and has been in use today. The above-mentioned investment incentive system was mainly formulated in accordance with the Resolution of the Government of the Russian Federation No. 166 of March 2005. The two subsequent investment programs[5] for

[3]The above description is collated from Stone, Messent, and Flaig (2015).
[4]The following three actual cases are separately compiled from Takacs (1994), Yen (2013) and Gourdon and Guilhoto (2019).
[5]The two automobile investment programs are the Order No. 73/81/58n released in April 2005 and the Order No. 678/1289/184n released in 2010.

automobiles both stipulated relevant requirements for obtaining import tariff reductions for automobile components. There are two main regulations in the Order No. 73/81/58n: Firstly, foreign manufacturers must sign investment agreements with the Russian competent authorities; secondary, they can only enjoy preferential tariff reductions after certain conditions are met. In addition to the requirements for annual production capacity and production activities, the automobile manufacturers are required to meet at least 30% of LCRs. The subsequent Order No. 678/1289/184n was an amendment to the Order in 2005, in which the requirements regarding production capacity and LCRs have become stricter. For LCRs, it is gradually required to achieve an LCRs requirement that accounts for 60% of the single-vehicle price. In order to protect the development of its own automobile manufacturing industry, Russia has gradually increased the level of LCRs in two automobile investment programs based on Resolution No.166 (2005). This case further increases the strength of LCRs under the existing LCRs level and provides support for our research on a real basis.

2.3. The case of Brazil's offshore oil and gas sector programs

Brazil is the ninth-largest oil producer in the world, and its output accounts for about 3% of the whole world. The country's National Agency of Petroleum, Natural Gas and Biofuels (ANP) oversees the operations of the oil and gas industry in complying with regulations and signing contracts. Since 1990, the agency has adopted local content requirements for both oil and gas exploration and production development. The LCRs clause is usually included in the franchise agreement between the ANP and the winning company of bid. In the 2003 and 2004 bidding rounds, ANP further set minimum and differentiated percentages in the LCR clauses for exploration at different depths of the ocean. The immense pre-salt cluster was discovered along the Atlantic coast of Brazil in 2005/2006, but the degree of LCRs has gradually increased. The mining of immense pre-salt cluster requires a lot of investment. In order to attract greater investment and achieve the goal of economic growth at an early date, ANP decided to reduce the percentage of LCRs in the 2017 bid. Based on a series of actions by Brazil on LCRs, it can be seen that the government will dynamically adjust the intensity of LCRs according to the needs of its policy implementation. This supports the government's motivation to adjust the strength of existing LCRs in our study.

The above three actual cases support the setting of our study that is the government's behavior to adjust the strength of LCRs under the existing LCRs level in order to further achieve its policy goals. In recent years, with the world's emphasis on environmental protection and the green energy economy, many countries have gradually applied LCRs to policy formulation in the field of green economy. Part of the reason comes from the adjustment of industrial structure, internal liberalization and WTO restrictions in various countries, which has led to the gradual elimination of the implementation of LCRs in strategic industries. Among the relevant cases of the green economy, South Africa's "New Growth Path" framework is an important case. An important goal of the framework is to create 5 million new jobs by 2020. The green economy is one of the important sectors that the South African government needs to control to achieve its policy goals. The local content requirement is the main core of South Africa's Green Economy Accord. In addition to the goal of its intervention measures to create 300,000 green jobs in 2020, the target for LCRs in the field of

renewable energy was set to 35% by 2016 and gradually increased to 75% in subsequent years.[6] According to this, the application of LCRs is still playing a role in different industry fields with the restrictions of the WTO and the adjustment of the industrial structure of various countries. It is still one of the non-tariff trade barriers in the field of international trade and provides a solid actual basis for the setting of this study.

