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Ghosh, Sujata and Mandal, Biswajit and Gupta, Kausik

Visva-Bharati University, Santiniketan, India, Visva-Bharati University, Santiniketan, India, University of Calcutta, Kolkata, India

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Sujata Ghosh

Visva-Bharati University, Santiniketan, India

Biswajit Mandal

Visva-Bharati University, Santiniketan, India

Kausik Gupta

University of Calcutta, Kolkata, India

Corresponding author:
Sujata Ghosh
PhD Research Scholar
Department of Economics and Politics,
Visva-Bharati University, Santiniketan
India-731235
Email: sujataghosh.eco@gmail.com

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Abstract

In this paper, we construct a three sector general equilibrium model of a small open economy with informal sector. The paper examines the impact of less protectionist policy on the output levels, factor prices, and the level of urban employment. Here, it has been shown that the urban unemployment rate has been lowered with the contraction of import competing manufacturing sector consequent upon a reduction in tariff. The informal intermediate sector has contracted as well. It is further shown here that there is a possibility of expansion of exportable agricultural sector with increased wage rate. The paper is then extended to introduce foreign capital inflow and examine on the output effects and the level of unemployment. Interestingly, in the extended model urban unemployment is aggravated due to an inflow of foreign capital.

Keywords: Informal Sector, Tariff Liberalization, Foreign Capital Inflow, General Equilibrium,

JEL classification: F11, F13, D58, D60.

1. Introduction

The developing economies are generally the hot bed of many socio-economic research as these economies are characterized by some phenomena typical to any country with low income, low quality of governance, low consumption etc (Ray (2003), Todaro and Smith (2006)).In addition to this, developing economies are also characterized by the co-existence of structured formal sector and unorganized informal sector.[1]Besides liberal economic policies are also nothing new to the researchers, readers and policy makers, but what is new is the dimension of formal-informal interconnectedness and their mutual dependence in benefitting from liberalized era. Substantial amount of research has already been done on and around different upshots of economic liberalization. But when informal sector comes into picture with its multifaceted character, the amount of significant research goes down to a sizable quantity. Hart (1971), Papola (1981), Banerjee (1985), Fields (1990) have studied the role of informal sector in the developing economy. Cole and Sanders (1983) introduce the informal sector in the Harris-Todaro (1970) model and emphasizes that much of migration takes place with the informal sector. Agenor (1996) provides an elegant survey on the size of the informal sectors in developing countries. Das (2000) has also tried to study the types of employment existing in the informal sector of a developing economy and has analyzed the contribution of informal sectors to the developing economy by providing employment and income to the migrant labours.

Grinols (1991), however, has questioned the validity of the famous Brecher-Alejandro (1977)[2] proposition in the presence of urban informal sector in a three-sector economy with unemployment while Marjit (2003) looked at the possibility of arising informal wage and employment. Marjit and Kar (2011) is also an interesting compilation of a good number of papers in this context. Chaudhuri and Mukhopadhyay (2009) have explored the workings of the informal sector in a general equilibrium framework. Therefore, our study takes into account the issues related to trade liberalization in the form of tariff reduction and foreign capital inflow with the informal sector and unemployment. In this context Chandra and Khan (1993) is an interesting paper that has re-examined the validity of the Brecher-Alejandro (1977) proposition in a mobile capital Harris-Todaro (HT) framework in the presence of flexible wage urban informal sector. In the same line Gupta (1997) has further extended Chandra and khan (1993) by generalizing the migration equilibrium condition of the HT model and also by introducing capital market

[1] Expansion of industries and the resulting economic opportunities in urban areas triggered rural-urban migration and massive urbanization. However, industrial development failed to generate adequate employment and income opportunities in the urban sector, so that the surplus labour force was pressurized to generate its own means of employment and survival in the informal sector.

[2] The Brecher-Alejandro (1977) proposition states that if the import competing sector is capital intensive and is protected by tariff, then an inflow of foreign capital in the presence of full repatriation of foreign capital income reduces welfare. However, in the absence of any tariff, the inflow of foreign capital with full repatriation of its earnings does not affect social welfare.

distortion and land as agricultural input. He has also examined the dichotomy between formal and informal credit markets by assuming that informal capital is a function of interest rate differential between two capital markets. But the urban informal wages in such models are less than the rural wage. Whereas, Chaudhuri (2000) shows about how simultaneous existence of open urban unemployment and urban informal sector in migration equilibrium is a possibility.

