ANNALS OF ECONOMICS AND FINANCE **19-1**, 279–300 (2018)

Country Size and Strategic Trade Policy: A Model of a Dominant Country Facing a Competitive Fringe

Jing Fang*

This paper develops a theory for why a large country might be special when it comes to pursuing strategic trade policy. Traditional theory holds that, a large country should hold back its exports to improve its terms of trade. However, if the learning-by-doing effect exists, then a large country has an incentive to subsidize exports. In this paper, I present a formal industrial organization (IO) model to capture this story. I embed this IO structure into a trade model with three goods. I also conduct some counter-factual analysis and welfare analysis about various trade policies of the importer countries.

Key Words: Country size; Strategic trade policy; Dominant country; Competitive fringe.
JEL Classification Numbers: F1, L1, L2.

1. INTRODUCTION

Perhaps the most controversial issue today regarding trade policy concerns China and its exports. There is wide agreement that China is pursuing a policy to promote exports by manipulating its exchange rate to subsidize exports and tax imports. If China is behaving strategically it begs the question: Why is it special? Why do we not hear similar accusations being leveled at small countries such as Vietnam or Thailand?

This paper develops a theory for why a particular country might be special when it comes to pursuing strategic trade policy. It considers an

* School of Economics, Huazhong University of Science and Technology, 1037 Luoyu Road, Wuhan, P.R.China, 430074. Email: jing_fang@hust.edu.cn. I am indebted to my adviser Thomas Holmes for his constant support and encouragement. I would like to thank my committee members Amil Petrin, Timothy Kehoe and Rodney Smith for their suggestions, which greatly improved the paper. I would also like to thank Patrick Bajari, Joel Waldfogel and Robert Town for their suggestions, in addition to Konstantin Golyaev, Jose Asturias, Nan Xu, Yenan Hou, Christina Marsh, and all participants of the University of Minnesota Applied Microeconomics Workshop. The usual disclaimer applies. This material is based upon work supported by the Fundamental Research Funds fro the Central Universities HUST: 2012WQN051.

1529-7373/2018

environment where countries are identical, except in terms of their scale. There is one exporting country (think of this as "China") that is an enormous proportional expansion of all the other exporting countries. On a per capita basis the exporting countries are the same in endowments.

Given its enormous size, the large country behaves strategically, and internalizes the impacts of its actions, in ways that the smaller exporting countries do not. In this paper there is a set of exporting countries, including the large country, that sells to another set of importing countries. In principle, with the large country acting as a dominant firm, we might see that it holds back its exports, relative to the small exporting countries, to maintain high export prices. However, suppose there is some kind of learning by doing (following the general idea of Arrow (1962)) that operates at the country level and that depends upon massive scale to be operative. Then, to exploit these scale economies the large country has an incentive to promote exports. As the small countries are not in a position to attain massive scale, the incentive for them to promote exports, to exploit learning by doing, is reduced. If these scale economies are external to the firm, then the large country will adopt export subsidies to promote exports. These subsidies will raise the real exchange rate for the large country compared to the small exporting countries.

This paper develops a formal model that captures this story. It makes explicit the assumptions that deliver the result that exports are higher in the large exporting country, compared to the small exporting countries, and the result that the real exchange rate is higher. The small exporting countries are modeled as "fringe firms",[1] as in the dominant firm model used in industrial organization, while the large country is a "dominant firm" (as in Riordan (1998) and Gowrisankaran and Holmes (2004)). The paper takes this industrial organization structure and embeds it into a trade model with three goods. Two goods are tradable and what we call the exporting countries sell good Y in return for good X. The third good is nontradable. With the nontradable good in the model, it is possible to analyze differences in real exchange rates.

This paper has some difference with the previous literature. Beginning with Brander and Spencer (1985), a large literature on strategic trade theory, such as Brander et al. (1995) and Bagwell and Staiger (2001) exists. There is also considerable literature on the question of why an export country can manipulate the exchange rate and push exports, starting from Krugman (1986), and followed by Knetter (1989), Knetter (1993), Goldberg and Knetter (1997), Atkeson and Burstein (2007), Goldberg and Hellerstein (2008), Atkeson and Burstein (2008) and Rodrik (2008). But none of them explain the question I asked above: Why is a big exporter special? This

[1]In the trade literature, they usually call it a "small open economy".

paper tries to answer this question and contributes to this literature. It is different from what has been done previously in several respects.

The first difference is that the main focus of this paper is competition between countries that are asymmetric in size, such as China compared to Vietnam. In the prototypical model of the literature, such as in Brander and Spencer (1985), competing countries are symmetric. A classic example is the Baldwin and Krugman (1988) analysis of competition in the wide-bodied aircraft industry. Their model examines the competition between Airbus (European market) and Boeing (U.S. market). A symmetric model is a reasonable starting place when comparing these two companies and markets. But now let us turn to a comparison of China and Vietnam. China is on the order of fifteen times as large as Vietnam, in terms of population. It is a dramatic asymmetry such as this one that this paper aims to capture through the use of its dominant firm/competitive fringe structure.

The second way in which this paper differs from typical strategic trade analysis is that the scale economies that are modeled are external to the firm but internal to the countries. For the Airbus versus Boeing analysis, it may be sufficient to rule out external economies. However for China, there are good reasons to think that there are external economies. Usually, the technology improvement is spillover from one firm to another, via blueprint trading or the patenting of a new technology. If a firm in a small country invents some new skill, it will easily spread out to other firms in other countries, but this is not true for a big country like China. According to Hessler (2010), in one industry, a first company imported a European-made machine to its shop in Fujian, a province in southeast China. An unskilled worker became an expert in the maintenance of the machine and secretly created a detailed blueprint of the machine. Then he moved to Guangdong, a province nearly seven hundred miles away from Fujian, and custom built the machine for a series of other companies. Clearly, the fruit of his learning traveled with him, some seven hundred miles, but still remained in China. Seven hundred miles is the approximate distance from Vietnam to Thailand, and it even crosses Cambodia or Laos. Of course, this story is not the usual way that new technology spillover occurs, but it is a good example to show that the scale factor of economics is very important in my analysis, and this factor is external to firms but internalized by a big country. There is also significant literature (Backus et al. (1992), Keller (2002) and Keller (2004)) that provides evidence that the benefits from technology spillover are related with distance, which again proves that scale is the key factor at the country level. And more importantly, as I will show in my results, if either the scale economies had already taken place (as in Krugman (1987)), or people anticipate it will happen in the future, I obtain the same conclusion — that a large country always wants to export more.

