Role of Finance in Dixit-Stiglitz-Krugman Model of International Trade

Sugata Marjit, Meghna Dutta, Moushakhi Roy

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Abstract

This paper introduces finance or credit in the Dixit-Stiglitz-Krugman (DSK) model of international trade. It identifies mechanisms by which finance can affect the main results of the conventional model. The key results are as follows. Perfect credit market does not affect number of varieties or output per variety, but it affects wage and interest rate, thus affecting income distribution. With a minimum wage and unemployment availability of credit affects number of varieties. With imperfect credit market, wealthier firms face lower cost of credit and produce greater number of varieties and given labour force less output per variety. Thus, availability of finance will determine a specific trade pattern between richer and poorer nations both with unemployment and imperfect credit market , a result in stark contrast with the conventional model with indeterminate pattern of trade.

Sugata Marjit
Indian Institute of Foreign Trade
Calcutta / India
marjit@gmail.com

Meghna Dutta
Indian Institute of Technology
Patna / India
86meghna@gmail.com

Moushakhi Roy
Siliguri College / West Bengal / India
moushakhi@gmail.com

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1. Introduction

This paper introduces finance in the Dixit-Stiglitz-Krugman model of trade drawing the idea of classical wage fund and financial capital from Findlay (1995), Hicks and Hollander (1977), Maneschi(2008) etc. Hitherto the role of financial capital has not been explicitly considered in the literature on trade. In the perfect credit market model which we use, the level of finance does not affect pattern of trade or real income, only distribution of income between capital and labour changes resulting in factor movements. When we bring in distortions as unemployment with a fixed wage, availability of finance affects aggregate employment as it must have during financial crisis and that impacts pattern of trade and therefore welfare too. The same problem arises with imperfect credit market, where the quantity of finance available with the producer affects the number of varieties produced and hence the pattern of trade.

Manova (2008), Antras and Caballero (2009), Dellas and Fernandes (2013), Egger and Keuschnigg (2015) and Marjit and Mishra (2020) discuss the impact of finance on production, innovation market structure, trade and capital flows. However, none of these studies analyses how introduction of finance would actually affect the most commonly used pedagogic and research framework of modern trade theory. (**Footnote -1In this sense our study is related to Marjit and Nakanishi (2021) and Marjit and Das (2021 , 2022) which deal with finance in the Ricardian Model , Specific Factor and the Heckscher-Ohlin model respectively**).

The world has seen major financial crises over the years, including the critical crisis of 2008 affecting trade and commerce worldwide. Availability of fiancé becomes critical for many firms to remain alive and financial crisis leads to significant exit of firms from the market. One can look at Dellas and Fernandes (2013) and Egger and   (Check out this reference from ECONOMICA)

on implications of such changes in market structure. Our purpose is to ask an elementary question – what does unavailability of finance do to the standard outcomes of a well-known trade model.

We deliberately abstract from the issue of trade finance. In our paper act of trade does not require finance and financial capital is critical for only running production as without finance one cannot employ workers and run the show. Trade can be executed without additional cost of finance. Our approach is based on working capital view of finance, a view that is remarkably common worldwide among medium and small sized firms who depend heavily on banks and financiers for their day to day operations. This is done to check out how the impact on overall production structure affects equilibrium number of varieties and output per variety. We obtain a series of interesting results which alter a key result of such a theory and so far it has not been analysed in DSK type models.

Stock of finance does not affect the key results of such models. However, it can alter income distribution between capital and labour and if one allows for labour to move globally from low finance to high finance region, it will affect production of varieties across borders and such asymmetry would generate a deterministic pattern of trade.

With Unemployment and/or Imperfect Credit Market, financial capital become pivotal in determining volume of production, number of varieties, output per variety etc. leading again to a determinate pattern of trade. With greater finance an unemployment ridden economy will produce greater number of varieties. However, there is a chance of capital flight away from the minimum wage economy. Such cross effects have serious implications.

Imperfect credit market reduces availability of finance for production and reduces equilibrium wage , but does not affect number of varieties or output per variety, the two key elements of the DSK model. But added with minimum wage i.e. unemployment, it affects everything.