3. The model

We consider a small open economy that involves a representative household and firms. There are two types of firms, downstream final-goods firms and upstream intermediate-goods firms. The final-goods firms are homogeneous and produce a non-tradable identical final good, while the intermediate-goods firms are heterogeneous in productivity and produce a continuum of tradable intermediate goods indexed by $i \in I$. The economy imports a continuum of foreign intermediate goods also indexed by$i \in I$. We assume that the foreign intermediate-goods firms are homogeneous in productivity that is higher than the average productivity of the domestic intermediate-goods firms. The final-goods firms use the domestic and foreign intermediate goods to produce final goods, and they compete with each other in a perfect-competition domestic market. For the upstream intermediate-goods industry, we suppose that the firms compete with each other in a monopolistic competition market. Labor, the only factor of production, is internationally immobile and is employed to produce the varieties of intermediate goods. The household supplies the labor force and owns all domestic firms.

3.1. Final-goods production

Firms are assumed to be homogeneous, with CES (constant elasticity substitution) production function as follows:

$$z(j) = \left\{ (\alpha_D)^{\frac{1}{\sigma}} [X_D]^{\frac{\sigma-1}{\sigma}} + (\alpha_F)^{\frac{1}{\sigma}} [X_F]^{\frac{\sigma-1}{\sigma}} \right\}^{\frac{\sigma}{\sigma-1}} \tag{1}$$

where $z(j)$ is the output of final goods produced by the representative final-goods firm j; X_D and X_F are composite quantity indices of domestic and foreign intermediate goods, respectively, and can be expressed as $X_D = \left(\int_{i \in I} x_D(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}$ and $X_F = \left(\int_{i \in I} x_F(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}$. The $x_D(i)$ and $x_F(i)$ stand for the quantities of intermediate goods produced by the representative domestic intermediate-goods firm and those imported from a foreign economy, respectively. The parameter $\sigma > 1$ is the elasticity of substitution between the two types of intermediate goods.[7] The relative weight (or importance) of domestic and foreign intermediate goods are $\alpha_D > 0$ and $\alpha_F > 0$, respectively, and $\alpha_D + \alpha_F = 1$. Given the weights of α_D and α_F, the

[6]The above South African case is compiled from Advisors (2013).
[7]For simplicity, we assume that the elasticity of substitution (σ) between domestic intermediate goods is equal to that between foreign intermediate goods.

domestic government can implement an LCRs policy to request domestic firms to increase α_D.[8]

The cost minimization problem for the representative final-goods firm is as follows:

$$\min \int_0^{N_D} p_D(i)x_D(i)di + P_F X_F, \tag{2}$$

$$s.t.\ (1),$$

where $p_D(i)$ is the price of a particular domestic intermediate variety i, N_D is the domestic intermediate firm number, and P_F is the price index of the foreign intermediate goods. The cost minimization problem discussed above implies that the demand function for a particular domestic intermediate variety i is

$$x_D(i) = X_D\left(\frac{p_D(i)}{P_D}\right)^{-\sigma}, \tag{3}$$

where $X_D = \alpha_D\left(\frac{P_D}{P_{z(j)}}\right)^{-\sigma} z(j)$ and $P_D = \left(\int_{i\in I} p_D(i)^{1-\sigma}di\right)^{\frac{1}{1-\sigma}}$ are the composite quantity index and the price index of the domestic intermediate goods, respectively. Correspondingly, the composite quantity index of the foreign intermediate goods can be derived and denoted as $X_F = \alpha_F\left(\frac{P_F}{P_{z(j)}}\right)^{-\sigma} z(j)$. The composite final good price index $P_z(j) = (\alpha_D {P_D}^{1-\sigma} + \alpha_F {P_F}^{1-\sigma})^{\frac{1}{1-\sigma}}$ can be presented as the function of the domestic and foreign composite intermediate-goods price indices with α_D and α_F as weights, respectively. A perfect-competition market in the final-goods industry implies that the outputs across firms are equal, and prices across firms are equal also. We denote that $P_z(j) = P_z(-j) = P_Z$ and $z(j) = z(-j) = z$. Hereafter, we simply adopt the combination (P_Z, z) to substitute the representative final-goods firm's price and output.