Drawing from these papers the current study tries to examine the effect of tariff liberalization and foreign capital inflow on the factor prices, outputs and unemployment in a three-sector general equilibrium structure of Harris-Todaro (1970) in the presence of informal sector. Introduction of urban unemployment in such a framework is surely an interesting addition to the literature as because urban employment in particular along with the presence of informal sector is a relatively less researched area. So, we believe that our study may add some value. In our model, a decline in tariff reduces urban unemployment but a foreign capital inflow increases urban unemployment.

This paper is organized as follows. Section 2 considers the basic model. Section 3 and section 4 have considered the impact of tariff liberalization on factor prices and unemployment. Section 5 and section 6 have described the effect of foreign capital inflow on output and unemployment. Finally, the concluding remarks are placed in section 7.

2. The Basic Model

Here we have considered three sectors of a small open economy in a Harris-Todaro framework. The first sector is agricultural sector (A), second one is informal sector (I) and the third sector is manufacturing sector (M). Sector A produces the exportable commodity X_A with the help of capital (K) and labour (L). Using the same factors of production I produces X_I.This sector is essentially a non traded one that produces intermediate input, and its product price is endogenously determined. Existing papers often considers this as exogenously given. While the other two sectors are price takers and their product prices are fixed in the international market. Manufacturing sector (M) produces output X_M using not only labour and capital but also uses the intermediate good, I. Capital and labour are perfectly mobile among three sectors[3]. Here capital (K) consists of both domestic capital (K_D) and foreign capital (K_F).We assume that domestic capital and foreign capital are perfect substitutes. It has also been assumed that sector M is the import competing sector and is protected by an ad-valorem tariff (t). The workers in the import competing manufacturing sector are employed at a wage rate which is above the competitive level. This follows from Harris-Todaro explanation for rigid urban wage. This wage

[3] The manufacturing and agricultural sectors produce final commodities but the informal sector gives intermediate goods to manufacturing sector in this model.

rate is $\overline{W}$ and it is greater than the competitive wage rate W. It is also assumed that both the informal sector and agricultural sector are located in the rural area.[4] Rural workers get competitive wage rate, W. Workers from the rural sector migrate to manufacturing sector as long as the expected wage of sector M is higher than the rural wage and migration stops when the two are equal. People who do not find job in the manufacturing sector they are left with two alternatives. To remain unemployed or to go to the rural area and work there at a wage rate lower than urban wage rate. Note that rural area has two components: agricultural sector and informal sector. We have considered that there is unemployment of labour in the urban sector, which is denoted by L_u. We assume that the agricultural sector is labour-intensive compared to the manufacturing sector and informal sector. The agricultural product is considered as the numeraire and its price is set equal to unity. Production function in each sector exhibits constant returns to scale with diminishing marginal productivity of the variable factor.

The following notations are used to describe the equational structure of the model.

X_i = product produced by the ith sector, i = A, I, M

P_A = price of commodity A

P_I = price of commodity I

P_M^* = world price of good M

$P_M = P_M^*(1+t)$ = tariff inclusive domestic price of good M

W = competitive wage rate of labour ($W_A = W_I$ = W)

$\overline{W}$ = fixed wage rate of labour in the manufacturing sector.

r = common rate of return on capital.

K_D = domestic capital

K_F = foreign capital

[4] Intermediate good producing sector is located outside the boundary of the urban area, may be in the suburbs of the city. To simplify matters we have clubbed the informal sector located in the suburbs with that of informal sector located in the rural area. So, both the agricultural sector and the informal sector are located in the rural area. On the basis of this assumption we can say that migration takes place from rural area to urban area. This implies migration from agricultural sector and informal sector (combining the two we can say rural sector)to the urban area.

K = economy's aggregate capital stock (K = $K_D + K_F$)

a_{ji} = quantity of jth factor/input for producing one unit of output in the ith sector. j = L, K, I and i = A, I, K.

t = ad-valorem rate of tariff on the import of commodity M.

λ_{ji} =employment share of jth factor/input in the production of ith commodity; j = L, K, I and i = A, I, M.

$\wedge$ = proportional change

θ_{ji} = distributive share of the jth input in the ith industry.