The **Model**

Let us consider a single sector producing a differentiated good X in both the Home and the Foreign country. The consumer's utility function is:

$$U = \sum_{j=1}^{n}(x_j^\theta)^{\frac{1}{\theta}} \tag{1}$$

Which they maximize subject to the

$$\sum_{j=1}^{n} p_j x_j = M \tag{2}$$

where $0 < \theta < 1$ and x_j is consumption of j-th variety of good x

2.1   PERFECT CREDIT MARKET

We assume there to be a wage-fund, or entrepreneurial finance (K) which is lent out by bankers to producers at the beginning of the period a' la (Marjit, 2020, Marjit and Das, 2021) who uses it to pay wages (w) to workers as revenue and profit is obtained after one period. Here, total labour employed is given as 'L'. After production and sales are over, the bankers get (1+r) as real rate of return or interest. Thus,

$$K = wL \tag{3}$$

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Firms can borrow any amount at a given rate of interest, but to clear the credit market with total demand for credit matching total supply of credit the above condition must be satisfied. Given capital (K), obtained via past savings and total labour force (L), equation (3) determines the wage rate (w). This is the classical wage fund approach which has been recently extended in full employment and dynamic context by Marjit and Nakanishi (2021) and in the Jonesian Specific Factor Model by Marjit and Das (2021).

There is a fixed cost of production and constant marginal costs. Let 'α' amount of labour be used as fixed cost and 'β' unit of labour as variable cost. The presence of fixed cost ensures that the average fixed cost in good 'X' is falling. As a result, the producer of each variety will not share its market and only one firm will produce the *j-th* variety as in case of particular brands – a well-known feature of Chamberlinian monopolistic competition.

Now, the standard total cost expression is as follows:

$$TC = w(\alpha + \beta x)(1 + r) \tag{5}$$

Hence, the average and marginal cost of production are shown as

$$AC = \left(\frac{w\alpha}{x} + w\beta\right)(1 + r) \tag{6}$$

$$MC = w\beta(1 + r) \tag{7}$$

Therefore, the market equilibrium price is given by

$$P = w\beta(1 + r)\mu \qquad\qquad (8)\ [1]$$

Where $\mu = \dfrac{\rho}{\rho - 1} = \dfrac{1}{\theta}$

However, absence of entry barriers in such models ensures that in the long run profit of a firm must be driven down to zero indicating that the price should be equal to the average cost of production[2].

Hence

$$P = AC \qquad\qquad\qquad\qquad (9)$$

$$P = \left(\frac{w\alpha}{x} + w\beta\right)(1 + r) \qquad\qquad (10)$$

$$P = \frac{(w\alpha + w\beta x)(1 + r)}{x} \qquad\qquad (11)$$

$$Px = (w\alpha + w\beta x)(1 + r) \qquad\qquad (12)$$

$$x = \frac{(w\alpha + w\beta x)(1 + r)}{P} \qquad\qquad (13)$$

$$x = \frac{(w\alpha + w\beta x)(1 + r)}{w\beta(1 + r)\mu} \qquad\qquad (14)$$

$$x = \frac{\alpha}{\beta} * \frac{1}{(\mu - 1)} \qquad\qquad (15)$$

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[1] Maximising the utility function for different varieties of the good subject to constraint one can show that elasticity of substitution between any two varieties may be defined as ρ, $where\ \rho > 1$. Also ρ stands for elasticity of demand (for more clarification consult Dixit and Stiglitz (1977).

[2] The quantity of each variety produced is assumed to be same.

The output is independent of wage (w) and the rate of interest (r). Price (P) is considered as the numeraire. So, $w = \frac{W}{P}$ and r are the real wage and real interest rate respectively. The factor market clearing conditions are:

$$L = \sum_{j=1}^{n}(\alpha + \beta x_j) \quad \alpha, \beta > 0 \tag{16}$$

The number of variety (n) is determined as follows

$$L = n(\alpha + \beta x) \tag{17}$$

$$n = \frac{L}{(\alpha + \beta x)} \tag{18}$$

$$n = \frac{L(\mu - 1)}{\alpha \mu} \tag{19}$$

Proposition 1: With perfect credit market, the results of a standard Krugman (1979, 1980) model still hold except that real wage is now determined by 'K/L'. However, the number of varieties or output per variety remains unaffected by the available stock of capital or finance (K).

It should be noted here that from equation (8) we can determine the rate of return or interest (r), since the wage rate (w) is determined by the capital labour ratio following equation (3). That is, w = K/L. The absence of any changes from the traditional model, raises the number of varieties available to the consumers as trade opens up and the usual gains from trade operates, though real wage remains the same. This leads us to ask whether greater availability of finance affects this scenario. It should be noted here that higher capital (K) will lead to higher wage rate (w) and lower rate of interest (r) in the presence of full employment. There is no other noticeable change in this regard. But if factor trade is allowed, factors will move freely across countries.

Suppose at a lower rate of interest we allow capital (K) to move out from the higher capital economy to a lower capital economy. This will raise the capital labour ratio (K/L) in the lower capital economy, raising the wage rate (w) and lowering the rate of interest (r) and vice versa in the lower capital economy. But as we have shown earlier, the movement in capital (K) would not affect number of varieties and hence trade in goods. But greater supply of labour (L) in the higher wage economy where capital (K) is higher would surely increase the number of varieties (n) and lower the same in the other country. However, total number of varieties in the world remains the same. But one country will export greater number of varieties being endowed with higher stock of labour (L).