3.2. Intermediate-goods firms

There is a continuum of firms, each of which employs labor to produce a particular variety $i \in I$. Labor is inelastically supplied at its aggregate level L and is assumed immobile across countries. Firm i's cost function is assumed to be linear and can be denoted as $l(i) = f + x/\varphi_D(i)$ where $f > 0$ is the fixed cost, $x/\varphi_D(i)$ is the variable cost, and $\varphi_D(i) > 0$ is the productivity index. We assume that firms' fixed costs are equal but productivity levels are different across firms. Firms with higher productivity $\varphi_D(i)$ have lower marginal costs $(1/\varphi_D(i))$. For simplicity, we further assume that the productivity is equal across foreign intermediate-goods firms, denoted as (φ_F). Due to the foreign firms' technology is superior assumed by Grossman (1981), we, therefore, assume that

[8]Since $\alpha_D + \alpha_F = 1$, an increase inα_D necessarily implies a decrease inα_F.

foreign firms' productivity φ_F is higher than the average productivity level of domestic intermediate-goods firms'.[9]

An isoelastic demand function, as shown in (3), implies that a firm sets its price equal to constant markup over the marginal cost. Hence, prices of the domestic and foreign intermediate-goods firms can be presented, respectively, as follows

$$p_D(i) = \frac{w_D}{\rho\varphi_D(i)}; \; p_F = \frac{w_F}{\rho\varphi_F}, \tag{4}$$

where $\rho = (\sigma - 1)/\sigma$, and $0 < \rho < 1$. w_D and w_F represent the domestic and foreign nominal wage rate, respectively, and therefore are normalized to be one. On the basis of (4), the revenue function of the domestic intermediate-goods firm can be denoted as

$$r_D\left(\varphi_D(i)\right) = \left(\frac{\alpha_D}{P_D}\right) H\left(P_Z\rho\varphi_D(i)\right)^{\sigma-1},$$

where H is the aggregate income of the domestic consumers. It is noted that α_D plays an important role in determining the domestic intermediate-goods firm's revenue. We, therefore, can derive a profit function as follows:

$$\pi_D\left(\varphi_D(i)\right) = \frac{r_D\left(\varphi_D(i)\right)}{\sigma} - f_D,$$

where f_D is operating fixed cost. Upon entry, domestic intermediate-goods firms randomly draw their own productivity level φ from a common distribution $G(\varphi)$, and the range is from φ_{min} to infinity, i.e., $\varphi \in [\varphi_{min}, \infty)$.

3.3. The representative household

The representative household supplies its labor to the domestic upstream intermediate-goods industry and earns income to consume final goods. For analytical convenience, we redefine the spectrum of the individual domestic final-goods firm j to be bounded between zero and one, i.e., $j \in [0, 1]$. The representative household's utility maximization is described by

$$\max \left(\int_0^1 z(j)^\gamma dj\right)^{\frac{1}{\gamma}}$$

$$s.t. \int_0^1 P_z(j)z(j)di = h, \tag{5}$$

where h is the representative household's income, which equals w_D, and is normalized as one. The parameter γ is the elasticity of substitution across domestic final goods and will be assumed to be infinity. The equality of the aggregate expenditure of the domestic final goods and the aggregate income imply that $(P_Z)(zL) = P_Z Z = H$, in which $zL = Z$

[9]LCRs policy will not be implemented if the productivity of the domestic firm is higher than that of the foreign firm. This assumption is theoretical, supported by Proposition 1 discussed in Takechi and Kiyono (2003).

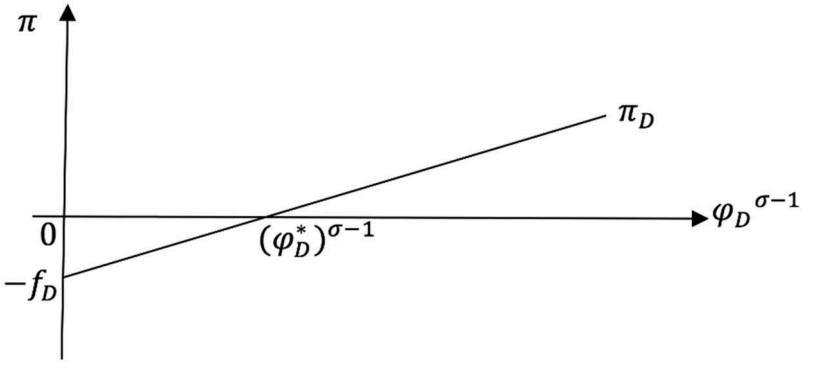

Figure 1. Relationship between profit and productivity index.

and $H = w_D L = L$. We, therefore, can demonstrate the demand function of domestic final goods as $Z = L/P_Z$.