The competitive equilibrium conditions in the product market for the three sectors give us the following equations.

$$a_{LA}W + a_{KA}r = P_A = 1 \tag{1}$$

$$a_{LI}W + a_{KI}r = P_I \tag{2}$$

$$a_{LM}\overline{W} + a_{KM}r + a_{IM}P_I = P_M^*(1+t) \tag{3}$$

Perfect mobility of capital between sectors A, I and M and full employment of K can be expressed as

$$a_{KA}X_A + a_{KI}X_I + a_{KM}X_M = K = (K_D + K_F) \tag{4}$$

The migration equilibrium condition is $\dfrac{\overline{W}a_{LM}X_M}{L - (a_{LA}X_A + a_{LI}X_I)} = W$

This equation can be rewritten as

$$\overline{W} = (1+\rho)W \tag{5}$$

Or

$$\frac{\overline{W}}{W} = (1+\rho) \tag{5.A}$$

Where, $$\rho = \frac{L_u}{a_{LM}X_M} \tag{6}$$

ρ is urban unemployment rate and L_u is level of urban unemployment.

The labour endowment equation is as follows

$$a_{LA}X_A + a_{LI}X_I + (1+\rho)\ a_{LM}X_M = \mathrm{L} \tag{7}$$

Or

$$a_{LA}X_A + a_{LI}X_I + \frac{\overline{W}}{W}a_{LM}X_M = \mathrm{L} \tag{7.A}$$

The equilibrium condition of the non-traded sector is

$$a_{IM}X_M = X_I \tag{8}$$

There are eight unknown variables in the system such as W, r, P_I, L_u, X_A, X_I, X_M and ρ with eight independent equations. Thus the system can be solved. From equations (1) and (2) we can express the value of W and r as a function of P_I. Plugging the value of r into equation (3), P_I is obtained. So, we can determine the values of w and r respectively. Then we can solve the value of ρ from the equation (5). X_A, X_M and X_I are simultaneously solved from equations (4), (5), (7) and (8). Finally, L_u is determined from equation (6).

3. Trade Liberalization and Factor Prices

Here we want to examine the impact of trade liberalization in form of tariff reduction on the output of different goods along with the return of several factors of production. Apart from that we will also make an effort to show the impact of reduction in tariff on the unemployment rate, as well as on the level of unemployment. To do so, at first we have considered the trade liberalization effect on the input returns.

From equations (1), (2) and (3), we can get[5]

$$\hat{W} = -\alpha\beta\hat{t} > 0 \tag{1.1}$$

$$\hat{r} = \alpha\delta\hat{t} < 0 \tag{2.1}$$

$$\hat{P}_I = \frac{\alpha}{\left[\dfrac{\theta_{KM}\theta_{LA}}{|\theta|} + \theta_{IM}\right]}\hat{t} < 0 \tag{3.1}$$

[5] See Appendix A.1 for detailed derivations.

Where, $\alpha = \frac{t}{1+t}$, $\beta = \frac{\theta_{KA}}{[\theta_{KM}\theta_{LA} + \theta_{IM}|\theta|]} > 0$, $\delta = \frac{\theta_{LA}}{[\theta_{KM}\theta_{LA} + \theta_{IM}|\theta|]} > 0$, $\theta_{LA} - \theta_{LI} = |\theta| > 0$[6]

So, the values of equations (1.1), (2.1) and (3.1) are as indicated since $\hat{t} < 0$.

Solving equations (4), (7) and (8) by Cramer's rule, we obtain,[7]

$$\hat{X}_A = -\frac{1}{|\lambda|}[A_3]\alpha\beta\hat{t} > 0 \tag{4.1}$$

$$\hat{X}_M = \frac{1}{|\lambda|}[A_4]\alpha\beta\hat{t} < 0 \tag{7.1}$$

$$\hat{X}_I = \frac{1}{|\lambda|}\lambda_{IM}[A_4]\alpha\beta\hat{t} < 0 \tag{8.1}$$

We define $|\lambda|$ as

$$|\lambda| = [\lambda_{LA}\lambda_{KI}\lambda_{IM} + \lambda_{LA}\lambda_{KM} - \lambda_{KA}\lambda_{LI}\lambda_{IM} - (1+\rho)\lambda_{KA}\lambda_{LM}] \quad > 0$$

$$\frac{[\lambda_{LI}\lambda_{IM} + (1+\rho)\lambda_{KA}\lambda_{IM}]}{(\lambda_{KI}\lambda_{IM} + \lambda_{KM})} < \frac{\lambda_{LA}}{\lambda_{KA}}$$

Because we assumed that sector M and I are more capital intensive than sector A.