Proposition 2: Factor trade in capital does not alter the direction of commodity trade whereas factor trade in labour does.

2.2 UNEMPLOYMENT AND PERFECT CREDIT MARKET

We now consider the case of unemployment to see how finance becomes critical in a situation of unemployment. We draw from Davis (1998), Meckel (2020), Marjit and Mandal (2021), and from more contemporary interest in the topic on trade and unemployment (Marjit, Ganguly and Acharyya (2021), and Marjit and Gupta (2022). Let us suppose that now in the full employment set up, one of the countries imposes a minimum wage. It is clear from equation (3) that a higher level of wage rate ($\overline{W}$) would definitely reduce the amount of labour (L), if the level of capital (K) remains the same causing unemployment.

Case 1: With unemployment and a minimum wage

It follows from equation (17) that in the presence of unemployment the number of varieties (n)

produced is determined by:

$$n(\alpha + \beta x) = L_e = L - L_U \tag{20}$$

Here L_U represents unemployment of unskilled workers whereas L_e indicates the total absorption of unskilled workers in production.

Therefore,

$$n = \frac{L - L_U}{(\alpha + \beta x)} \tag{21}$$

$$n = \frac{(L - L_U)(\mu - 1)}{\alpha\mu} \tag{22}$$

or,

$$n = \frac{L_e(\mu - 1)}{\alpha\mu} \tag{23}$$

Hence, equation (23) indicates that the number of varieties (n) must fall in the unemployment ridden economy. It should be noted here that at a higher level of minimum wage ($\overline{W}$), firms cannot charge higher price to remain competitive as varieties are symmetric, so only the rate of interest (r) will drop. This is obvious from equation (8). However, real wage will move up and real interest rate will fall. But the world will see fewer varieties and along with rising unemployment gains from trade will decline with fewer varieties. Thus, there are two counts of welfare loss. First, income distribution will move in favour of employed workers and against unemployeds. Second, increasing unemployment reduces the number of varieties thereby reducing welfare and gains from trade.

However, at a high level of constant minimum wage ($\overline{W}$), greater availability of capital (K) in the

unemployment ridden economy will raise the total absorption of workers (Le) and reduce the level of unemployment (Lu). Therefore, the number of varieties (n) will rise. Higher amount of capital (K) will help the system by reducing unemployment and raising the number of varieties produced, which also raises welfare. If this is true, then financial crisis in the form of a fall in the amount of capital stock (K) would definitely adversely affect production, employment and trade. This leads to the following proposition.

Proposition 3: With unemployment the availability of finance or capital (K) affects welfare and trade in terms of total number of varieties and the degree of unemployment.

Case 2: Considering a finance capital flight

We now turn to another consequence of unemployment. Since higher minimum wage $(\overline{W})$ reduces real return to capital, capital in the unemployment ridden economy will have a tendency to move out to a full employment economy. This will bring disaster as without a change in the minimum wage, interest rate (r) does not change and the entire capital stock (K) will flow out of the high wage economy. At a reduced level of capital (K) and constant minimum wage $(\overline{W})$, employment of labour (L) falls. Thus, lesser varieties will be produced in the unemployment ridden economy. Whereas, in the full employment economy with higher capital (K), the capital labour (K/L) ratio and wage rate (W) rises. But the movement in capital (K) does not affect the number of varieties in the full employment economy. However, if two unemployment ridden economies are engaged in trade, they will produce and trade in fewer number of varieties as compared to the full employment situation, and real wage will be higher in each country. But then the availability of

greater amount of capital (K) would reduce unemployment and increase the number of varieties produced in each country.

Proposition 4: Two unemployment ridden economies will produce and trade in fewer numbers of varieties.

2.3   IMPERFECT CREDIT MARKET

The introduction of imperfect credit market in a full employment scenario significantly highlights the impact of capital stock (K) on the output per variety and the number of varieties produced. It should be noted here that banks raise capital by paying the rate of interest (r) to the depositors and charging the borrowing interest rate (R) from the borrowers, such that

$R = a*r$; where $a > 1$

Thus, imperfect capital market represents a situation where the borrowing rate of interest (R) is greater than the lending rate of interest (r), that is, $R > r$.

We assume here that some amount of capital (k) is taken from banks and given to the firms, such that total capital (K) remains same. In this situation, if 'K_0' represents the amount of capital with the banks and 'n_1' represents the number of firms then,

$$K_0 + n_1 k = K = wL \qquad\qquad (24)$$

Now, we suppose that firms have some amount of owned capital (k). Each firm owns the same level of capital (k). Then, $k(1+r)$ is the opportunity cost of any firm as it can lend its owned capital (k) at a lender's rate of interest (r). If the firm requires capital beyond the amount (k), then it can borrow the amount from banks at the borrowing rate of interest (R).