3.4. Equilibrium in a small open economy

Following Melitz (2003), we may derive the free-entry condition[10] and the zero-cutoff profit condition[11] to obtain the level of cutoff productivity φ_D^*. That is, the profit of a firm with productivity φ_D^* is zero. In the space of (π, φ), both conditions ensure the existence and the uniqueness in equilibrium $\left(\tilde{\pi}_D, \varphi_D^*\right)$.[12] Following the illustration in Helpman, Melitz, and Yeaple (2004) and Antràs and Helpman (2004), we can demonstrate the equilibrium $\left(\varphi_D^*\right)^{\sigma-1}$ in Figure 1, where productivity index $\varphi_D{}^{\sigma-1}$ is used on the horizontal axis. It demonstrates that more productive firms earn more profits, the relationship between profit and productivity index is proportional, and $\pi(0) = -f_D$.

4. Comparative statics analysis

In this section, this article will examine whether a strict LCRs policy simultaneously increases the productivity and production of the domestic intermediate-goods industry. And further explore the changes in social welfare.

4.1. Analysis of average productivity and quantity

In this section, we analyze the effects on productivity cutoff and the composite quantity index of domestic intermediate goods when the domestic government strengthens its

[10]The free-entry condition for prospective entrants is that the firm's expected future value $v(\tilde{\varphi}_D)$ equals entry sunk cost f_E, i.e., $v(\tilde{\varphi}_D) = f_E$. If the free-entry condition is rewritten as the function of the productivity-cutoff level φ_D^*, it can be shown that $\tilde{\pi}_D(\tilde{\varphi}_D) = \delta f_E/(1 - G(\varphi_D^*))$.

[11]The zero-cutoff profit condition posits that the cutoff firm's revenue equals its operating fixed cost, i.e., $r_D^*(\varphi_D^*) = f_D$. By applying the ratio, $r_D^*(\varphi_D^*)/\tilde{r}_D(\tilde{\varphi}_D) = \left(\varphi_D^*/\tilde{\varphi}_D\right)^{\sigma-1}$, and the average profit, $(\tilde{\pi}_D)$, we derive the relationship between the average profit and the cutoff productivity level as $\tilde{\pi}_D(\tilde{\varphi}_D) = (\tilde{r}_D(\tilde{\varphi}_D)/\sigma) - f_D = f_D\left[\left(\tilde{\varphi}_D/\varphi_D^*\right)^{\sigma-1} - 1\right]$.

[12]See Melitz (2003), Appendix B, 1719–1720.

LCRs policy. We rewrite the zero-cutoff profit condition and the composite quantity indices as follows:

$$\varphi_D^* = \frac{1}{P_Z \rho}\left(\frac{P_D f_D}{P_Z Z}\frac{1}{\alpha_D}\right)^{\frac{1}{\sigma-1}}, \tag{6}$$

$$X_D = \alpha_D\left(\frac{P_D}{P_{z(j)}}\right)^{-\sigma} z(j). \tag{7}$$

If the domestic government adopts a stricter LCRs policy that requires domestic final-goods firms to increase α_D, we obtain results by taking the total differentiation of (6) and (7) as follows:

$$\frac{d\varphi_D^*}{d\alpha_D} = \underbrace{\frac{\partial \varphi_D^*}{\partial \alpha_D}}_{direct\ effect(-)} + \underbrace{\frac{\partial \varphi_D^*}{\partial Z}\frac{\partial Z}{\partial P_Z}\frac{\partial P_Z}{\partial \alpha_D}}_{indirect\ effect(+)}, \tag{8}$$

$$\frac{dX_D}{d\alpha_D} = \underbrace{\frac{\partial X_D}{\partial \alpha_D}}_{direct\ effect(+)} + \underbrace{\frac{\partial X_D}{\partial Z}\frac{\partial Z}{\partial P_Z}\frac{\partial P_Z}{\partial \alpha_D}}_{indirect\ effect(-)}. \tag{9}$$