Where,

$A_3 = (\lambda_{KI}\lambda_{IM} + \lambda_{KM})[A_2] + (\lambda_{LI}\lambda_{IM} + (1+\rho)\lambda_{LM})[A_1]$, $A_4 = [\lambda_{LA}(A_1) + \lambda_{KA}(A_2)]$, $A_1 = \frac{1}{\theta_{KA}}[\lambda_{KA}\sigma_A\theta_{LA} + \lambda_{KI}\sigma_I\theta_{LI}]$, $A_2 = \left[\lambda_{LA}\sigma_A\theta_{KA}\left(1+\frac{\theta_{LA}}{\theta_{KA}}\right) + \lambda_{LI}\sigma_I\theta_{KI}\left(1+\frac{\theta_{LA}}{\theta_{KA}}\right) + (1+\rho)\lambda_{LM}\right] > 0$

$$\alpha = \frac{t}{1+t},\ \beta = \frac{\theta_{KA}}{[\theta_{KM}\theta_{LA} + \theta_{IM}|\theta|]} > 0$$

[6] By assumption, agricultural sector is more labour intensive than informal intermediate sector.

[7] See Appendix A.1 for details

Here equations (7.1) and (8.1) states that when $\hat{t} < 0$, then $\hat{X}_M < 0$ and $\hat{X}_I < 0$. But on the other hand, equation (4.1) follows that $\hat{X}_A > 0$ when $\hat{t} < 0$. These results are summarized in the form of following proposition.

Proposition 1: *Trade liberalization leads to: (i) a decrease in the price of intermediate good and increase in wage rate; (ii) contraction of informal intermediate sector and manufacturing sector but expansion of agricultural sector.*

Firstly, we express wage rate and rate of return on capital in terms of price of the intermediate good. So that, when rate of tariff decreases the price of intermediate good also decreases. That leads to Stolper Samuelson effect resulting in a decrease in the rate of return of capital and an increase in the wage rate.

Again, a decrease in tariff rate causes a less-protectionist effect on the import competing manufacturing sector resulting in a decrease in its output. It implies a contraction of import competing manufacturing sector (M) due to tariff reduction. Thus demand for intermediate input falls. This causes a contraction of the intermediate sector from equation (8). Reduction in r makes capital constraint more binding and an increase in W will make the labour constraint less binding. This is primarily because of factor substitution and profit maximizing behavior of the producers. The deterioration of rate of return on capital implies that the resources are shifted from contracted import competing manufacturing sector to exportable agricultural sector and results in an expansion of agricultural sector.[8]

4. Impact of trade liberalization on urban unemployment rate

The growing incidence of urban unemployment has been a matter of deep concern to the developing economies. To analyse the implication on urban unemployment rate as well as level of urban unemployment due to tariff reduction, we take up the following exercise. Totally differentiating equations (5) and (6), we obtain[9]

$$\hat{\rho} = \alpha\beta \frac{(1+\rho)}{\rho} \hat{t} < 0 \tag{5.1}$$

[8] This produces a Rybczynski-type effect. As agricultural sector is labored intensive compared to sector M and sector I.

[9] See Appendix.A.2 for details.

$$\hat{L}_u = \left[\frac{\rho a_{LM} X_M}{L_u}\right] \alpha\beta \left[\frac{A_4}{|\lambda|} + \frac{1+\rho}{\rho}\right] \hat{t} < 0 \tag{6.1}$$

So, from equations (5.1) and (6.1) it follows that $\hat{\rho} < 0$ and $L_u < 0$ when $\hat{t} < 0$. These results may be stated in terms of following proposition.

<u>Proposition 2</u>: *In the presence of Harris – Todaro type migration and urban unemployment, a policy of trade liberalization lowers the urban unemployment rate and the level of urban unemployment.*

Trade liberalization lowers the domestic price of informal good, which in turn, reduces the rate of return of capital (Eq. 2). This leads to an increase in competitive wage rate (Eq. 1). Thus, W grows at the same rate in both agricultural and informal sectors. So, the difference between the competitive wage and urban wage is reduced .So, tendency of migration from rural to urban area goes down with a falling gap between urban and rural wage. On the contrary, as X_M contracts, informal sector also shrinks as it supplies the intermediate good to the urban manufacturing sector. Thus, probability of getting job in urban sector falls as well. Again we find that the agricultural sector is expanding along with an increasing wage rate. As the agricultural sector is more labour intensive relative to sector M and sector I, more labour will be required to satisfy the increased demand. This excess demand for labour in the agricultural sector leads to absorption of released (unemployed, *per se*) labours of manufacturing and informal sector. Even the rural workers who migrated in search of higher wage in urban sector and could not find a job, they come back to the expanded agricultural sector with a relatively higher wage compared to the initial situation. So, trade liberalization lowers both the urban unemployment rate and the level of urban unemployment.

