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A BRIEF THEORETICAL ANALYSIS OF FIRMS' CAPITAL SELECTION IN TURKEY[1]

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Abstract

Production process has utmost importance on a firm's survival in a competitive market. For this purpose, firms from developed countries choose to produce in different parts of the world to benefit from cheap labor supply. On the contrary, firms in developing countries prefer to import capital goods from developed countries to increase their chance to survive in a harsh competitive environment. But these capital goods are designed and optimized specially for the firms in developed countries. Thus, it is unclear whether the strategy of firms in developing countries is beneficial or not. In this paper, we clarify the results of firms' strategies from both developed and developing countries. Theoretically, the strategy of firms that originated from developed countries is profitable. On the other hand, the strategy of firms in developing countries harms their profit levels.

Keywords: Production, Capital selection, Developing countries

I. INTRODUCTION AND LITERATURE SURVEY

The relations of capital and labor are attracted many scholars and mainly tried to be discovered in Cobb and Douglas (1928). Because production functions are not easily observable, economists spend a great deal of time to understand the effects of capital and labor on production. Cobb and Douglas (1928) accomplish this aim by a special form of production function. Their findings that are based on US manufacturing data provide academicians with the ways to study other sophisticated features of production.

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Robinson (1953) studies the relationship between production and capital. Robinson (1953) includes technological changes into the study and determines when the rate of profit on capital tends to be higher compared to the real wages. If technical opportunities to increase production are plenty; or if the rate of capital accumulation in relation to the population is slower; or if the competition in the market is weaker, then the profit rate of capital is higher. Solow (1957) segregates shifts of the production function from movements along it. Actually, Solow (1957) brings the idea of evolving production function and incorporates a time dependent technological change into the production function framework. Fisher (1968) separated capital into two: movable capital and fixed capital. Making use of this separation, Fisher (1968) tries to aggregate these two types of capital goods and integrate into the production function. Garagnani (1970) considers heterogeneous capital compared to aggregate version in Solow (1957) and uncovers its relations with production. Also, Garagnani (1970) studies the distribution problem in the context of heterogeneous capital structure. Rowley (1972) compares Cobb Douglas and Constant Elasticity of Scale production functions for British economy. Cobb Douglas production function is found to be inappropriate for British economy. Also, Constant Elasticity of Scale production function is not a good fit and does not explain British economy in a proper way. Spanel and Sling (1977) study the absorption capacity of the economy. Since technological changes increase the return of investment and capital depreciates along the time, the absorption capacity of the economy increases. Starting from this point, Spanel and Sling (1977) utilize production function to explain reproduction of capital assets. Faurot (1978) develops globally optimal flexible accelerator model of production to analyze the demand for capital and labor. He concludes that there exist benefits of capital adjustment, but he finds very slow adjustment to capital using three different data sets.

Studies related to the capital are not restricted to production function and its alternative forms. Capital and technology selection also occupy some important place in literature. Spiegel (1996) investigates the technology choice of a firm when it is regulated. In a case where firms are regulated, they tend to choose different technologies with high variable costs and low fixed costs. These choices are not socially optimal. The alleviation of this burden on technology choice depends on the permission of debt financing. If regulators allow firms to borrow with lesser limitations, then firms can make use of more socially optimal technologies without wasting precious resources. Beneito (2003) makes an in depth study on technology selection of firms. The results of this study are generally in parallel with main findings in the literature. But it is worth to mention two important results on importing technology. First of all, the firm size favors the import of technology. Secondly, financial capability of the firm is the main force that determines its activities

on research and development. Istaitieh and Fernandez (2006) survey the literature for the interaction between the financial structure and firm's strategic management. They also emphasize that, this interaction is not in one direction but it is actually in two directions. Recently, Parker and Pingle (2006) warn the econometricians on the distribution of total factor productivity, since capital accumulation has effects which changes skewness of this distribution. Tomiura (2009) compares foreign and domestic outsourcing of technology in Japan. Firm level micro data show that domestic outsourcing is preferred over foreign outsourcing in the case where research and development is intensive.