Equation (8) shows that the effect of stricter LCRs on productivity cutoff can be divided into two parts: the direct effect and the indirect effect. The direct effect, representing how a stricter LCRs directly affects the level of productivity cutoff, is negative.[13] The direct effect implies that a higher LCRs, ceteris paribus, forces the domestic downstream firms to accept the higher ratio of and higher demand for domestic intermediate inputs, and hence allows lower-productivity firms to serve the domestic intermediate-goods market. The indirect effect, displaying how a stricter LCRs indirectly affect the level of productivity cutoff via price and output in the downstream final-goods market, is positive.[14] The indirect effect indicates that stricter LCRs lead to increased costs of production and downstream final goods and decreased demand for final goods. Lower demand for final goods compresses the demand for upstream intermediate goods such that the productivity cutoff moves to the right, and firms with higher productivity can survive in the domestic intermediate-goods market. The total effect of the combination of direct and indirect effects is ambiguous. Figure 2 describes the effect, in which the direct effect moves the curve to the left while the indirect effect moves the curve to the right, causing the productivity cutoff to be indeterminate. Therefore, a stricter LCRs may either raise or lower the average productivity of the domestic upstream intermediate-goods industry.

Equation (9) shows that the effect of a stricter LCRs on the industry output can also be divided into two effects. The direct effect, representing how a stricter LCRs directly affects the component quantity indices in the domestic intermediate-goods market, is positive.[15] This effect implies that, ceteris paribus, higher LCRs require final-goods firms to use

[13] A simple proof shows that $\frac{\partial \varphi_D^*}{\partial \alpha_D} = \frac{1}{P_Z \rho}\left(\frac{P_D f_D}{P_Z Z}\frac{1}{\alpha_D}\right)^{\frac{1}{\sigma-1}}\frac{1}{1-\sigma}(\alpha_D)^{\frac{\sigma}{1-\sigma}} < 0$.

[14] A simple proof shows that $\frac{\partial P_Z}{\partial \alpha_D} = -\frac{1}{\sigma-1}(P_Z)^{\sigma}\left(P_D^{1-\sigma} - P_F^{1-\sigma}\right) > 0$, $\frac{\partial Z}{\partial P_Z} = -(P_Z)^{-2}H < 0$ and $\frac{\partial \varphi_D^*}{\partial Z} = \frac{1}{1-\sigma}\frac{1}{\rho}(P_Z)^{\frac{\sigma}{1-\sigma}}(Z)^{\frac{\sigma}{1-\sigma}}(P_D f_D)^{\frac{1}{\sigma-1}}(\alpha_D)^{\frac{1}{1-\sigma}} < 0$.

[15] A simple proof shows that $\frac{\partial X_D}{\partial \alpha_D} = \left(\frac{P_D}{P_Z}\right)^{-\sigma} Z > 0$.

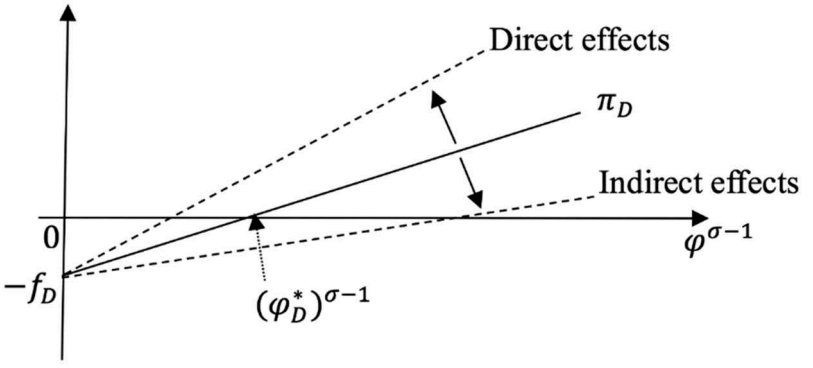

Figure 2. Effect of strengthening LCRs on productivity cutoff.

a higher ratio of domestic intermediate goods, and the output of the domestic intermediate goods hence expands. However, the indirect effect, displaying how stricter LCRs indirectly affect industry output via price and output in the downstream final-goods market, is negative.[16] The total effect of stricter LCRs policy on the output of the domestic intermediate industry becomes ambiguous.