5. Foreign Capital Inflow and Sectoral Effects

In this section we discuss the role of foreign capital .for that the importance and desirability of inflow of foreign capital in the context of a developing economy have triggered much debate among trade and development economists. In the traditional literature on development economics the issues related to foreign capital inflow and social welfare are very crucial and hence we have to start with the famous Brecher-Alejandro (1977) proposition. Chandra and khan (1993) have further re-examined the validity of the Brecher-Alejandro (1977) proposition in a mobile capital Harris-Todaro framework in the presence of 'flexible wage urban informal sector'. Chaudhuri (2007) has also considered the impact of foreign capital inflow in the presence of non traded agricultural final commodity in a general equilibrium structure. Now we want to show the effect of foreign capital inflow on factor prices, sectors and as well as unemployment in the model we have developed here.

Considering the former set of equations and notations we have examined the effect of foreign capital inflow and have observed a decomposable system where factor prices are determined from the price system alone (equations (1), (2) and (3)) without using output system.

In a decomposable system, an increase in capital has no effect on factor prices, so that $\left(\frac{W_i}{r}\right)$ also remains constant. Hence, $a_{Li} = a_{Li}\left(W_i/r\right)$ and $a_{Ki} = a_{Ki}\left(W_i/r\right)$ remain constant as well. Therefore, solving equations (4), (7) and (8) by Cramer's rule, we obtain,[10]

$$\hat{X}_A = -\frac{1}{|\lambda|}\left[\lambda_{LI}\lambda_{IM} + \left(\frac{\overline{W}}{W}\right)\lambda_{LM}\right]\hat{K} < 0 \tag{4.2}$$

$$\hat{X}_M = \frac{1}{|\lambda|}\lambda_{LA}\hat{K} > 0 \tag{7.2}$$

$$\hat{X}_I = \frac{1}{|\lambda|}\lambda_{IM}\lambda_{LA}\hat{K} > 0 \tag{8.2}$$

Here equations (7.2) and (8.2) states that when $\hat{K} > 0$, then $\hat{X}_M > 0$ and $\hat{X}_I > 0$. But on the other hand, equation (4.2) follows that $\hat{X}_A < 0$ when $\hat{K} > 0$. These results are summarized in the form of following proposition.

Proposition 3: *An inflow of foreign capital leads to an expansion of informal intermediate sector and manufacturing sector but contraction of agricultural sector in the economy.*

The above proposition can be explained as follows. When foreign capital endowment increases, the manufacturing sector expands and agricultural sector contracts owing to Rybczynski effect. As manufacturing sector is most capital intensive when capital comes in this sector produces more output. The informal sector has also blown up as expansion of manufacturing sector calls for higher demand for informal intermediate input produced in I. However, these sectors require more labour. These labours are shifted from agricultural sector for higher wage[11] and better job

[10] See Appendix B.1 for details

[11] $\overline{W} > W$.

in sector M. Due to lack of availability of resources agricultural sector contracts because of most labour intensive nature.

6. Impact of foreign capital inflow on urban unemployment

In order to analyse the effect of foreign capital inflow on urban unemployment level, we rewrite the migration equilibrium condition as follows[12]:

Using equations (5) and (6), we obtain

$$L_u = \left(\frac{\overline{W} - W}{W}\right) a_{LM} X_M \tag{6.A}$$

Differentiating equation (6.A) and using the equation (7.2), we get

$$\hat{L}_u = \left(\frac{\overline{W} - W}{W}\right) \frac{1}{|\lambda|} L_u \lambda_{LM} \lambda_{LA} \hat{K} > 0 \tag{6.2}$$

Here equations (6.2) states that when $\hat{K} > 0$, then $\hat{L}_u > 0$. Hence we have following proposition.