The third difference is that this paper explicitly incorporates nontradable goods, (as in Chipman (2007)) so it is conceptually possible to include a discussion of the real exchange rate in the analysis. Some papers (Krugman (1987)) may mention the scale economies that are external to the firm, but not incorporates the nontradable goods, and other papers may incorporate the nontradable goods but not use this structure to analyze the change of the real exchange rate.

In this paper, I find that, with the learning-by-doing effect, a big country exports more in both time periods, in comparison with the no learning-by-doing case. The real exchange rate is higher and increases as the learning-by-doing effect increases. This is mainly because, with learning by doing, inputs move to the export sector and significantly increase the price of non-tradable goods. The utility of a big exporter and importers increases dramatically but remains nearly the same for small exporters, since they take the price of export goods as given.

The rest of the paper is organized as follows. Section 2 provides some background information about China's trade policies and in particular compares it to Thailand. Section 3 describes the model and characterizes the equilibrium. Section 4 provides some numerical findings. Section 5 concludes.

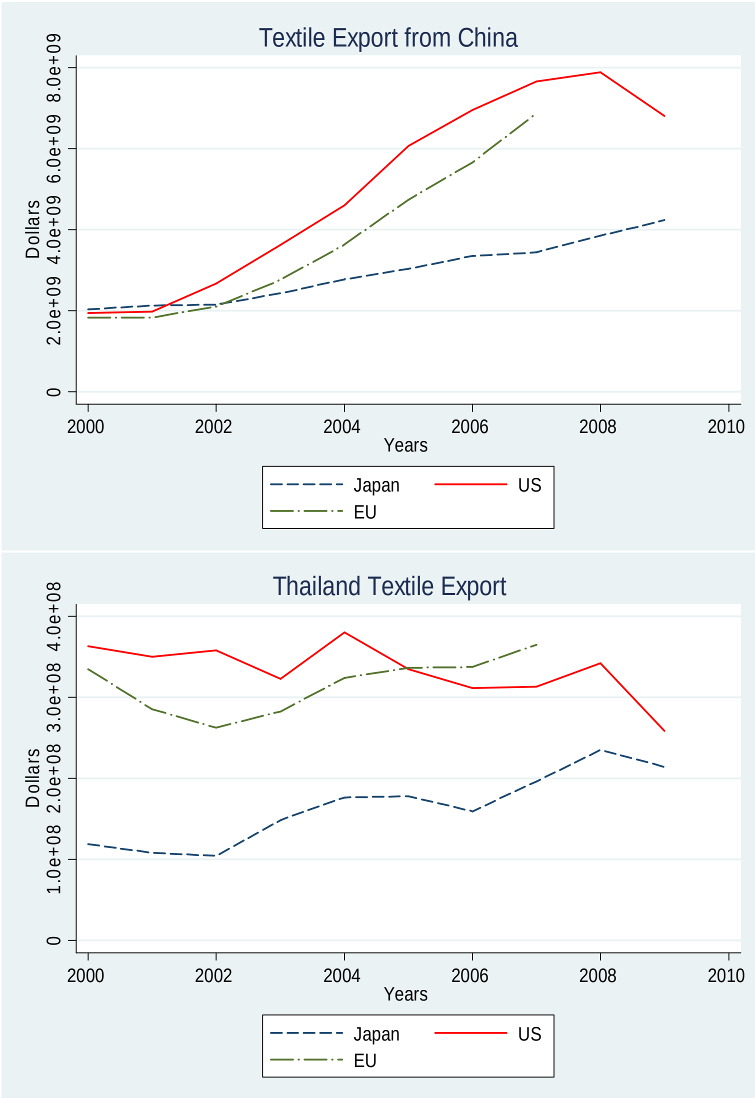
2. EXPORT GROWTH AND TRADE POLICIES

Beginning in 1978, China started its economic reform, opening up China to the world. It tried to build an export-oriented economy to stimulate economic growth. To illustrate the explosion in trade, I take two industries, textiles and toys and three export destinations, U.S., Japan, and the European Union as examples, as shown in figures 1 and 2.

In these two industries, exports from China doubled over this period. In some countries, like the United States, the import of textiles is nearly four times as large as ten years ago. Comparing with exports from Thailand, we can see clearly that China's exports to the U.S. did not increase very much. How could this huge difference happen?

Usually, there are two ways to promote exports. The first and most well-known method is subsidies. The New York Times once reported on a solar panel firm in Hunan province, China (Bradsher (2010)). This firm received subsidies from the local government instead of the central government, because subsidies from the central government are not allowed by World Trade Organization (WTO) rules. This is a very typical example of this method.