To further clarify the LCRs effect, we can use Equations (8) and (9) to derive the following two conditions and summarize the results in proposition 1 and Figure 3.[17]

$$\frac{d\varphi_D^*}{d\alpha_D} \gtreqless 0 \qquad if\ \alpha_D \gtreqless \alpha_D^{margin} = \frac{1}{2}\frac{P_F^{1-\sigma}}{P_F^{1-\sigma} - P_D^{1-\sigma}} \tag{10}$$

$$\frac{dX_D}{d\alpha_D} \gtreqless 0 \qquad if\ \alpha_D \lesseqgtr \alpha_D^{margin} = \frac{1}{2}\frac{P_F^{1-\sigma}}{P_F^{1-\sigma} - P_D^{1-\sigma}} \tag{11}$$

4.1.1. Proposition 1

For the purposes of improving industrial productivity and/or helping industry grow through the adoption of stronger LCRs, the initial level of LCRs plays an important role

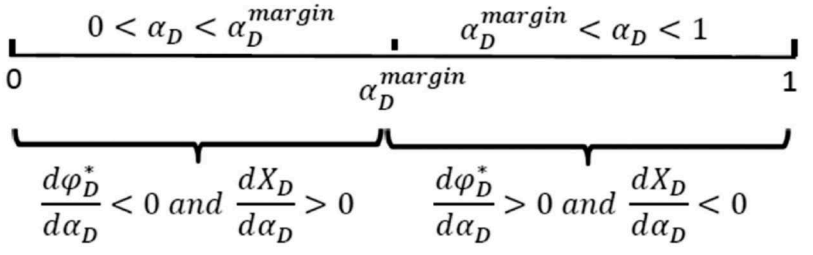

Figure 3. Result summary.

[16] A simple proof shows that $\frac{\partial P_Z}{\partial \alpha_D} = -\frac{1}{\sigma-1}(P_Z)^{\sigma}\left(P_D^{1-\sigma} - P_F^{1-\sigma}\right) > 0$, $\frac{\partial Z}{\partial P_Z} = -(P_Z)^{-2}H < 0$ and $\frac{\partial X_D}{\partial Z} = a_D\left(\frac{P_D}{P_Z}\right)^{-\sigma} > 0$.

[17] The ratio of the indirect effect to the direct effect is less than, equal to, or greater than 1 if the level of LCRs is less than, equal to, or greater than $\alpha_D^{margin} = \frac{1}{2}\frac{P_F^{1-\sigma}}{P_F^{1-\sigma} - P_D^{1-\sigma}}$.

in affecting policy. If the initial level of the LCRs is higher (lower) than α_D^{margin}, a stricter LCRs raises (decreases) the productivity cutoff (and hence the average productivity) and decreases (increases) the output of the domestic upstream intermediate-goods industry. However, the productivity cutoff, the average productivity, and the output of the industry are not affected if the initial level of LCRs equals α_D^{margin}.

The proposition and Figure 3 show that stricter LCRs policy would not accomplish the two policy objectives simultaneously. If the initial level of LCRs is low and falls into the interval $0 < \alpha_D < \alpha_D^{margin}$, the policy can help the industry grow (i.e., $\frac{dX_D}{d\alpha_D} > 0$), but it will lower the industry's productivity (i.e., $\frac{d\varphi_D^*}{d\alpha_D} < 0$). However, when the initial level of LCRs is higher and falls into the interval $\alpha_D^{margin} < \alpha_D < 1$, the policy can raise the industry's productivity (i.e., $\frac{d\varphi_D^*}{d\alpha_D} > 0$) but it cannot help the industry grow (i.e., $\frac{dX_D}{d\alpha_D} < 0$).

