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Abstract

Informal sector comprising of unrecorded, unregistered activities in developing economies of the world is a common feature at present scenario. Existence of such sectors in an economy clearly reflects the weakness of government to provide employment opportunities for all. Such informal activities are again facilitated through the extortionists who are bribed by the informal producers. Under such an economic structure the paper investigates into the effect of inflow of educational capital on endogenously determined factor prices and output of formal and informal sectors of an economy. Though there is no change in the factor earnings, an inflow of educational capital gives a boost to the output of skilled sector irrespective of any factor intensity assumption. Output of formal sector also expands depending on the factor intensity assumption but quite interestingly no change is seen in the output of informal sector. Inflow of educational capital leads to dampening of intermediation activities in an economy which is a positive result and this can help the policy makers to choose the right path of development.

JEL Classification: E26, D50, D73

Keywords: Educational capital, Informal sector, Corruption

1. Introduction

The developing economies of the world are characterised by the existence of a vast informal sector. This sector in particular not only chalks out a way to help economies to solve its unemployment problem but also contributes significantly to domestic savings and investments. In simple words the informal economy or the grey economy refers to those income earning activities that are outside government regulation, taxation and observation. However, illegal activities are typically excluded from its definition. There are several examples of informal economic activity including people who sell produce at a roadside stand or those who perform day labour at a construction site in exchange for cash payments. The informal forms of organizations are major players in manufacturing, construction, transport, trade, hotels and restaurants services. Some of the characteristic features of informal employment are lack of protection in the event of non-payment of wages, compulsory overtime or extra shifts, lay-offs without notice or compensation, unsafe working conditions and the absence of social benefits such as pensions, sick pay and health insurance. To suit the purpose of the paper we define the informal sector as one which does not have to pay the minimum wage. A lot of papers in literature of informal sector have used this interpretation such as Agenor and Montiel (1997), Carruth and Oswald (1981), Marjit (2003), Marjit and Kar (2009, 2009a), Marjit, Kar and Beladi (2007), Kar and Marjit (2001), Beladi and Chao (1993), Beladi and Yabuuchi (2001) etc.

Emerging markets tend to rank highly among nations that have the largest informal economies, whereas developed markets tend to have the least informal economic activity within them. In a recent study by Friedrich Schneider (2012), 162 countries were ranked by the relative size of their informal economies and it is found that Bolivia, Georgia and Panama are countries that have the largest concentration of informal economic activity followed by the others. U.S ranked at the bottom at 161 followed by Switzerland. Shadow economies may seem advantageous to certain workers because wages are received free of taxes. However, the social cost of these wages manifest themselves in the form of lost tax revenues and social security payments. Informalisation of jobs has become a matter of concern with the initiation of liberalisation policies in the early nineties. On an average, more than 70 percent of the working population in developing economies is employed in the informal sector (Agenor, 1996). This sector also accounts for a large share in the Gross Domestic Product (GDP) of the developed and developing countries. According to the estimates of Schneider (2005), the contribution of income generated in the informal economy to GDP varied from 8.4 percent in United States to 68.3 percent in Bolivia in the years 2002-03. Moreover, the percentage contribution is on rise in several countries, such as Columbia moved from 39.1 percent in the years 1999-2000 to 43.4 percent in the years 2002-03, Haiti from 55.4 percent to 58.6 percent and so on for other economies. The share of informal economy is also significantly large in terms of contribution to employment, particularly in developing world. In all regions of the developing world, informal employment outside of agriculture represents nearly half or more of the total non-agricultural employment (ILO, 2002).

In case of India, the unorganized sector accounts for more than 90 percent of the workforce in the country and almost 50 percent of national income evolve from this sector (National Statistical Commission, 2012).