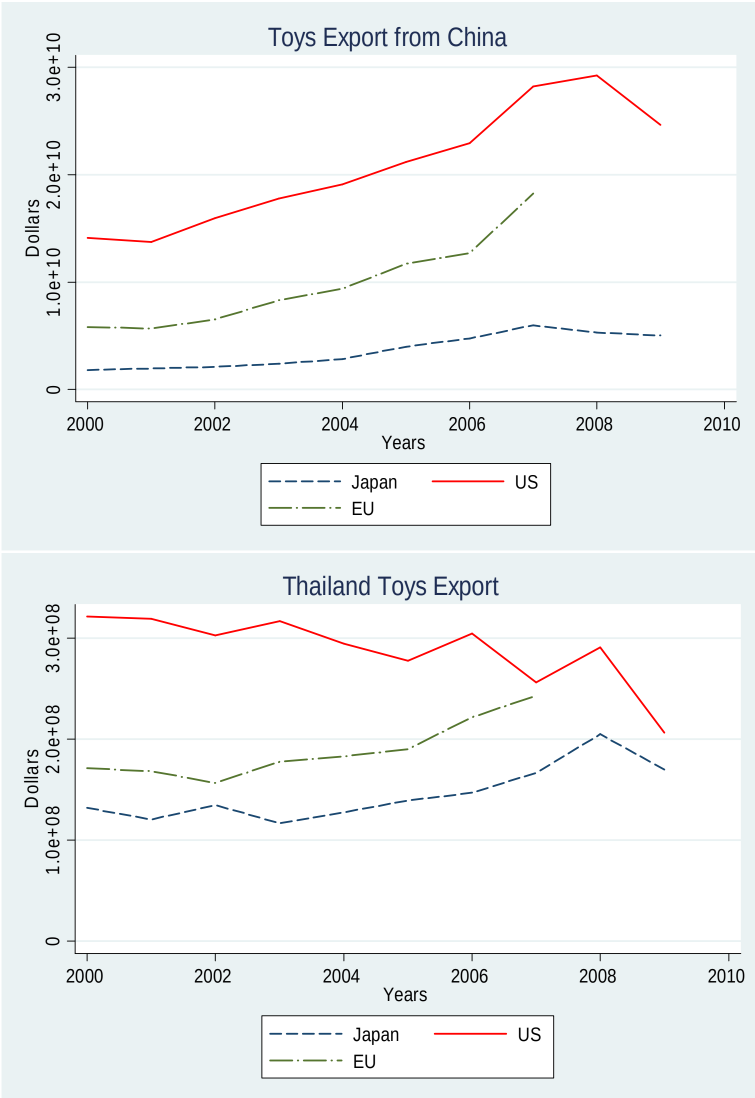
FIG. 1. Textile Exports.



The other way to do so is to manipulate the exchange rate. In figure 3 I present the change in the exchange rate from 2001 to 2010.

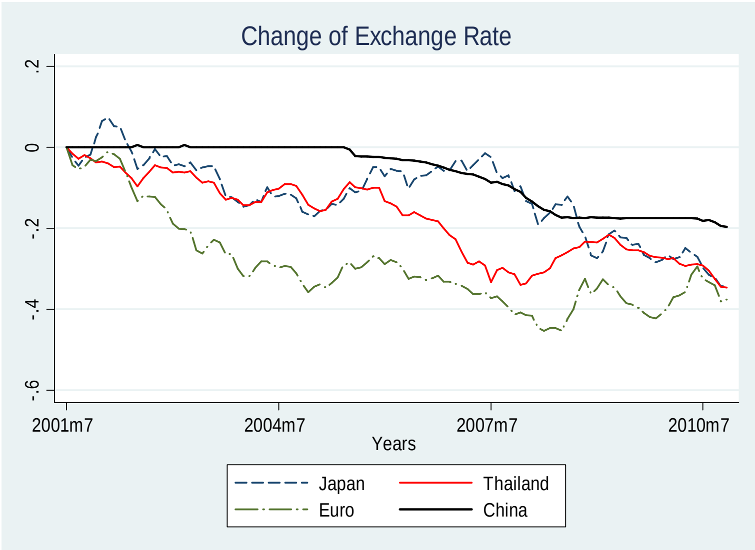
Figure 3 shows the change in the exchange rate for 1 U.S. dollar. So when the curve goes up, it means the U.S. dollar appreciated to this currency, and vice versa. In these ten years, it is clear that the U.S. dollar depreciated

FIG. 2. Toy Exports.



considerably relative to some other currencies, like the euro or the Japanese yen, but not for the Chinese yuan. China kept its rate pegged for the most of time. When the U.S. dollar depreciated, so did the Chinese yuan. This is obviously helpful for the export firms in China. Then, I use the Thai baht

FIG. 3. Exchange Rate.



as a comparison. When the U.S dollar depreciated to other currencies, it also depreciated to the Thai baht. That means, the Thai baht appreciated and of course, this did not help export firms in Thailand.

3. MODEL

In this section, I present my model. It is a two-period model, with a learning-by-doing effect in the second period. First, I present a simple version, in which the consumer only cares about the first period, so the learning-by-doing effect does not influence consumers' behavior. Then, I compare my model's result to the first simple version, to see the difference between these two versions. I believe the two-period version is more helpful in explaining a big exporter's behavior.

In my model, I assume there is a population of N in the world. Every consumer, with 1 unit of labor, owns a firm. The firm could produce tradable goods X, Y and non-tradable goods Z.[2] Every firm has the same technology and for n units of labor, they can produce n units of X, or $f(n)$ units of Y or n units of Z. (Suppose $f' > 0$ and $f'' < 0$, $\lim_{y\to 0} f(y) = +\infty$ and $\lim_{y\to +\infty} f(y) = 0$.) All of them are exporters and sell some Y to

[2] I use uppercase letters to denote the names of goods and lowercase letters to denote the quantity of those goods.

obtain X in return. I normalize the price of X to 1. The price of Y is $P_y > 1$ and the price of Z is decided by firms in their countries.

The consumer has the utility function:

$$U = x_{c1}^{\alpha_x} y_{c1}^{\alpha_y} z_{c1}^{\alpha_z} + \rho x_{c2}^{\alpha_x} y_{c2}^{\alpha_y} z_{c2}^{\alpha_z},$$

where ρ is the discount between periods and x_{ci}, y_{ci}, z_{ci} is the consumption of that goods in period i.

At the country level, the total measure of export countries is 1. There is a large country, with measure μ of land. The rest of the exporting countries together have $1-\mu$ of land. Each small exporting country has a measure of zero.

3.1. One-period version

Here I want to present a simple version of my model, as a baseline to compare. In this version, consumers only care about the first period, that is, $\rho = 0$.

For a small country, since it is really small, there are some competitive firms in it, and the firms could decide the p_{zs1}, and also they are competitive in the whole world export market. This means, the firms will take p_{y1} as given. The representative consumer supplies the labor that a firm needs and owns this firm, so the consumer's income is equal to the wage plus the profit of the firm. Since wage is the cost of the firm, the consumer will only care about the total revenue of his/her firm. In fact, at the location level, this is a social planner's problem. The planner needs to decide how much labor should be supplied to produce Y (n_{ys1}) or Z (n_{zs1}), and how many Y units (y_{se1}) should be sold to trade back X ($p_{y1}y_{se1}$).