4.2. Analysis of social welfare

In the calculation of domestic social welfare, since the final-goods market in the domestic country is assumed as a completely competitive market, it only needs to calculate the consumer surplus in an equilibrium state. Based on the domestic consumer's utility function $\left(U_D = \int_0^1 (z(j)^\gamma dj)^{\frac{1}{\gamma}}\right)$, the demand function of domestic final goods $(Z = L/P_Z)$, and the equilibrium results which obtained above, the domestic social welfare can be obtained as follows:

$$SW_D = \left\{ \alpha_D \left[\left(\frac{w_D}{\rho \tilde{\varphi}_D} \right)^{-\sigma} (P_Z)^{\sigma-1} \right]^{\frac{\sigma-1}{\sigma}} + \alpha_F \left[\left(\frac{w_F}{\rho \tilde{\varphi}_F} \right)^{-\sigma} (P_Z)^{\sigma-1} \right]^{\frac{\sigma-1}{\sigma}} \right\}^{\frac{\sigma}{\sigma-1}} \tag{12}$$

where $\tilde{\varphi}_D$ and $\tilde{\varphi}_F$ are the average productivity of the domestic and foreign intermediate-goods markets, respectively.[18] Based on the above domestic social welfare, a stricter LCRs policy will lead to the following inequality:

$$\frac{dSW_D}{d\alpha_D} = \frac{1}{\sigma - 1} \left(\frac{w_D}{\rho \tilde{\varphi}_D} \right)^{1-\sigma} \left[\alpha_D \left(\frac{w_D}{\rho \tilde{\varphi}_D} \right)^{1-\sigma} + \alpha_F \left(\frac{w_F}{\rho \tilde{\varphi}_F} \right)^{1-\sigma} \right]^{\frac{2-\sigma}{\sigma-1}} > 0 \tag{13}$$

According to inequality (13), stricter LCRs policy will have a positive impact on the domestic social welfare through its domestic intermediate-goods market. This also means that although the government's LCRs policy cannot simultaneously increase the average productivity and production of the intermediate-goods industry, overall that the raising of LCRs level will benefit the increase of social welfare in the domestic country.

5. Conclusion

LCRs policy has been embraced by developing countries to realize industrialization. It is intended to help domestic intermediate-goods industries increase both production and

[18] Here, $\tilde{\varphi}_D = \left(\int_{i \in I} \varphi_D(i)^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}$ and $\tilde{\varphi}_F = \left(\int_{i \in I} \varphi_F(i)^{1-\sigma} di \right)^{\frac{1}{1-\sigma}}$.

productivity. Although this policy is important and has been explored by academic research, existing studies have neglected to investigate whether strengthening an LCRs can accomplish both objectives simultaneously. This paper provides a much-needed bridge over this gap in the literature by examining this issue; it does so by constructing a small open general-equilibrium economy in which firms are heterogeneous in productivity and compete with each other in a monopolistic competition market.

Our results show that a stricter LCRs policy would not simultaneously increase both production and productivity. Instead, it is the initial level of LCRs that determines the efficacy of the policy. When the initial level of the LCRs is low, lower than a certain (critical) level, a stricter LCRs will increase production but decrease productivity in the domestic intermediate-goods industry. However, the policy effects the opposite outcome – i.e., it decreases production but increases productivity – if the initial level is higher than that certain level. This seems to show that one policy is unable to hit two targets. In addition, although a more stringent level of LCRs cannot meet both of the government's expectations simultaneously, overall, the social welfare in the domestic country will have a positive impact through the domestic intermediate-goods market.

Since the intermediate and final markets are vertically related, and firm heterogeneity prevails across firms in this paper, making some assumptions to simplify model computation has been unavoidable. It would be interesting for future research to consider the possible effects of external economies (i.e., the larger the industry is, the lower the industry's costs are) and dynamic increasing return to scale (i.e., a firm's productivity, its average cost, falls as cumulative output over time rises). If one of these two possibilities exists, the LCRs policy is likely to simultaneously increase production and lift productivity. Due to inferior technology in the upstream industry, downstream firms in developing countries prefer foreign intermediate goods. If the LCRs policy is not implemented (i.e., in the case of free trade), the percentage of domestic intermediate goods embodied in the domestic final goods is low and the initial level of local content, which can be called the natural LCRs, is more likely to fall below the critical level of a legislated LCRs. If this situation occurs, a stricter LCRs implemented by the government in the developing country will increase production and decrease productivity in the beginning. However, the external economies and dynamic increasing return to scale will lift productivity as time goes by.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Shiue-Hung Lin graduated from the Department of Economics in National Chengchi University in Taiwan. He is currently an assistant professor in the Business School at the NanFang College of Sun Yat-Sen University. Lin's research fields include International Trade (heterogeneous firms model) and Applied Economics.