A lot of literature suggests corruption that has its roots lie deep in bureaucratic and political institutions as one of the reasons for the existence of informal sector in developing economies (Kaufmann 1997, Johnson et al. 1998, Kaufmann and Zoido-Lobaton 2000). In other words, we may say that the survival of informal sector requires some negotiations with the administration as it is illegal by nature. This negotiations is done by politically supported intermediaries, called the 'extortionists' who take care of legal troubles and other hurdles for the informal producers and in turn extracts some amount of the value of informal produce (Marjit and Mandal, 2010). Theoretically, corruption and informal economy can be either complements or substitutes. The negative link between corruption and the size of informal economy is studied by scholars like Johnson et al. (1997), Choi and Thum (2004), Dreher et al. (2005) to name a few. The full employment model of Johnson et al (1997) depicts informal economy as a substitute for the official (formal) economy and exhibits a negative relationship between the two. An increase in informal economy results in a decrease in the official economy. Higher corruption in the official economy increases the size of informal economy which functions like a tax on firms in the official economy and drives them underground. Choi and Thum (2004) present a model where the option of entrepreneurs to get underground constrains a corrupt official's ability to ask for bribes. The shadow or informal economy mitigates distortions in the official economy and disables bureaucrats from realizing personal gains. The existence of the informal economy thus reduces corruption. Johnson et al. (1998), Schneider and Enste (2000), Friedman et al., (2000) on the contrary, model corruption and informal economy as complements. Dreher and Schneider (2006) suggest that corruption and the informal economy tend to be substitutes in high income countries but complements in low income countries. Bribes are one of the main tools of corruption which raises transaction costs and uncertainty in an economy. It impedes long term foreign and domestic investment, misallocates talent to rent-seeking activities and distorts sectoral priorities and technology choices. It pushes firms underground, undercuts the state's liability to raise revenues and leads to ever-higher tax rates being levied on fewer and fewer taxpayers (Gray and Kaufmann, 1998). Bribes can be used to reduce the amount of taxes and other fees collected by Government to set up a legal institution or firm. Corruption tends to flourish when institutions are weak and government policies generate economic rents. Substantial corruption among the law enforcement authorities, financial agencies, bureaucrats, politicians and other regulators would essentially mean more bribery and greater rent seeking in the formal sector (Saha, 2001). Thus cost of creating new business and maintaining it in the formal sector rises in presence of intermediation activities and this crowds out some entrepreneurs in preference for informal entrepreneurship as they seek to avoid bureaucratic rigidities and high tax burden. Marjit, Mukherjee and Kolmer (2006)

analyzed the causes behind the emergence of an informal sector in a political economy framework. For economies characterised by high unemployment, high inequality and poverty, the government may choose a lower level of good governance to maximize income for a large informal sector and avoid social conflicts and political disturbances. Loayza (1996) in a study of Latin American economies shows that a robust and less burdensome institutional framework reduces the size of informal sector. Specifically, a standard deviation improvement in the strength and efficiency of the institutional framework is associated with 0.42 standard deviation decrease in the size of informal sector. In a study of 49 countries of Latin America, former Soviet Union and OECD, it is shown that one-point improvement in Transparency International (TI) corruption index is associated with a 5.1 percent reduction in the informal economy. Further, using the Global Competitiveness Survey as proxy for bribery, a one-point improvement in the index implies an 8 percent reduction in informal sector (Johnson et al., 1998). Friedman et al. (2000) shows that irrespective of country's level of economic activity as proxied by GDP per capita, a one-point improvement in the corruption index is associated with 9.7 percent reduction in the size of informal sector. Thus, regardless of the economy's level of economic activity and the kind of corruption index used it is clear that the size of informal sector increases with the level of corruption. Dutta, Kar and Roy (2011) made the first empirical attempt to investigate corruption-informality linkage in India based on a study of 20 Indian states. The result confirms the positive relationship between level of corruption and size of informal sector. Beside this the study also points out that as state level productivity rises the positive impact of corruption on the size of informal sector reverses itself. In order to reduce extortion in the informal segment countries like Ghana, Senegal, Kenya and others have already attempted to facilitate and promote registration and license to informal units. This has resulted in a significant reduction in the degree of extortion (Fjeldstad, 2001). In this paper we stick to the general definition of corruption as the misuse or abuse of public power for private gains (World Bank, 1997, UNDP, 1999). The World Bank (2009) defines corruption as "It distorts the rule of law, weakens a nation's institutional foundation, and severely affects the poor who are already the most disadvantaged members of our Society and is among the greatest obstacles to economic and social development".