So formally, the planner's problem is:

$$\max_{n_{sy1}, y_{se1}} U = x_{sc1}^{\alpha_x} y_{sc1}^{\alpha_y} z_{sc1}^{\alpha_z}, \tag{1}$$

where

$$\begin{aligned} x_{sc1} &= p_{y1} y_{se1} \\ y_{sc1} &= f(n_{sy1}) - y_{se1} \\ z_{sc1} &= 1 - n_{sy1} \end{aligned}$$

such that:

$$\begin{gathered} 0 \leqslant n_{sy1} \leqslant 1 \\ y_{se1} \leqslant f(n_{sy1}) \ . \end{gathered}$$

If I know the form of the production function $f(n_y)$, for example, assume $f(n_y) = \beta n_y^\lambda$, where $0 < \lambda < 1$, then I can obtain a first-order condition and solve it.

F.O.C.:

$$\begin{aligned} \alpha_y(1-n_{sy1})\beta\lambda n_{sy1}^{\lambda-1} &= \alpha_z(\beta n_{sy1}^\lambda - y_{se1}) \\ \alpha_x(\beta n_{sy1}^\lambda - y_{se1})p_{y1} &= \alpha_y p_{y1} y_{se1}. \end{aligned}$$

Solve it, and we get

$$\begin{aligned} n_{sy1} &= \frac{\lambda(\alpha_x+\alpha_y)}{\lambda(\alpha_x+\alpha_y)+\alpha_z} \\ y_{se1} &= \frac{\alpha_x}{\alpha_x+\alpha_y}\beta n_{sy1}^\lambda. \end{aligned}$$

Since the ratio of marginal utility should be equal to the ratio of price of that good, i.e.,

$$\frac{U_x}{U_y} = \frac{1}{p_y}, \frac{U_x}{U_z} = \frac{1}{p_z}, \text{ and } \frac{U_z}{U_y} = \frac{p_z}{p_y},$$

we could solve p_{zs1}:

$$p_{sz1} = \frac{U_z}{U_x} = \frac{\alpha_z x_{sc1}}{\alpha_x z_{sc1}}.$$

For the big country, it has a large area of land with a measure of μ. It has more labor endowment and more firms in this country. Of course it can produce much more to export. So obviously, this big country can decide the price level (p_{y1}) as it wants. The remaining small countries can only take the price (p_{y1}) as given and solve the question (1).

On the other hand, the big country knows its followers' response to a different price and will solve a similar problem as the small countries do and get n_{by1}, n_{bz1} and y_{be1}. Here I want to write down the big country's problem.

I also need to know the outside demand for the export tradable good Y. To do this, I assume the outside demand for Y is a constant elasticity demand: $p_y = cQ_d^\varepsilon$ ($c > 0, -1 < \varepsilon < 0$). And in the equilibrium, the quantity of demand should be equal to the quantity of export: $Q_d = \mu N y_{be1} + (1-\mu)N y_{se1}$. On the firm side, again assume that $f(n_y) = \beta n_y^\lambda$. Remember that y_{se1} is a function of p_{y1} and now we can see that p_{y1} is a function of y_{be1} and y_{se1}, so we know that y_{se1} is a function of y_{be1}. This function $y_{se1}(y_{be1})$ is the response function of the small countries.

The planner's problem in the big country is similar to (1):

$$\max_{n_{by1},y_{be1}} U = x_{bc1}^{\alpha_x} y_{bc1}^{\alpha_y} z_{bc1}^{\alpha_z},$$

where

$$\begin{aligned} x_{bc1} &= p_{y1} y_{be1} \\ &= c[\mu N y_{be1} + (1-\mu) N y_{se1}(y_{be1})]^{\varepsilon} y_{be1} \\ y_{bc1} &= \beta n_{by1}^{\lambda} - y_{be1} \\ z_{bc1} &= 1 - n_{by1} \end{aligned}$$

such that:

$$\begin{aligned} 0 \leqslant n_{by1} \leqslant 1 \\ y_{be1} \leqslant \beta n_{by1}^{\lambda} \quad . \end{aligned}$$

F.O.C.:

$$\begin{aligned} \alpha_y (1 - n_{by1}) \beta \lambda n_{by1}^{\lambda - 1} &= \alpha_z (\beta n_{by1}^{\lambda} - y_{be1}) \\ \alpha_x (\beta n_{by1}^{\lambda} - y_{be1}) [p_{y1} + y_{be1} p'_{y1}(y_{be1})] &= \alpha_y p_{y1} y_{be1}. \end{aligned}$$

I cannot solve for an analytical solution. But I will try to obtain some numerical results in next section. Mainly, I want to use this one-period model as a baseline, so that I can compare the two-period model result with this and see which one is a better fit for the real world situation and why.

3.2. Two-period version

Now I present my model, where $\rho > 0$, so all the countries face a two-period problem. And all of them have some learning-by-doing effect. Here I always assume that the spillover of technology could not be prevented from one firm to another. The workers of small countries can easily spread the technology improvement to firms in other countries. However, workers in the big country can only spread knowledge to firms inside the big country.

The second period production will be multiplied by an extra learning-by-doing effect parameter A, where

$$A = g\left(\int_{countryarea} (TotalOutput) dl\right).$$

For small countries, firms still produces Y and Z, and trade some Y for X. Firms in the country could decide the price of a non-tradable good at each period, p_{szi}. But since a small country is still a price taker in the world export market, the firms will take p_{yi} as given for any period. Again, the consumer's income is still equal to the wage plus the profit of the firm and therefore he/she will only care about the total revenue of his/her firm.

So in each period, the planner still needs to decide how much labor (n_{syi}) should be used to produce Y and the rest (n_{szi}) to Z, and how many Y (y_{sei}) should be sold to trade back X ($p_{yi}y_{sei}$).