Proposition 4: *An inflow of foreign capital aggravates the problem of urban unemployment in the economy.*

An increase in capital endowment causes manufacturing sector and informal sector to expand and agricultural sector to contract. But factor prices do not change because of decomposable structure. As sector M is the most capital intensive sector, the probability of getting employed for extra K is higher in manufacturing sector. In order to employ extra capital, sector M requires more labour. Since agricultural sector is most labour intensive sector, it releases more labour than capital which is again going to be absorbed either in manufacturing sector or informal sector. But as sector M and I are less labour intensive, they fail to accommodate all the released labours. So the amount of labours exceeds the number of new jobs created in the urban sector. This precisely raises the level of urban unemployment.

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[12] In a decomposable system, an increase in capital has no effect on factor prices, so that $\left(\frac{W_i}{r}\right)$ also remains constant.

7. Concluding Remarks

Informal sector is a segment in a dichotomous economic structure and it is essentially an extensive discipline as an element of the production system and labour markets in developing economy. In this paper we try to give an insight into the relationship between trade liberalization and informal sector and its multi-faceted interaction with the other sectors of the economy. We have constructed a three sectors general equilibrium model (based on Harris-Todaro framework) where two sectors produce final commodity and informal sector produces intermediate input and it is located at suburbs. Capital and labour are perfectly mobile between these three sectors. In such a set up we have shown that a tariff reduction leads to a contraction of both manufacturing and informal intermediate sector and expansion of agricultural sector. However, interestingly, tariff liberalization reduces urban unemployment rate. We also find that the foreign capital inflow leads to an expansion of both manufacturing and informal intermediate sector. On the contrary, agricultural sector contracts. More importantly inflow of foreign capital aggravates urban unemployment.

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APPENDIX

Appendix A.1.Detailed Derivations of different Expressions

Differentiating equations (1) (2) and (3) and using envelope condition, we get,

$$\hat{W}\theta_{LA} + \hat{r}\theta_{KA} = 0 \tag{A.1}$$

$$\hat{W}\theta_{LI} + \hat{r}\theta_{KI} = \hat{P}_I \tag{A.2}$$

$$\hat{r}\theta_{KM} + \hat{P}_I\theta_{IM} = \alpha\hat{t} \tag{A.3}$$

Where, $\alpha = \dfrac{t}{1+t}$

From equation (A.1) we get

$$\hat{W} = -\frac{\theta_{KA}}{\theta_{LA}}\hat{r} \quad \text{and} \quad \hat{r} = -\frac{\theta_{LA}}{\theta_{KA}}\hat{W} \tag{A.4}$$

Putting the value of $\hat{W}$ at equation (A.2), we get

$$\hat{r} = \frac{\theta_{LA}}{|\theta|}\hat{P}_I \tag{A.5}$$

Where, $\theta_{LA} - \theta_{LI} = |\theta| > 0$. By assumption, agricultural sector is more labour intensive than informal intermediate sector.

Substituting the value of $\hat{r}$ at equation (A.3), we can obtain

$$\hat{P}_I = \frac{\alpha}{\left[\dfrac{\theta_{KM}\theta_{LA}}{|\theta|} + \theta_{IM}\right]}\hat{t} < 0 \tag{A.6}$$

Equation (A.6) is same as equation (3.1) in the body of the paper.

$$\hat{r} = \frac{\alpha\theta_{LA}}{\left[\theta_{KM}\theta_{LA} + \theta_{IM}|\theta|\right]}\hat{t} < 0 \tag{A.7}$$

This equation (A.7) is same as equations (2.1) shown in the body of the paper.

We assume, $\delta = \dfrac{\theta_{LA}}{[\theta_{KM}\theta_{LA} + \theta_{IM}|\theta|]} > 0$

Equation (A.6) can be written as,

$$\hat{r} = \alpha\delta\hat{t} < 0 \tag{A.8}$$

Using equation (A.5) in equation (A.4), we get

$$\hat{W} = -\frac{\theta_{KA}}{|\theta|}\hat{P}_I \tag{A.9}$$

Where, $\theta_{LA} - \theta_{LI} = |\theta| > 0$. By assumption, agricultural sector is more labour intensive than informal intermediate sector.

Putting the value of $\hat{P}_I$ in equation (A.9), we obtain

$$\hat{W} = -\frac{\alpha\theta_{KA}}{[\theta_{KM}\theta_{LA} + \theta_{IM}\lfloor\theta\rfloor]}\hat{t} > 0 \tag{A.10}$$

We assume, $\beta = \dfrac{\theta_{KA}}{[\theta_{KM}\theta_{LA} + \theta_{IM}|\theta|]} > 0$

Equation (1.4) can be written as,

$$\hat{W} = -\alpha\beta\hat{t} > 0 \tag{A.11}$$

This equation (A.11) is same as equation (1.1) shown in the body of the paper.