In this paper we have incorporated educational capital as an indirect factor of production. This educational capital is used only to train the unskilled labours of the economy and let them secure a job in the highly paid skilled sector. This form of capital is not directly involved in the production process. Unskilled labour forces are employed by both the formal and informal entrepreneurs. Even after satisfaction of demand of formal and informal producers some unskilled labours are still left without a job. Now, this part of labour force cannot remain unemployed for a long time and ultimately they get involved in the extortion sector to earn a livelihood. Developing economies of the world face a great crisis of educational capital or training facilities. Thus educational capital now-a-days moves from developed to developing countries as the demand for skilled labour naturally grows with the

process of development. Hence, educational capital mobility is an important ingredient of development process. Importance of educational capital has been studied by a number of scholars like Lucas (2002), Barro (1996), Easterly (2001), Findlay (1995), Banerjee and Newman (1993), Galor and Zeira (1993) etc. to name a few. Educational capital mainly enriches human capital of an economy through the process of training. A microeconomic model shows that education investment for workers significantly affects his or her productivity in workplace (Lucas, 1988). Empirical literature on the link between human capital and growth indicates that it contributes not only towards output growth but also improves a country's capacity to adopt new technologies. Countries with larger stock of human capital experience faster growth. Technology fails to flow to the poor countries because of their poor endowment of human capital and a high level of initial endowment of human capital improves economy's ability to utilize new ideas (Nelson and Phelps, 1966). In this particular paper we have tried to trace out the effect of inflow of such educational capital on output of an economy which is plagued with activities like corruption, bribery etc.

The remainder of the paper is organized as follows. Section 2 presents a detailed discussion about the structure of the economy along with the competitive price equations for different sectors. Section 3 discusses about the results obtained and its empirical explanations. Finally section 4 concludes. A detailed mathematical calculation is provided in the appendix.

2. The Basic Model and Solutions

One important feature of informal sector is the existence of harassment related corruption. Since by definition informal sector is illegal or extra legal, it is susceptible to bureaucratic and political harassment. Therefore, in order to get rid of the harassment producers need to get hold of intermediation. Precisely speaking this intermediation is done by unskilled labour and capital. Thus a part of the value of informal produce is lost which is spent for labour and capital used in intermediation. Based on this background we have considered a small open economy comprising of three sectors producing three different goods X, Y and Z and one intermediation (corruptive) sector represented by N. Out of these three goods X and Y are produced in a formal sectors and Z is produced informally. Physical Capital and labour are the factors of production used for producing these three commodities. According to the tradition labours are segregated into skilled labour and unskilled labour. Skilled labours are sector specific and are trained using certain amount of educational capital endowed within the economy. Educational capital is not directly involved in the production process, it is used only for training the unskilled labour force of the economy. Physical capital is a direct input and is freely mobile among these three sectors. Unskilled labour and physical capital are assumed to be freely mobile between the informal sector and the extortion sector. Prices of the goods are determined in rest of the world as the country in consideration is a small open economy with a small contribution in world's trade volume.

Commodity X is produced in a skill specific formal sector using skilled labour (S) and physical capital (K). The labours of sector X have attained some special training to secure a job here. Special training can easily encompass the issues such as vocational training, technical training, computer literacy, software knowledge etc. A software developing firm may be a good example of this type of sector. Since X is a skill intensive formal sector the labours are paid a wage at a rate W_S which is obviously greater than the wage of unskilled labour. Physical capital (K) gets a return 'r' per unit. Per unit price of commodity X (P_X) is determined in the international market and the country in assumption being a small participant in world trade is unable to influence the price. Competitive price equation for this sector is given as

$$W_S a_{SX} + r a_{KX} = P_X \quad (1)$$

Commodity Y is also produced in a formal sector using unskilled labour (L) and physical capital (K). Formal sector is characterised by presence of strong labour union and the workers here get a pre negotiated fixed wage (\bar{W}). Physical capital (K) gets a return 'r' per unit. Labours of this sector do not have any specified skill as the labours employed in sector X but they are lucky enough to secure a job in this formal sector and earn an assured high and fixed wage (\bar{W}). As discussed earlier price of commodity Y is again assumed to be given as the country in consideration is a small participant in world trade. The competitive price equation for this sector is written as

$$\bar{W} a_{LY} + r a_{KY} = P_Y \quad (2)$$

After satisfying the demand for labour in these two formal sectors, some labour still remain unemployed. This unemployed section of the workforce have neither any specific training nor are they lucky enough to secure a job in the unskilled formal sector Y. But they cannot of course remain without a job for a long time. They have to get engaged somewhere to obtain their subsistence level of earning. This leads to the existence of informal sector Z in our model. Sector Z uses unskilled labour (L) and physical capital (K) for its production. Z being an informal sector there is absence of trade union to protect the interest of the workers and hence there is no minimum wage legislation law. Workers are paid a market based competitive wage (W) and the capital gets a return r. However, this sector is distorted by the intermediation of local 'tolapickers' and thus a certain proportion (α) of the value of the good (P_Z) is appropriated by L_N as a fee of extortion. The competitive price equation for this sector is written as