More formally, the question is:

$$\max_{n_{syi},y_{sei}} U = x_{sc1}^{\alpha_x} y_{sc1}^{\alpha_y} z_{sc1}^{\alpha_z} + \rho x_{sc2}^{\alpha_x} y_{sc2}^{\alpha_y} z_{sc2}^{\alpha_z},$$

where

$$\begin{aligned} x_{si} &= p_{yi}y_{sei} \\ y_{s1} &= f(n_{sy1}) - y_{se1} \\ y_{s2} &= Af(n_{sy2}) - y_{se2} \\ &= g\left(\int_{countryarea} f(n_{sy1})dl\right) f(n_{sy2}) - y_{se2} \\ z_{si} &= 1 - n_{syi} \end{aligned}$$

such that:

$$\begin{gathered} 0 \leqslant n_{syi} \leqslant 1 \\ y_{se1} \leqslant f(n_{sy1}) \\ y_{se2} \leqslant Af(n_{sy2}) \quad . \end{gathered}$$

Again, I need to assume that $f(n_y) = \beta n_y^{\lambda}$. And for $g(x)$, I assume:

$$g(x) = \begin{cases} 1+\delta \text{ if } x < \beta \\ (1+\delta)(1+\ln(1-\beta+x)) \text{ if } x \geqslant \beta. \end{cases}$$

This functional form means that there is a threshold level at which to export. If a country's exports are less than that level, the learning-by-doing effect will be small. On the other hand, if exports are more than that level, the learning-by-doing effect will be large, and increasing as the exporting quantity increases.

The learning-by-doing effect has this functional form for several reasons. First, every country should have some learning-by-doing effect, regardless of its size and how much it produces. Thus the learning-by-doing effect parameter $A = g(x)$ should be bigger than 1 across countries. Second, small producers have a small and constant learning-by-doing effect. It is small because they cannot learn much from production, and it is constant because of spillovers across small countries.

But for the big country, the learning-by-doing effect is large and increasing as the production and exports rise. This is because, the big country is big enough to internalize the learning-by-doing effect.

Now go back and look at the small country's learning-by-doing effect. The small country only has an area with a measure of 0, so $g(\int_{countryarea} f(n_{sy1})dl) = g(0) = 1 + \delta$, since the small country's production does not exceed the threshold level.

Now we can see that, the small country's consumers do not have any dynamic decision to make. They solve the maximization problem in each period, so I can restate the small country's problem as follows:

In the first period, consumers solve:

$$\max_{n_{sy1}, y_{se1}} U = x_{sc1}^{\alpha_x} y_{sc1}^{\alpha_y} z_{sc1}^{\alpha_z},$$

where

$$\begin{aligned} x_{sc1} &= p_{y1} y_{se1} \\ y_{sc1} &= \beta n_{sy1}^{\lambda} - y_{se1} \\ z_{sc1} &= 1 - n_{sy1} \end{aligned}$$

such that:

$$\begin{aligned} &0 \leqslant n_{sy1} \leqslant 1 \\ &y_{se1} \leqslant \beta n_{sy1}^{\lambda} \quad . \end{aligned}$$

And in the second period, the consumers solve:

$$\max_{n_{sy2}, y_{se2}} U = \rho x_{sc2}^{\alpha_x} y_{sc2}^{\alpha_y} z_{sc2}^{\alpha_z},$$

where

$$\begin{aligned} x_{sc2} &= p_{y2} y_{se2} \\ y_{sc2} &= A\beta n_{sy2}^{\lambda} - y_{se2} \\ &= (1+\delta)\beta n_{sy2}^{\lambda} - y_{se2} \\ z_{sc2} &= 1 - n_{sy2} \end{aligned}$$

such that:

$$0 \leqslant n_{sy2} \leqslant 1$$
$$y_{se2} \leqslant (1+\delta)\beta n_{sy2}^{\lambda} \ .$$

Solve this question and I see:

$$\begin{aligned}
n_{sy1} &= \frac{\lambda(\alpha_x+\alpha_y)}{\lambda(\alpha_x+\alpha_y)+\alpha_z} \\
y_{se1} &= \frac{\alpha_x}{\alpha_x+\alpha_y}\beta n_{sy1}^{\lambda} \\
n_{sy2} &= \frac{\lambda(\alpha_x+\alpha_y)}{\lambda(\alpha_x+\alpha_y)+\alpha_z} \\
y_{se2} &= \frac{\alpha_x}{\alpha_x+\alpha_y}(1+\delta)\beta n_{sy1}^{\lambda}.
\end{aligned}$$

Similar to the one-period model,

$$p_{szi} = \frac{U_z}{U_x} = \frac{\alpha_z x_{sci}}{\alpha_x z_{sci}}.$$

For the big country, it has a large area of land with a measure of μ and sets the price level of tradable goods (p_{yi}). The big country knows the small country's response to a different price, $y_{sei}(p_{y1}, p_{y2})$ and will solve the similar problem and get n_{byi}, n_{bzi} and y_{bei}.

Again I assume the outside demand for Y is still $p_y = cQ_d^{\varepsilon}$ ($c > 0, -1 < \varepsilon < 0$) and the quantity demand is $Q_d = \mu N y_{bei} + (1-\mu)N y_{sei}$. On the firm side, again assume that $f(n_y) = \beta n_y^{\lambda}$, but the learning-by-doing effect for the big country is

$$\begin{aligned}
A &= g(x) = g\left(\int_{countryarea} TotalOutput\ dl\right) \\
&= g\left(\int_{countryarea} \mu N f(n_{by1})\right) \\
&= g(\mu^2 N f(n_{by1})) \\
&= (1+\delta)(1+\ln(1-\beta+\mu^2 N f(n_{by1}))).
\end{aligned}$$

The big country has an area (measure μ) and population (N) large enough to make the big country's production cross the threshold level. Again, notice that y_{sei} is a function of p_{yi} and we can see now, that p_{yi} is a function of y_{bei} and y_{sei}, so we know that y_{sei} is a function of y_{bei}.