Yungho Weng graduated from the Department of Economics at the University of Wisconsin. He is currently a professor in the Department of Economics at the National Chengchi University and has served as the dean of the Department of Economics. Weng's research fields include International Trade and International Investment.

References

Advisors, W. T. I. 2013,June. *Local content requirements and the green economy. Ad Hoc expert group meeting on domestic requirements and support measures in green sectors: Economic and environmental* effectiveness *and* implications for trade. 13–14

Antràs, P., & Helpman, E. (2004). Global sourcing. *Journal of Political Economy*, *112*(3), 552–580.

Beghin, J. C., & Sumner, D. A. (1992). Domestic content requirements with bilateral monopoly. *Oxford Economic Papers*, *44*(2), 306–316.

Belderbos, R. A., & Sleuwaegen, L. I. E. (1997). Local content requirements and vertical market structure. *European Journal of Political Economy*, *13*(1), 101–119.

Carbaugh, R. (1983). The consequences of local content protection. *Business Economics*, *18*(4), 55–62.

Carbaugh, R., & Wassink, D. (1985). Joint venture, voluntary export quotas, and domestic content requirement. *Quarterly Journal of Business and Economics*, *24*, 21–36.

Davidson, C., Matusz, S. J., & Kreinin, M. E. (1985). Analysis of performance standards for direct foreign investments. *Canadian Journal of Economics*, *18*(4), 876–890.

Dixit, A., & Stiglitz, J. (1977, June). Monopolistic competition and optimum product diversity. *American Economic Review*, *76*, 389–405.

Findlay, R., & Wellisz, S. (1986). Tariffs, quotas and domestic content protection: Some political considerations. *Public Choice*, *50*(1–3), 221–242.

Fung, M. K. Y. (1994). Content protection, resource allocation, and variable labour supply. *The Canadian Journal of Economics*, *27*(1), 175–182.

Gourdon, K., & Guilhoto, J. (2019). Local content requirements and their economic effect on shipbuilding.

Grossman, G. M. (1981). The theory of domestic content protection and content preference. *Quarterly Journal of Economics*, *96*(4), 583–603.

Helpman, E., Melitz, M. J., & Yeaple, S. R. (2004). Export versus FDI with Heterogeneous Firms. *American Economic Review*, *94*(1), 300–316.

Hollander, A. (1987). Content protection and transnational monopoly. *Journal of International Economics*, *23*(3), 283–297.

Krishna, K., & Itoh, M. (1988). Content protection and oligopolistic interactions. *Review of Economic Studies*, *55*(1), 107–125.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity. *Econometrica*, *71*(6), 1695–1725.

Mussa, M. (1984). The Economics of content protection, NBER Working Paper Series No.1457.

Rennkamp, B., & Westin, E. F. (2013). *Boosting technological development through local content requirements in the wind energy industry, Energy Research Centre (ERC)*. South Africa: University of Cape Town (UCT).

Richardson, M. (1991). The effect of a content requirement on a foreign duopsonist. *Journal of International Economics*, *31*(1), 143–155.

Stone, S., Messent, J., & Flaig, D. (2015). *Emerging policy issues: Localisation barriers to trade* (No. 180). OECD Publishing.

Takacs, W. E. (1994). Domestic content and compensatory export requirements: Protection of the motor vehicle industry in the Philippines. *The World Bank Economic Review*, *8*(1), 127–149.

Takechi, K., & Kiyono, K. (2003). Local content protection: specific factor model for intermediate goods production and market segmentation. *Japan and the World Economy*, *15*(1), 69–87.

Veloso, F. M. (2006). Understanding local content decisions: economic analysis and an application to the automotive industry. *Journal of Regional Science*, *46*(4), 747–772.

Vousden, N. (1987). Content protection and tariffs under monopoly and competition. *Journal of International Economics*, *23*(3), 263–282.

Yen, C. S. (2013). Analysis on the consistency of Russia's automobile investment programs and WTO regulations. *Information of Economic and Trade Law*, *148*. Retrived from http://www.tradelaw.nccu.edu.tw/?p=191