This paper sheds light on capital good (such as machinery) transfers between developed and developing countries. Assuming similar production functions but differently designed capital goods, the optimal behaviors of firms originating from two different types of countries are clarified within a theoretical approach. Because of the lack of micro level data, the theoretical findings of the paper cannot be tested. But most probably, availability of micro level data in future can provide us with empirical results. In the next section of the paper, we establish a theoretical model and derive some results. In section 3, we make concluding remarks.

II. THE MODEL

There exist two countries in the model. The first country is a developing country with plenty of labor force. This country can be easily exemplified by means of Turkey. The other country is a developed one with plenty of capital but with limited labor resource. This country can be thought as a European country throughout the paper. We look at the analysis of the paper from the angle of developing country. Thus, whenever domestic market is used in text, we intend to indicate Turkish market.

There are mainly three different cases that attract attention and worth to be included into the analysis of this paper:

a) A domestic firm that produces with domestic capital goods (designed and appropriate for domestic conditions) in domestic market.

b) A foreign firm that produces with foreign capital goods in domestic market.

c) A domestic firm that imports foreign capital goods (designed and appropriate for foreign conditions) and produces with other domestic inputs i.e. labor.

To set up the model, similar Cobb Douglas production functions are defined assuming that the production takes place in similar sectors. The production function is given by:

$$F(K,L) = AK^{\alpha}L^{1-\alpha} \tag{1}$$

where capital is denoted as K, labor is denoted as L, and A is a constant.

For the firm originated from developed or developing country, the budget constraint is defined as B. Thus, the problem for a firm becomes:

$$\text{max. } F(K,L) = AK^{\alpha}L^{1-\alpha} \tag{2}$$

$$\text{subject to } wL + rK = B$$

where w is wage and r is cost of capital.

Setting a Lagrangian function is a simple procedure to find a solution to this optimization problem:

$$\gamma = AK^{\alpha}L^{1-\alpha} + \lambda(B - wL - rK) \tag{3}$$

$$\frac{\partial \gamma}{\partial L} = A(1-\alpha)K^{\alpha}L^{-\alpha} - \lambda w = 0 \tag{4}$$

$$\frac{\partial \gamma}{\partial K} = A\alpha K^{\alpha-1}L^{1-\alpha} - \lambda r = 0 \tag{5}$$

The solution of the equations 4 and 5 gives the production expansion path:

$$K = \frac{w}{r}\frac{\alpha}{1-\alpha}L \tag{6}$$

Optimal production occurs along the production expansion path. The production expansion path can be used to manipulate the production function:

$$Q = F(K,L) = A\left(\frac{w}{r}\frac{\alpha}{1-\alpha}L\right)^{\alpha}L^{1-\alpha} = AL\left(\frac{w}{r}\frac{\alpha}{1-\alpha}\right)^{\alpha} \tag{7}$$

Assuming that the product is sold with constant price of p, the profit of a firm can be written as:

$$\pi = pQ - wL - rK = pAL\left(\frac{w}{r}\frac{\alpha}{1-\alpha}\right)^{\alpha} - wL - rK \tag{8}$$

The budget constraint is given by the equation of:

$$B = wL + rK \tag{9}$$

Using production expansion path, the equation for the budget can be written as:

$$wL + r\frac{w}{r}\frac{\alpha}{1-\alpha}L = Lw\frac{1}{1-\alpha} \tag{10}$$

The profit function can be rewritten by means of equation (10):

$$\pi = pA\left(\frac{w}{r}\frac{\alpha}{1-\alpha}\right)^{\alpha}\left(\frac{B(1-\alpha)}{w}\right) - B \tag{11}$$

Equation 11 will be used to calculate the profits of firms in three cases: 1) where a domestic firm produces with domestic capital goods (designed and appropriate domestic conditions) in domestic market; 2) where a foreign firm produces with foreign capital goods in domestic market; 3) where a domestic firm imports foreign capital goods and produces with other domestic inputs.