Then the planner's problem for the big country is:

$$\max_{n_{byi}, y_{bei}} U = x_{bc1}^{\alpha_x} y_{bc1}^{\alpha_y} z_{bc1}^{\alpha_z} + \rho x_{bc2}^{\alpha_x} y_{bc2}^{\alpha_y} z_{bc2}^{\alpha_z},$$

where

$$\begin{aligned}
x_{bci} &= p_{yi} y_{bei} \\
&= c[\mu N y_{bei} + (1-\mu) N y_{sei}(y_{bei})]^{\varepsilon} y_{bei} \\
y_{bc1} &= f(n_{by1}) - y_{be1} = \beta n_{by1}^{\lambda} - y_{be1} \\
y_{bc2} &= A f(n_{by2}) - y_{be2} \\
&= g\left(\int_{countryarea} f(n_{by1}) dl\right) f(n_{by2}) - y_{be2} \\
&= [(1+\delta)(1+\ln(1-\beta+\mu^2 N f(n_{by1})))] f(n_{by2}) - y_{be2} \\
&= [(1+\delta)(1+\ln(1-\beta+\mu^2 N \beta n_{by1}^{\lambda}))] \beta n_{by2}^{\lambda} - y_{be2} \\
z_{bci} &= 1 - n_{byi}
\end{aligned}$$

such that:

$$\begin{gathered}
0 \leqslant n_{byi} \leqslant 1 \\
y_{be1} \leqslant \beta n_{by1}^{\lambda} \\
y_{be2} \leqslant [(1+\delta)(1+\ln(1-\beta+\mu^2 N \beta n_{by1}^{\lambda}))] \beta n_{by2}^{\lambda} \ .
\end{gathered}$$

I can only solve for the optimal n_{byi}, n_{bzi} and y_{bei} numerically. I will show this in the next section.

4. NUMERICAL RESULT

In this section, I present some numerical results to examine the difference between these two versions. I expect that in the one-period setting, the big exporter should hold back the quantity of production to increase the price. In the two-period version, since the learning-by-doing effect exists, even a big exporter will increase its quantity and lower its price. I will also conduct a counter-factual analysis at the end of this section, to analyze the effect of an export quota on the big country.

In the utility function, I assume that $\alpha_x = 0.3, \alpha_y = 0.4$ and $\alpha_z = 0.3$. And in the two-period version, consumers have the same weight on the first and second period, that is, $\rho = 1$. So the utility function will be $U = X_1^{\alpha_x} Y_1^{\alpha_y} Z_1^{\alpha_z} + X_2^{\alpha_x} Y_2^{\alpha_y} Z_2^{\alpha_z} = X_1^{0.3} Y_1^{0.4} Z_1^{0.3} + X_2^{0.3} Y_2^{0.4} Z_2^{0.3}$. About the production function, I want to use a Cobb-Douglas production function,

$f(k,l) = \beta k^{1-\lambda} l^{\lambda}$. But in my model, there is no capital, so I assume $k = 1$ here and so that $f(n) = \beta n^{\lambda}$. The average share of labor in the national income in the U.S. is about 0.64. Considering that exporter countries' products are generally more labor-intensive, I assume $\beta = 1$ and $\lambda = 0.7$. So the production function is $f(n_y) = \beta n_y^{\lambda} = n_y^{0.7}$. The outside demand from import countries has constant elasticity; and, mainly they import necessities, so the absolute elasticity will be lower than 1. So here I assume $c = 10$ and $\varepsilon = -0.5$, and the demand function is $p_y = 10Q_d^{-0.5}$. Finally, I assume there is a population of 100 in the export world, and half of them belong to the big country. That is $N = 100$ and $\mu = 0.5$.

4.1. One-period version

For small countries, the problem is:

$$\max_{n_{sy1}, y_{se1}} U = x_{sc1}^{0.3} y_{sc1}^{0.4} z_{sc1}^{0.3},$$

where

$$\begin{aligned} x_{sc1} &= p_{y1} y_{se1} \\ y_{sc1} &= \beta n_{sy1}^{\lambda} - y_{se1} \\ &= n_{sy1}^{0.7} - y_{se1} \\ z_{sc1} &= 1 - n_{sy1} \end{aligned}$$

such that:

$$\begin{aligned} 0 \leqslant n_{sy1} \leqslant 1 \\ y_{se1} \leqslant n_{sy1}^{0.7} \end{aligned} \quad .$$

For the big country, the question is:

$$\max_{n_{by1}, y_{be1}} U = x_{bc1}^{0.3} y_{bc1}^{0.4} z_{bc1}^{0.3},$$

where

$$\begin{aligned} x_{bc1} &= p_{y1} y_{be1} \\ &= c[\mu N y_{be1} + (1-\mu) N y_{se1}(y_{be1})]^{\varepsilon} y_{be1} \\ &= 10[50 y_{be1} + 50 y_{se1}(y_{be1})]^{\varepsilon} y_{be1} \\ y_{bc1} &= n_{by1}^{0.7} - y_{be1} \\ z_{bc1} &= 1 - n_{by1} \end{aligned}$$

such that:

$$\begin{array}{c} 0 \leqslant n_{by1} \leqslant 1 \\ y_{be1} \leqslant n_{by1}^{0.7} \end{array} .$$

Solve it and obtain the result in table 1.

TABLE 1.

One Period

	The big country	Small countries
n_{y1}	0.5958	0.6203
n_{z1}	0.4042	0.3797
y_{e1}	0.2554	0.3068
p_{y1}	1.8861	1.8861
p_{z1}	1.1919	1.5237
x_{c1}	0.4817	0.5786
y_{c1}	0.4405	0.4090
z_{c1}	0.4042	0.3797
U	0.4410	0.4439

The real exchange rate (RER, big/small) is:

$$RER = \frac{p_{bz1}\frac{p_{bz1}z_{bc1}}{x_{bc1}+p_{y1}y_{bc1}+p_{bz1}z_{bc1}} + p_{y1}\frac{p_{y1}y_{bc1}}{x_{bc1}+p_{y1}y_{bc1}+p_{bz1}z_{bc1}} + \frac{x_{bc1}}{x_{bc1}+p_{y1}y_{bc1}+p_{bz1}z_{bc1}}}{p_{sz1}\frac{p_{sz1}z_{sc1}}{x_{sc1}+p_{y1}y_{sc1}+p_{sz1}z_{sc1}} + p_{y1}\frac{p_{y1}y_{sc1}}{x_{sc1}+p_{y1}y_{sc1}+p_{sz1}z_{sc1}} + \frac{x_{sc1}}{x_{sc1}+p_{y1}y_{sc1}+p_{sz1}z_{sc1}}} \approx 0.9671.$$

Since I know the demand curve, I can calculate the consumers' surplus:

$$\begin{aligned} CS &= \int_0^{Q_d} c * Q^{\varepsilon} dQ \\ &= 106.0369. \end{aligned}$$

4.2. Two-period version

I still assume the same parameter values as in the one-period version. Now I have the learning-by-doing effect in the second period:

$$A = g(x) = \begin{cases} 1+\delta \text{ if } x < 1 \\ (1+\delta)(1+\ln(x)) \text{ if } x \geqslant 1. \end{cases}$$

Here I will give every country a 10% increase for the second period if it is below the threshold level, that is $\delta = 0.1$. This is not a very high forecast, considering the rapid growth of technological innovation.