Thus, each firm faces the following total cost function

$$TC = \big((w\alpha + w\beta x) - k\big)(1 + R) + k(1 + r) \tag{25}$$

$$TC = (w\alpha + w\beta x)(1 + R) - k(R - r)) \tag{26}$$

The average and marginal cost of production are given as follows

$$AC = \left(\frac{w\alpha}{x} + w\beta\right)(1 + R) - \frac{k(R - r)}{x} \tag{27}$$

$$MC = w\beta\mu(1 + R) \tag{28}$$

Therefore, the price equation of the firm is expressed as below

$$P = w\beta\mu(1 + R) \tag{29}$$

Similar to a perfect credit market scenario, in case of an imperfect credit market with the total capital stock (K) remaining same the wage rate also remains unaltered. However, the gap between the borrowing and lending rates of interest (R>r) under an imperfect credit market suggests that the term 'P/w' in equation (29) is relatively higher. This is indicative of the fact that in comparison to a perfect credit market, the real wage rate (w/P) falls more under an imperfect credit market.

Furthermore, in the absence of entry barriers long run profit of a firm must be driven down to zero indicating that the price should be equal to the average cost of production.

Hence,

$$P = AC \tag{30}$$

$$P = \left(\frac{w\alpha}{x} + w\beta\right)(1 + R) - \frac{k(R - r)}{x} \tag{31}$$

$$x = \frac{\alpha - \left[\frac{k(R-r)}{w(1+R)}\right]}{\beta(\mu - 1)} \qquad (32)$$

Then, the number of variety (n_1) is determined as follows

$$L = n_1(\alpha + \beta x) \qquad (33)$$

$$n_1 = \frac{L}{\alpha + \beta \left\{\frac{\alpha - \left[\frac{k(R-r)}{w(1+R)}\right]}{\beta(\mu - 1)}\right\}} \qquad (34)$$

Under imperfect credit market a producer with higher initial capital stock (k) will face lower fixed cost of production and produce lower amount of output to break-even. Whereas, with lower initial capital stock (k), the producer faces higher fixed cost of production and produces greater amount of output. This is clear in equation (32) above. With higher initial capital stock the opportunity cost of using the capital stock for production is less for the producer. So, at the same price he effectively reaches the break-even point by producing lower level of output. However, with total labour supply remaining same, lower amount of output produced under imperfect credit market indicates greater number of varieties (n_1) being manufactured. This is evident from equation (34), where lower value of output (x) indicates higher number of varieties (n_1) being produced. This is indicative of the fact that the number of varieties (n_1) manufactured under imperfect credit market is relatively greater than the number of varieties (n) produced in a perfect credit market situation. Now, if trade opens up between two countries, then more varieties will be available to the world thereby rendering positive impact on welfare and trade. Trade allows consumers to get greater number of varieties as in a Standard Krugman Model.

Therefore, few points must be noted regarding the impact of imperfect credit market. First, higher amount of own capital stock (k) reduces the effective cost of capital, lowers the fixed cost of production and therefore output per variety. With the same labour force, more varieties will hence be produced in each country. Second, real wage rate (derived from the equilibrium price condition) will be lower with $R > r$.

Proposition 5: In the presence of full employment in an imperfect credit market, availability of finance determines the output per variety as well as the number of varieties produced.

At this juncture we seek to analyse the impact of movement in capital under imperfect credit market. Here, we suppose that there are two countries, where everything is same but capital stock is higher in the home country. In the presence of full employment of labour, at a greater amount of capital stock the wage rate (w) is high. Higher wage rate increases the real wage (w/P), and the rate of interest is relatively low. Now, at lower rate of interest capital moves out of the home country if factor trade is allowed. Therefore, at a lower level of capital stock, the output per variety (x) increases and the number of varieties (n_1) falls. Thus, in the home country the positive effect is the rise in real wage rate, whereas, the negative effect is the fall in the number of varieties. However, in the foreign country the effect is bad. This is because; if 'R' is same in both countries the real wage rate (w/P) does not change. Also, consumers are forced to consume fewer varieties.

Proposition 6: When two similar countries are engaged in trade, under imperfect credit market, higher availability of capital in the home country results in a mixed impact on the home country, whereas it adversely affects the foreign economy.

3. **Conclusion**

We have introduced financial capital in the well- known workhorse of modern trade theory, the monopolistic competition driven product variety model of trade. With perfect credit market, major results of the Krugman model remain unaffected, though with impacted wage and rate of interest, factor movements are possible and hence optimum number of varieties and output per variety would change. With unemployment and/or imperfect credit market pattern of trade would be determinate, contrary to the classic result of this type of models.

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