To analyze these three different cases, there is a need to make further discrimination between wages and costs of capital of foreign and domestic firms. Thus, we define w_T as wage in domestic country, w_E as wage in foreign country, r_T as the cost of capital in domestic country, and r_E as the cost of capital in foreign country.

Also to compare the profits of different firms, we will denote the profit of a domestic firm that operates with domestic capital goods/machines in domestic country as p_{TT}. Moreover, the profit of a domestic firm that operates with foreign capital goods in domestic country is shown as p_{TE}. In addition, the profit of a foreign firm that operates with foreign capital goods in domestic country is presented as p_{ET}. Lastly, we will denote the profit of a foreign firm that operates with foreign capital goods in its country of origin as p_{EE}.

The profit of a domestic firm that operates with domestic capital goods/machines in domestic country is given by equation 12:

$$\pi_{TT} = pA\left(\frac{w_T}{r_T}\frac{\alpha}{1-\alpha}\right)^{\alpha}\left(\frac{B(1-\alpha)}{w_T}\right) - B \tag{12}$$

In converse, the profit of a foreign firm that operates with foreign capital goods in its country of origin is shown in equation 13:

$$\pi_{EE} = pA\left(\frac{w_E}{r_E}\frac{\alpha}{1-\alpha}\right)^{\alpha}\left(\frac{B(1-\alpha)}{w_E}\right) - B \tag{13}$$

Lastly, the profit of a foreign firm that operates with foreign capital goods in domestic country is given in equation 14:

$$\pi_{ET} = pA\left(\frac{w_T}{r_E}\frac{\alpha}{1-\alpha}\right)^{\alpha}\left(\frac{B(1-\alpha)}{w_T}\right) - B \tag{14}$$

When a foreign firm operates with foreign capital goods in Turkey, the profit function of this firm becomes a little bit different. The most important point for this case lies on the production expansion path. If a domestic firm uses foreign capital, it uses foreign production expansion path, since machines (capital goods) are specially designed for the production in a developed country. Secondly, because the firm operates in a developing country, it utilizes domestic country's labor market and benefits from the cheap labor force. But, the cost of capital increases compared to the foreign capital good prices because of transportation, import duties and related costs. It is actually equalized to the domestic price of the capital. As a result, the cost of capital for this case is equal to r_T. The profit of the domestic firm that operates with foreign capital goods in domestic country can be derived by means of foreign firm's production expansion path.

The product expansion path is given in equation 15:

$$K = \frac{w_E}{r_E}\frac{\alpha}{1-\alpha}L \tag{15}$$

Using equation 15, the production function can be rewritten in equation 16:

$$Q = A\left(\frac{w_E}{r_E}\frac{\alpha}{1-\alpha}L\right)^{\alpha}L^{1-\alpha} = AL\left(\frac{w_E}{r_E}\frac{\alpha}{1-\alpha}\right)^{\alpha} \tag{16}$$

Using budget constraint and production expansion path, an equation for labor demand can be derived.

$$w_T L + r_T K = B \tag{17}$$

$$w_T L + r_T \frac{w_E}{r_E} \frac{\alpha}{1-\alpha} L = B \tag{18}$$

$$L = \frac{B}{w_T + r_T \frac{w_E}{r_E} \frac{\alpha}{1-\alpha}} \tag{19}$$

With the help of equation 19, the profit function of a domestic firm, which operates with foreign capital goods in Turkey, can be derived as in equation (20):

$$\pi_{TE} = pA\left(\frac{w_E}{r_E}\frac{\alpha}{1-\alpha}\right)^{\alpha} \frac{B}{w_T + r_T \frac{w_E}{r_E} \frac{\alpha}{1-\alpha}} - B \tag{20}$$

Two main comparisons can be made on the profitability of the firms under three scenarios. First of all, the difference between the profits of the foreign firm, which produces in foreign market with foreign capital goods, and the foreign firm, which produces in domestic market with foreign capital goods, is worth to be compared. This comparison is made by calculating p_{ET}-p_{EE}.