For small countries, in the first period consumers solve:

$$\max_{n_{sy1}, y_{se1}} U = x_{sc1}^{0.3} y_{sc1}^{0.4} z_{sc1}^{0.3},$$

where

$$\begin{aligned} x_{sc1} &= p_{y1} y_{se1} \\ y_{sc1} &= \beta n_{sy1}^{\lambda} - y_{se1} \\ &= n_{sy1}^{0.7} - y_{se1} \\ z_{sc1} &= 1 - n_{sy1} \end{aligned}$$

such that:

$$\begin{gathered} 0 \leqslant n_{sy1} \leqslant 1 \\ y_{se1} \leqslant n_{sy1}^{0.7} \quad . \end{gathered}$$

In the second period, consumers solve:

$$\max_{n_{sy2}, y_{se2}} U = \rho x_{sc2}^{\alpha_x} y_{sc2}^{\alpha_y} z_{sc2}^{\alpha_z},$$

where

$$\begin{aligned} x_{sc2} &= p_{y2} y_{se2} \\ y_{sc2} &= A\beta n_{sy2}^{\lambda} - y_{se2} = (1+\delta)\beta n_{sy2}^{\lambda} - y_{se2} \\ &= 1.1 n_{sy2}^{0.7} - y_{se2} \\ z_{sc2} &= 1 - n_{sy2} \end{aligned}$$

such that:

$$\begin{gathered} 0 \leqslant n_{sy2} \leqslant 1 \\ y_{se2} \leqslant 1.1 n_{sy2}^{\lambda} \quad . \end{gathered}$$

The big country's problem is:

$$\max_{n_{byi}, y_{bei}} U = x_{bc1}^{0.3} y_{bc1}^{0.4} z_{bc1}^{0.3} + x_{bc2}^{0.3} y_{bc2}^{0.4} z_{bc2}^{0.3},$$

where

$$\begin{aligned} x_{bci} &= p_{yi}y_{bei} = c[\mu N y_{bei} + (1-\mu)N y_{sei}(y_{bei})]^{\varepsilon} y_{bei} \\ &= 10[50y_{bei} + 50y_{sei}(y_{bei})]^{\varepsilon} y_{bei} \\ y_{bc1} &= f(n_{by1}) - y_{be1} = \beta n_{by1}^{\lambda} - y_{be1} = n_{by1}^{0.7} - y_{be1} \\ y_{bc2} &= Af(n_{by2}) - y_{be2} = g(\int_{countryarea} f(n_{by1})dl) f(n_{by2}) - y_{be2} \\ &= [(1+\delta)(1+\ln(1-\beta+\mu^2 N\beta n_{by1}^{\lambda}))]\beta n_{by2}^{\lambda} - y_{be2} \\ &= [1.1(1+\ln(25n_{by1}^{0.7}))]n_{by2}^{0.7} - y_{be2} \\ z_{bci} &= 1 - n_{byi} \end{aligned}$$

such that:

$$\begin{gathered} 0 \leqslant n_{byi} \leqslant 1 \\ y_{be1} \leqslant n_{by1}^{0.7} \\ y_{be2} \leqslant 1.1(1+\ln(25n_{by1}^{0.7}))]n_{by2}^{0.7} \quad . \end{gathered}$$

The solution to the above problem is reported in table 2.

TABLE 2.

Two Periods.

	$i=1$		$i=2$	
	The big country	Small countries	The big country	Small countries
n_y	0.6996	0.6203	0.5788	0.6203
n_z	0.3004	0.3797	0.4212	0.3797
y_e	0.2824	0.3068	0.9546	0.3375
p_y	1.8424	1.8424	1.2441	1.2441
p_z	1.7318	1.4884	2.8197	1.1056
x_c	0.5203	0.5652	1.1877	0.4198
y_c	0.4963	0.4090	2.0226	0.4499
z_c	0.3004	0.3797	0.4212	0.3797
U	0.4330	0.4408	1.0768	0.4188

The real exchange rate (big/small) is:

$$\begin{aligned} RER_1 &\approx 1.0710 \\ RER_2 &\approx 1.3879. \end{aligned}$$

Comparing to the one-period case, I find that consumers in the big country obtain a higher price of non-tradable goods Z and a lower price of tradable goods Y, and have a higher real exchange rate. The utility goes up considerably in the second period, because of increased production destined for the export market. For small countries, their utility is nearly the same as in the one-period model.

Again, we can calculate the consumers' surplus in both periods:

$$\begin{aligned} CS_1 &= 108.5521 \\ CS_2 &= 160.7533. \end{aligned}$$

It is very clear that, when comparing with the one-period model, consumers of the importer country are better off in both periods, especially for the second period, because they can buy more tradable goods Y at a lower price.

4.3. Counter-factual analysis

Although the consumers of the import country are better off, we should notice that the utility of small exporters decreases a little bit. Now suppose a small country asks the WTO to apply a new policy of export quotas. No firm can export more than $\theta = 0.5$ units of Y in any period. This is nearly 1.5 times the quantity of export from a small-country firm. Let us see what will happen when I restrict the big country's export.

Now all the countries face nearly the same problem as before. The only difference is that all the export quantity y_{bei} and y_{sei} should be less than $\theta = 0.5$. Solve this policy questions, and I get the results in table 3.

TABLE 3.

Counter-factual Analysis.