Total differentiating equation (4) and using substitution theorem the equation becomes

$$\lambda_{KA}\hat{X}_A + \lambda_{KI}\hat{X}_I + \lambda_{KM}\hat{X}_M = -[A_1]\hat{W} \tag{A.12}$$

Where, $A_1 = \dfrac{1}{\theta_{KA}}[\lambda_{KA}\sigma_A\theta_{LA} + \lambda_{KI}\sigma_I\theta_{LI}] > 0$

Differentiating equation (5), we get

$$\hat{\rho} = -\frac{(1+\rho)}{\rho}\hat{W} \tag{A.13}$$

Total differentiating equation (7) and using substitution theorem the equation becomes

$$\lambda_{LA}\hat{X}_A + \lambda_{LI}\hat{X}_I + (1+\rho)\lambda_{LM}\hat{X}_M = [A_2]\hat{W} \tag{A.14}$$

Where, $A_2 = \left[\lambda_{LA}\sigma_A\theta_{KA}\left(1+\frac{\theta_{LA}}{\theta_{KA}}\right) + \lambda_{LI}\sigma_I\theta_{KI}\left(1+\frac{\theta_{LA}}{\theta_{KA}}\right) + (1+\rho)\lambda_{LM}\right] > 0$

Differentiating equation (8), we get

$$\lambda_{IM}\hat{X}_M = \hat{X}_I \tag{A.15}$$

Using (A.15) and solving equations by Cramer's rule and simplifying, we obtain

$$\hat{X}_A = \frac{1}{|\lambda|}[A_3]\hat{W} \quad \text{and} \quad \hat{X}_M = -\frac{1}{|\lambda|}[A_4]\hat{W}$$

Putting the value of $\hat{W}$, we get

$$\hat{X}_A = -\frac{1}{|\lambda|}[A_3]\alpha\beta\hat{t} > 0 \tag{A.16}$$

$$\hat{X}_M = \frac{1}{|\lambda|}[A_4]\alpha\beta\hat{t} < 0 \tag{A.17}$$

Using equation (A.17), the equation (A.15) becomes

$$\hat{X}_I = \frac{1}{|\lambda|}\lambda_{IM}[A_4]\alpha\beta\hat{t} < 0 \tag{A.18}$$

These equations (A.16), (A.17) and (A.18) are same as equations (4.1), (7.1) and (8.1), respectively shown in the main text.

Where, $\lambda = \lambda_{LA}\lambda_{KI}\lambda_{IM} + \lambda_{LA}\lambda_{KM} - \lambda_{KA}\lambda_{LI}\lambda_{IM} - (1+\rho)\lambda_{KA}\lambda_{LM} > 0$

$$A_3 = (\lambda_{KI}\lambda_{IM} + \lambda_{KM})[A_2] + (\lambda_{LI}\lambda_{IM} + (1+\rho)\lambda_{LM})[A_1] > 0$$

$$A_4 = [\lambda_{LA}(A_1) + \lambda_{KA}(A_2)] > 0$$

$$A_1 = \frac{1}{\theta_{KA}}[\lambda_{KA}\sigma_A\theta_{LA} + \lambda_{KI}\sigma_I\theta_{LI}] > 0$$

$$A_2 = \left[\lambda_{LA}\sigma_A\theta_{KA}\left(1+\frac{\theta_{LA}}{\theta_{KA}}\right) + \lambda_{LI}\sigma_I\theta_{KI}\left(1+\frac{\theta_{LA}}{\theta_{KA}}\right) + (1+\rho)\lambda_{LM}\right] > 0$$

$$\alpha = \frac{t}{1+t}$$

$$\beta = \frac{\theta_{KA}}{\left[\theta_{KM}\theta_{LA} + \theta_{IM}|\theta|\right]} > 0$$

.Appendix A.2. The impact on urban unemployment rate and level of unemployment

Putting the value of $\hat{W}$ in terms of $\hat{t}$ in the equation (A.13), we get

$$\hat{\rho} = \alpha\beta\frac{(1+\rho)}{\rho}\hat{t} < 0 \qquad \text{(A.19)}$$

Equation (A.19) is same as equation (5.1) in the body of the chapter.