$$W a_{LZ} + r a_{KZ} = P_Z (1 - \alpha) \quad (3)$$

We further assume that unskilled labour and some amount of physical capital are involved in the activities of intermediation. Labours involved in the intermediation activities (L_N) get a wage equal to the wage of the informal workers (W) and capital involved in intermediation activities (K_N) gets a

return of r . Now the expenditure involved in intermediation activities must be equal to the value of lost output of the informal sector. Suppose α is the fraction of output that is lost due to institutional complications related intermediations. Thus we may write

$$WL_N + rK_N = \alpha P_Z Z \quad (4)$$

We also assume that the production function for intermediation exhibits a linear relationship represented by the following equation

$$L_N = \gamma K_N \quad (5)$$

The economy is endowed with certain amount of skilled labour (S), unskilled labour (L), physical capital (K) and educational capital (E). It is assumed that all the factors are fully utilized in the production process.

Informal workers have a chance to get trained and secure job in the skill specific sector X. We assume that L_1 amount of informal workers are trained and upgraded to skilled labour S_1 using a certain amount of educational capital (E). This upgraded skilled labour now gets a job in the skill specific sector X. S amount of skilled labour were already given in the economy and S_1 is the amount of informal labour that are getting trained in the process and adding to the stock of skilled labours. The full employment condition for skilled labour in the economy can be written as

$$a_{SX}X = S + S_1 \quad (6)$$

Now, the economy in concerned is already endowed with L amount of unskilled labour. Out of this stock L_N is the amount of unskilled labour who are engaged in corruption activities and S_1 is the amount of labour that goes out for training. Thus full employment condition for unskilled labour is given by the following equation

$$a_{LY}Y + a_{LZ}Z = L - L_N - S_1 \quad (7)$$

Similarly the full employment condition for physical capital is given by the following equation

$$a_{KX}X + a_{KY}Y + a_{KZ}Z = K - K_N \quad (8)$$

The economy in concerned is also endowed with certain amount of educational capital (E) which is used only for the purpose of training the unskilled labour. In this model we do not incorporate the time factor needed in acquiring skill. This is a static model. Another important point to be noted is that the educational training sector reflects fixed proportion technology μ_{ES} . The cost of acquiring skill has to borne by the unskilled labour himself. The full employment condition for educational capital is given by

$$\mu_{ES}S_1 = E \quad (9)$$

For simplicity we assume that only skilled labours will undergo training in lieu of getting a job in the high skilled intensive sector X where they could get a higher wage premium. This wage must compensate his earning from the informal sector Z (W) and the return to the educational capital spent on training. This is given by equation (10)

$$W + \mu_{ES}R = W_S \quad (10)$$

The variables of the model are W_S, \bar{W}, W, r and R that are determined using the price equations. All markets are assumed to be perfectly competitive along with the market for corruption related activities. Competitive corruption market implies that the lost output due to intermediation is fully exhausted in paying out extortionists. We also have the standard neo-classical assumption of constant returns to scale and diminishing return to factors. We determined r from equation (2). Substituting the value of r in equation (1) and (3) we obtain W_S and W respectively. Finally using the value of W in equation (10) we obtain R. Further solving the endowment equations (6), (7), (8) and (9) we get the output effect of sector X, Y and Z. The mathematical results are summerized in the appendix and this will help us in exploring the effects of inflow of educational capital on price of factors and output of different sectors of the economy. The set of symbols used in representing the equations of the model are usual and used in different trade models.¹

3. Effect of inflow of educational capital in presence of intermediation activities

An inflow of educational capital in the economy helps to train the large chunk of unskilled labour force of the economy. It helps to upgrade the unskilled labours into skilled labour. An inflow of educational capital (E) will essentially have no impact on rate of return to physical capital (r) as it is already determined from equation (2) of the basic model given the wage of formal labour (\bar{W}) and price of the commodity Y. Wage of unskilled labour (W) should remain unchanged for any given α and P_Z and wage of skilled labour (W_S) also remains unchanged as there is no change in r. Hence there will be no change in the rate of return to educational capital (R). However, an inflow of educational capital raises the output of the skilled formal sector X by increasing the supply of skilled