	$i = 1$		$i = 2$	
	The big country	Small countries	The big country	Small countries
n_y	0.6817	0.6203	0.5319	0.6203
n_z	0.3183	0.3797	0.4681	0.3797
y_e	0.2780	0.3068	0.5000	0.3375
p_y	1.8494	1.8494	1.5454	1.5454
p_z	1.6149	1.4940	1.6507	1.3733
x_c	0.5141	0.5674	0.7727	0.5215
y_c	0.4867	0.4090	2.2935	0.4499
z_c	0.3183	0.3797	0.4681	0.3797
U	0.4356	0.4413	1.0273	0.4470

The real exchange rate (big/small) is:

$$\begin{aligned} RER_1 &\approx 1.0487 \\ RER_2 &\approx 1.1116. \end{aligned}$$

I find that, with the export cap, in comparison to the two-period model, consumers of the big country suffer from a higher price of tradable goods Y, and also, their welfare decreases a large amount in the second period. The big country has a lower real exchange rate, in comparison to the one-period case. For small countries, they still have the similar utility level.

Once again, I calculate the consumers' surplus in both periods:

$$\begin{aligned} CS_1 &= 108.1429 \\ CS_2 &= 129.4182. \end{aligned}$$

Comparing with the one-period model, consumers of the importer country are worse off in both periods, especially in the second period, because of the increased price of goods Y.

5. CONCLUSION AND FUTURE RESEARCH

This paper develops a theory for why a big country might be special when it comes to pursuing strategic trade policy. I present an industrial organization model to capture the story of international trade with one big exporter and many small exporters. The first and simple version of my model embeds the basic static dominant fringe firm structure to describe the one-period case. Then I expand it to a two-period version with a learning-by-doing effect. All the countries have this kind of effect, but only the big country can internalize it to a much larger effect. This is the main reason why a big country should subsidize exports by controlling the nominal exchange rate.

From the numerical result section, we can see that, with the learning-by-doing effect, the big country exports much more than before. Consumers in both the big country and the importer country are better off, and the welfare of small exporters remains roughly the same. The real exchange rate rises for the large country compared to the small exporting countries.

The counter-factual analysis shows that, an export quota policy does not benefit the small countries much but makes both big exporters and importers significantly worse off. Thus the export cap for big countries reduces international welfare.

For future research, there are three possible directions. The first is to expand the model from a two-period to a multi-period dynamic version.

The firms have similar learning-by-doing effects in each period, and the spillover could not be prevented from firm to firm at any time. Of course, this new version is much more complicated but fits the real world much better and may reveal some new charscteristics of a big exporter. The second is to apply the same method to the world import market. Currently, a big country, like China, is not only a big exporter but also a large importer, especially of natural resources. It would be beneficial to see what is optimal for a big importer, and what is the effect of its behavior on other countries. Lastly, how should we consider the micro-base of the behavior I describe in this paper? Why do people prefer to purchase from big exporters? Is it because a big exporter supplies cheap products or a variety of products? The question involves a totally new model.

REFERENCES

Arrow, K. J., 1962. The economic implications of learning by doing. *Review of Economic Studies* **29(3)**, 155-173.

Atkeson, A. and A. Burstein, 2007. Pricing-to-market in a Ricardian model of international trade. *American Economic Review* **97(2)**, 362-367.

Atkeson, A. and A. Burstein, 2008. Pricing-to-market, trade costs, and international relative prices. *The American Economic Review* **98(5)**, 1998-2031.

Backus, D. K.,, P. J. Kehoe, and T. J. Kehoe, 1992. In search of scale effects in trade and growth. *Journal of Economic Theory* **58**, 377-409.

Bagwell, K. and R. W. Staiger, 2001. Strategic trade, competitive industries and agricultural trade disputes. *Economics & Politics* **13(2)**, 113-128.

Baldwin, R. and P. Krugman, 1988. Industrial policy and international competition in wide- bodied jet aircraft. In: Trade Policy Issues and Empirical Analysis. University of Chicago Press, pp. 45-78.

Bradsher, K., 2010. On clean energy, china skirts rules. New York Times 9, A1.

Brander, J. A., 1995. Strategic trade policy. *Handbook of International Economics* **3**, 1395-1455.

Brander, J. A. and B. J. Spencer, 1985. Export subsidies and international market share rivalry. *Journal of International Economics* **18(1)**, 83-100.

Chipman, J. S., 2007. Protection and exchange rates in a small open economy. *Review of Development Economics* **11(2)**, 205-216.

Goldberg, P. K. and R. Hellerstein, 2008. A structural approach to explaining incomplete exchange-rate pass-through and pricing-to-market. *The American Economic Review* **98(2)**, 423-429.

Goldberg, P. K.and M. M. Knetter, 1997. Goods prices and exchange rates: What have we learned? *Journal of Economic Literature* **35(3)**, 12-43.

Gowrisankaran, G. and T. J. Holmes, 2004. Mergers and the evolution of industry concentration: results from the dominant-firm model. *RAND Journal of Economics* **35(3)**, 1-22.

Hessler, P., 2010. Country Driving: A Chinese Road Trip. Canongate Books.

Keller, W., 2002. Geographic localization of international technology diffusion. *The American Economic Review* **92(1)**, 120-142.

Keller, W., 2004. International technology diffusion. *Journal of Economic Literature* **42(3)**, 752-782.

Knetter, M. M., 1989. Price discrimination by US and German exporters. *The American Economic Review* **79(1)**, 198-210.

Knetter, M. M., 1993. International comparisons of pricing-to-market behavior. *American Economic Review* **83(3)**, 473-486.

Krugman, P., 1987. The narrow moving band, the Dutch disease, and the competitive con- sequences of Mrs. Thatcher: Notes on trade in the presence of dynamic scale economies. *Journal of Development Economics* **27(1)**, 41-55.

Krugman, P. R., 1986. Pricing to market when the exchange rate changes. NBER Working Paper (w1926).

Riordan, M. H., 1998. Anticompetitive vertical integration by a dominant firm. *American Economic Review* **88(5)**, 1232-1248.

Rodrik, D., 2008. The real exchange rate and economic growth. *Brookings Papers on Economic Activity* **2008(2)**, 365-412.