$$\pi_{ET} - \pi_{EE} = pA\left(\frac{w_T}{r_E}\frac{\alpha}{1-\alpha}\right)^{\alpha}\left(\frac{B(1-\alpha)}{w_T}\right) - B - \left[pA\left(\frac{w_E}{r_E}\frac{\alpha}{1-\alpha}\right)^{\alpha}\left(\frac{B(1-\alpha)}{w_E}\right) - B\right] \tag{21}$$

$$\pi_{ET} - \pi_{EE} = pAB(1-\alpha)\left(\frac{1}{r_E}\frac{\alpha}{1-\alpha}\right)^{\alpha}\left[w_T^{\alpha}\frac{1}{w_T} - w_E^{\alpha}\frac{1}{w_E}\right] \tag{22}$$

$$\pi_{ET} - \pi_{EE} = pAB(1-\alpha)\left(\frac{1}{r_E}\frac{\alpha}{1-\alpha}\right)^{\alpha}\left[\frac{1}{w_T^{1-\alpha}} - \frac{1}{w_E^{1-\alpha}}\right] \tag{23}$$

Equation 23 can be separated into two: such as part(M) and part(N).

$$part(M) = pAB(1-\alpha)\left(\frac{1}{r_E}\frac{\alpha}{1-\alpha}\right)^{\alpha} \tag{24}$$

$$part(N) = \left[\frac{1}{w_T^{1-\alpha}} - \frac{1}{w_E^{1-\alpha}} \right] \tag{25}$$

Part(M) is positive and it is trivial. Part(N) is also positive since $w_E > w_T$. As a result, p_{ET}-p_{EE} in equation 23 is positive i.e. p_{ET}-$p_{EE}>0$. Thus, we can conclude that it is beneficial for a foreign firm to produce with foreign machinery in domestic country instead of producing in its country of origin.

Secondly, a question arises for a domestic firm. Is it more profitable for a domestic firm to import foreign capital goods such as machinery and produce in domestic market or is it better for the firm to use machinery that is designed for the domestic conditions? To solve this dilemma, it is sufficient to calculate p_{TE}-p_{TT}:

$$\pi_{TE} - \pi_{TT} = pA\left(\frac{w_E}{r_E} \frac{\alpha}{1-\alpha} \right)^{\alpha} \frac{B}{w_T + r_T \frac{w_E}{r_E} \frac{\alpha}{1-\alpha}} - B - \left[pA\left(\frac{w_T}{r_T} \frac{\alpha}{1-\alpha} \right)^{\alpha} \left(\frac{B(1-\alpha)}{w_T} \right) - B \right] \tag{26}$$

$$\pi_{TE} - \pi_{TT} = pA\left(\frac{\alpha}{1-\alpha} \right)^{\alpha} B(1-\alpha) \left[\left(\frac{w_E}{r_E} \right)^{\alpha} \frac{r_E}{(1-\alpha) r_E w_T + \alpha r_T w_E} - \left(\frac{w_T}{r_T} \right)^{\alpha} \left(\frac{1}{w_T} \right) \right] \tag{27}$$

Equation 27 can be separated into two parts such as part(O) and part(P).

$$part(O) = pA\left(\frac{\alpha}{1-\alpha} \right)^{\alpha} B(1-\alpha) \tag{28}$$

$$part(P) = \left[\left(\frac{w_E}{r_E} \right)^{\alpha} \frac{r_E}{(1-\alpha) r_E w_T + \alpha r_T w_E} - \left(\frac{w_T}{r_T} \right)^{\alpha} \left(\frac{1}{w_T} \right) \right] \tag{29}$$