¹ W_S =Wage of skilled labour, \bar{W} =Wage of unskilled labour employed in formal sector, W=Wage of informal workers, r=rate of return to physical capital, R= rate of return to educational capital, X= Output of skilled intensive formal sector, Y= output of formal sector, Z= Output of informal sector, P_X, P_Y, P_Z =Exogenous prices of commodities, E,L,S,K= Total supply of educational capital, unskilled labour, skilled labour and physical capital in the economy, S_1 =amount of unskilled labour upgraded to skilled labour. a_{ij} = input coefficients, θ_{ij} = Relative share of i th input in the total value of j th commodity where i= S,L,K and j= X, Y, Z, ^>=represents percentage changes for particular variables.

labour(S_1) in the economy. Some amount of unskilled labour gets trained using educational capital and secures a job in the skilled formal sector. Educational capital has a two way effect on the supply of labour. On one hand, it raises the supply of skilled labours in the economy and on the other it reduces the amount of unskilled labours in the economy. The unskilled labours going out for training may either come from sector Y, sector Z or the intermediation sector represented by N. The expansion of skilled sector also requires some capital that has to be relocated to X either from Y, Z or corruption activity represented by N. In general, as output of sector X expands the combined output effect of sector Y, Z and N falls unambiguously. The magnitude of output effect on these sectors depends significantly on factor intensity assumption. The mathematical solution to this general equilibrium model shows that there is no change in the output of informal sector Z (as is evident from equation 4) but the output effect on formal sector Y and that of the corruption sector N depends on the factor intensity assumption.

Proposition 1: *There is no change in factor earnings following an inflow of educational capital in presence of corruption.*

The solutions for factor prices in the model are obtained by solving the price equations of the model represented through equations (1) to (4) and equation (10) (see appendix). Using the simple solution method for general equilibrium model through use of zero profit condition and envelope theorem we first derive the solution for rate of change in return to physical capital (r) from equation (2). With given wage rate (\bar{W}) for unskilled labour and given price of informal commodity Y we find that there is no change in the rate of return to physical capital. Substituting the value of $\hat{r} = 0$ in equations (1) we have $\widehat{W}_S = 0$ as price of formal good (X) is considered to be given exogenously. Further substituting $\hat{r} = 0$ in equation (3) we have $\widehat{W} = 0$ with given price of commodity Z. Then using $\widehat{W} = 0$ in equation (10) we obtain $\hat{R} = 0$ as μ_{ES} is constant.

Explanation: In present model we consider a small open economy with formal, informal sectors which is pegged with corruption related activities. The economy being a small one has negligible influence on volume of international trade and essentially has no role in determination of international prices of the commodities. Under such a model structure an inflow of educational capital in the economy which is used only for training the unskilled labour force has no factor price effect.

Proposition 2: *An inflow of educational capital increases the output of the skilled sector independent of any factor intensity assumption even in presence of corruption sector.*

Differentiating equation (7) we derive an expression for change in output of skilled sector X as $\hat{X} = \hat{E}\lambda_{S_1T}$ [see equation (16) of appendix]. From the expression it is evident that change in output of sector X is dependent on change in educational capital used for training the unskilled labours. Thus $\hat{X} > 0$ when $\hat{E} > 0$.

Explanation: The present model assumes that sector X is a skilled intensive technical sector that uses skilled labour (S) and a common type of physical capital (K) in its production process. Labours employed in this particular sector has gone through certain specific training programme to secure a job here. As more and more unskilled labours from other sectors of the economy get trained using a certain amount of educational capital and are absorbed by the skill intensive sector, its output gets a boost.

Proposition 3: *Output of formal sector gets a boost due to inflow of educational capital even in presence of intermediation activities under specific factor intensity assumption.*

Solving equations (8) and (9) and manipulating it we derive an expression for change in output of formal sector Y as $\hat{Y} = \frac{\hat{E}}{|\lambda|} (\lambda_{KX}\lambda_{S_1T}\lambda_{LN} - \lambda_{S_1L}\lambda_{KN})$ [see equation (20) of appendix]. Now, $\hat{Y} > 0$ if $\lambda_{KX}\lambda_{S_1T}\lambda_{LN} > \lambda_{S_1L}\lambda_{KN}$ as $\lambda > 0$. This is quite reasonable as $\lambda_{S_1T} > \lambda_{S_1L}$ and the intermediation sector may be assumed to be labour intensive in absolute term.

Explanation: Sector Y is a formal traded sector of the economy that uses unskilled labour hired at a fixed higher pre-negotiated wage and physical capital in its production process. If we assume corruption sector to be more labour intensive in absolute sense then an inflow of educational capital in the economy will boost up the output of formal sector Y. Thus, the formal sector would expand.