Where,

$$\alpha = \frac{t}{1+t}$$

$$\beta = \frac{\theta_{KA}}{\left[\theta_{KM}\theta_{LA} + \theta_{IM}|\theta|\right]} > 0$$

Differentiating equation (6), we obtain

$$\hat{L}_u = \left[\frac{\rho a_{LM} X_M}{L_u}\right]\left[\hat{X}_M + \hat{\rho}\right] \qquad \text{(A.20)}$$

Using the values of (A.17) and (A.19) in the equation (A.20), we get

$$\hat{L}_u = \left[\frac{\rho a_{LM} X_M}{L_u}\right]\alpha\beta\left[\frac{A_4}{|\lambda|} + \frac{1+\rho}{\rho}\right]\hat{t} < 0 \qquad \text{(A.21)}$$

Equation (A.21) is same as equation (6.1) in the body of the paper.

Where,

$$A_4 = [\,\lambda_{LA}(A_1) + \lambda_{KA}(A_2)\,] > 0$$

$$A_1 = \frac{1}{\theta_{KA}}\left[\lambda_{KA}\sigma_A\theta_{LA} + \lambda_{KI}\sigma_I\theta_{LI}\right] > 0$$

$$A_2 = \left[\lambda_{LA}\sigma_A\theta_{KA}\left(1+\frac{\theta_{LA}}{\theta_{KA}}\right) + \lambda_{LI}\sigma_I\theta_{KI}\left(1+\frac{\theta_{LA}}{\theta_{KA}}\right) + (1+\rho)\lambda_{LM} \right] > 0$$

Appendix B.1. Detailed Derivations of different expressions

Total differentiating equation (4) we get

$$\lambda_{KA}\hat{X}_A + \lambda_{KI}\hat{X}_I + \lambda_{KM}\hat{X}_M = \hat{K} \tag{B.1}$$

Total differentiating equation (7.A) we obtain

$$\lambda_{LA}\hat{X}_A + \lambda_{LI}\hat{X}_I + \frac{\overline{W}}{W}\lambda_{LM}\hat{X}_M = 0 \tag{B.2}$$

Using A.15 these equations become

$$\lambda_{KA}\hat{X}_A + [\lambda_{KI}\lambda_{IM} + \lambda_{KM}]\hat{X}_M = \hat{K} \qquad \lambda_{LA}\hat{X}_A + \left[\lambda_{LI}\lambda_{IM} + \left(\frac{\overline{W}}{W}\right)\lambda_{LM}\right]\hat{X}_M = 0$$

Solving equations by Cramer's rule and simplifying, we obtain

$$\hat{X}_A = -\frac{1}{|\lambda|}\left[\lambda_{LI}\lambda_{IM} + \left(\frac{\overline{W}}{W}\right)\lambda_{LM}\right]\hat{K} < 0 \tag{B.3}$$

$$\hat{X}_M = \frac{1}{|\lambda|}\lambda_{LA}\hat{K} > 0 \tag{B.4}$$

Using equation (B.4), the equation (A.15) becomes

$$\hat{X}_I = \frac{1}{|\lambda|}\lambda_{IM}\lambda_{LA}\hat{K} > 0 \tag{B.5}$$

Where, $\lambda = \lambda_{LA}\lambda_{KI}\lambda_{IM} + \lambda_{LA}\lambda_{KM} - \lambda_{KA}\lambda_{LI}\lambda_{IM} - \left(\frac{\overline{W}}{W}\right)\lambda_{KA}\lambda_{LM} > 0$

Sector A is more labour intensive than sector M. Thus, $\lambda_{LA} > \lambda_{KA}$

These equations (B.3), (B.4) and (B.5) are same as equations (4.2), (7.2) and (8.2), respectively shown in the main text.

Appendix B.2. The impact on urban unemployment

Differentiating equation (6.A) and using the equation (B.4), we get

$$\hat{L}_u = \left(\frac{\overline{W} - W}{W}\right)\frac{1}{\lambda} L_u \lambda_{LM} \lambda_{LA} \hat{K} > 0 \tag{B.6}$$

Where, $\lambda = \lambda_{LA}\lambda_{KI}\lambda_{IM} + \lambda_{LA}\lambda_{KM} - \lambda_{KA}\lambda_{LI}\lambda_{IM} - \left(\frac{\overline{W}}{W}\right)\lambda_{KA}\lambda_{LM} > 0$

This equation (B.6) is same as equation (6.2) in the body of the paper.