Part(O) is positive, which is a trivial result. If, also, part(P) is positive, then it is better for a domestic firm to import foreign capital goods and produce in domestic market. Thus, there is a further need to determine the sign of part(P). The condition that makes part(P) positive is found by:

$$\left(\frac{w_E}{r_E} \right)^{\alpha} \frac{r_E}{(1-\alpha) r_E w_T + \alpha r_T w_E} > \left(\frac{w_T}{r_T} \right)^{\alpha} \left(\frac{1}{w_T} \right) \tag{30}$$

$$\left(\frac{r_T w_E}{r_E w_T} \right)^{\alpha} > \frac{(1-\alpha) r_E w_T + \alpha r_T w_E}{r_E w_T} \tag{31}$$

$$\left(\frac{r_T w_E}{r_E w_T}\right)^{\alpha} - \frac{\alpha r_T w_E}{r_E w_T} + \alpha - 1 > 0 \tag{32}$$

We can make simplifications defining equation 33:

$$\left(\frac{r_T w_E}{r_E w_T}\right)^{\alpha} = x \tag{33}$$

The simplified equation is given in equation 34:

$$x^{\alpha} - \alpha x + \alpha - 1 > 0 \tag{34}$$

Equation 34 is satisfied as a approaches to 1. This result points out two important aspects. If the production is too much capital intensive, then it is beneficial for a domestic firm in a developing country to import capital goods like machinery from a developed country. On the other hand, if the production is less capital intensive, then it is much more appropriate for a domestic firm in a developing country to use domestic capital goods, since they are better designed to fit to the developing country's input market structure.

III. CONCLUSION

Capital goods are an important part of production. Many scholars focused on the role of capital in quite different contexts. In this paper, appropriate design of capital goods for a firm is analyzed in different cases. There are mainly three distinct theoretical results. For a firm from a developed country, it is more profitable to operate with foreign capital goods in a developing country like Turkey. On the other hand for a domestic firm which operates in a less capital intensive sector in a developing country, it is more profitable to use domestic capital goods, which are designed to fit domestic input market. If production is more capital intensive, then it is appropriate to import foreign capital goods such as machinery from developed countries for production.

IV. REFERENCES

Cobb, C.W., & Douglas, P.H. 1928. A Theory of Production. *The American Economic Review*, 18: 139-165.

Robinson, J. 1953-1954. The Production Function and the Theory of Capital. *The Review of Economic Studies*, 21: 81-106.

Solow, R.M. 1957. Technical Change and the Aggregate Production Function. *The Review of Economic Studies,* 39: 312-320.

Fisher, F.M. 1968. Embodied Technology and the Aggregation of Fixed and Movable Capital Goods. *The Review of Economic Studies*, 35: 417-428.

Garagnani, P. 1970. Heterogeneous Capital, the Production Function and the Theory of Distribution. *The Review of Economic Studies*, 37: 407-436.

Rowley, J.C.R. 1972. Investment and Neoclassical Production Functions. *The Canadian Journal of Economics*, 5: 430-435.

Spanel, J., & Sling, M. 1977. The Production Function, Absorption Capacity of the Economy, and Reproduction of Capital Assets. *Eastern European Economics,* 15: 3-16.

Faurot, D.J. 1978. Interrelated Demand for Capital and Labor in a Globally Optimal Flexible Accelerator Model. *The Review of Economics and Statistics*, 60: 25-32.

Spiegel, Y. 1996. The choice of technology and capital structure under rate regulation. *International Journal of Industrial Organization,* 15: 191-216.

Beneito, P. 2003. Choosing among alternative technological strategies: an empirical analysis of formal sources of innovation. *Research Policy*, 32: 693-713.

Istaitieh, A., & Fernandez, J.M.R. 2006. Factor-product markets and firm's capital structure: A literature review. *Review of Financial Economics*, 15: 49-75.

Parker, E., & Pingle, M. 2006. The distributional effects of selection and capital accumulation on firm productivity under imperfect capital markets. *Empirical Economics*, 31: 677-697.

Toimura, E. 2009. Foreign versus domestic outsourcing: Firm-level evidence on the role of technology. *International Review of Economics and Finance*, 18: 219-226.