Proposition 4: *An inflow of educational capital leads to a reduction in the degree of pursuing intermediation activities.*

Differentiating equation (9) and manipulating it we derive the expression for rate of change of amount of labour employed in the intermediation sector represented by N in our model. This is given by $\widehat{L}_N = \frac{\hat{E}}{|\lambda|} (\lambda_{KY}\lambda_{S_1L} - \lambda_{KX}\lambda_{LY}\lambda_{S_1T})$ [see equation (21) of appendix]. Now, λ_{KX} is significant as sector X is a skilled intensive technical sector. Moreover, $\lambda_{S_1T} > \lambda_{S_1L}$ and thus $\widehat{L}_N < 0$.

Explanation: The economy in consideration is characterized by the existence of intermediation activities which requires unskilled labour and physical capital. An inflow of educational capital in the economy motivates the labours engaged in intermediation activities to get trained and secure a job in the formal sector. Thus, labour forces are driven out from the intermediation sector and its output falls unambiguously.

4. Conclusion

In this paper we have tried to trace out the effects of an inflow of educational capital on factor prices and output of different sectors of the economy. The economy comprises of two formal, one informal sector along with a corruptive sector. An inflow of educational capital has no effect on factor prices

used in the model. But, the output of skilled intensive formal sector gets a boost due to inflow of educational capital without any factor intensity assumption. This is due to the fact that as educational capital flows in, more and more labour gets trained and secures a job in the skill intensive formal sector thereby raising its output. On the other hand output of formal sector using unskilled labour in its production process may expand if the intermediation sector is assumed to be labour intensive in absolute sense. This is quite a reasonable assumption. One most important and positive effect of inflow of educational capital is that it drives out labour from the corruptive sector, motivates them for training and these labours secure a job in the highest paid skilled intensive formal sector of the economy. Thus, an inflow of educational capital leads to a fall in pursuing intermediation activities in an economy.

APPENDIX

Differentiating equation (2) and using zero-profit and envelope condition we get

$$\hat{r} = 0 \dots\dots\dots (11)$$

Similarly differentiating (1) and (3) we get

$$\widehat{W}_S = 0 \dots\dots\dots (12)$$

$$\widehat{W} = 0 \dots\dots\dots (13)$$

Solving equation (10) we obtain

$$\widehat{R} = 0 \dots\dots\dots (14)$$

Differentiating equation (9) we get

$$\widehat{S}_1 = \widehat{E} \dots\dots\dots (15)$$

as educational capital has no other alternative use except for training the informal workers.

Differentiating equations (6), (7), (8) and then manipulating them we arrive at the following equations

$$\widehat{X} = \widehat{E} \lambda_{S_1 T} > 0 \dots\dots\dots (16)$$

$$\lambda_{LY} \widehat{Y} + \widehat{L}_N \lambda_{LN} = -\widehat{E} \lambda_{S_1 L} \dots\dots\dots (17)$$

$$\lambda_{KX} \widehat{X} + \lambda_{KY} \widehat{Y} + \lambda_{KZ} \widehat{Z} = -\widehat{K}_N \lambda_{KN} \dots\dots\dots (18)$$

Using equation (4) we have $\widehat{Z} = 0$

Substituting this value and manipulating equation (18) we can write

$$\lambda_{KY} \widehat{Y} + \widehat{L}_N \lambda_{KN} = -\lambda_{KX} \widehat{E} \lambda_{S_1 T} \dots\dots\dots (19)$$

Solving equations (17) and (19) we obtain

$$\widehat{Y} = \frac{\widehat{E}}{|\lambda|} (\lambda_{KX} \lambda_{S_1 T} \lambda_{LN} - \lambda_{S_1 L} \lambda_{KN}) \dots\dots\dots (20)$$

$\widehat{Y} > 0$ if $\lambda_{KX} \lambda_{S_1 T} \lambda_{LN} > \lambda_{S_1 L} \lambda_{KN}$ as $|\lambda| > 0$

$$\widehat{L}_N = \frac{\widehat{E}}{|\lambda|} (\lambda_{KY} \lambda_{S_1 L} - \lambda_{KX} \lambda_{LY} \lambda_{S_1 T}) \dots\dots\dots (21)$$

$\widehat{L}_N < 0$ if $\lambda_{KY} \lambda_{S_1 L} > \lambda_{KX} \lambda_{LY} \lambda_{S_1 T}$

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