

Input trade reform and wage inequality

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ABSTRACT

This paper, using a general equilibrium model of production and trade for a developing country with non-traded goods, dual unskilled labour markets and internationally fragmented skill-intensive production, illuminates how liberalised input trade affects the unskilled wages prevailing in the informal sectors and employment conditions in those sectors. Numerical analysis further highlights importance of the elasticities of factor substitution in production of different sectors to determine the movement in informal wage and therefore the movement in skilled–unskilled wage gap. These results are consistent with the empirical evidence on developing countries (like India) that suggests liberalisation-inequality relationship cannot be explained by focusing on tradable goods alone.

1. Introduction

One popular yet contentious issue of research in the context of developing countries is to find out implications of trade liberalisation on the skill-unskilled wage inequality, since one cannot rule out the ambiguity on the resultant implication on the unskilled wage given the complex production structure of a developing dual economy like India. As pointed out by [Sharma and Morrissey \(2006\)](#), in order to be competitive in the world market, the exportable producers in developing countries often seek efficient and relatively high skilled labour. The poor, unskilled labour may only experience changes in their real earnings in an indirect way, through backward linkages in production and consequent demand. A large body of trade theory literature takes recourse to the famous Stolper–Samuelson theorem that considers international trade as the main driving force behind the behavior of wages ([Leamer, 1992](#); [Wood, 1994](#); [Beladi & Batra, 2004](#); and so on). However, developing countries are characterised by peculiarities such as exporting both skill-intensive manufacturing and unskilled labour intensive agricultural products, coexistence of organised and informal labour markets and the production and selling of finished non-traded goods.

A relatively sparse strand of theoretical literature focused on the implications of technical progress on the inter-sectoral wage differential in the presence of non-traded goods ([Beladi & Batra, 2004](#); [Oladi & Beladi, 2008](#); to name among the few). This paper contributes to this class of literature by identifying the avenues through which trade-induced productivity surges in the skill-intensive sector can affect the poor unskilled workers in a developing economy with the presence of dual unskilled labour markets and finished non-tradables, in terms of wage-employment conditions. The relationships suggested by the theoretical model have subsequently been quantified using numerical analysis.

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In order to take up the issue of ‘trade-induced productivity surge’ this paper utilises the fact that in developing countries like India, liberalisation has facilitated greater access of capital-intensive imported inputs (Goldberg, Khandelwal, Pavcnik, & Topalova, 2009; 2010). To utilise the foreign technology embedded within those inputs in the most effective way, demand for additional skills has been generated. This leads to increased demand for skilled workforce driving their wages up. Hasan (2002); Kijima (2006); Dehejia and Panagariya (2012); have provided evidences on such trade-induced productivity growth in India's skill-intensive services sector. Such typical trade pattern, does definitely have an implication on the income distribution aspect, which is well established in recent relevant empirical literature (Bensidoun, Jean, & Sztulman, 2011; Caselli, 2012; and so on).

The general equilibrium framework used in this paper follows the available empirical evidence that unskilled workers of a developing country like India cannot sustain to be unemployed (without any wages) and the retrenched unskilled workers from the organised formal sectors get absorbed in the unorganised informal sectors at market-determined lower wages (Mukherjee, 2016). Hence, this paper considers full employment of unskilled workers in this general equilibrium set-up. Later the baseline model has also been extended with involuntary unemployment of the skilled workforce.

Oladi and Beladi (2008) provided evidences on the fact that unskilled workers are mostly employed in the non-traded good sector with no institutionally fixed minimum wage in the United States. India is not an exception. In fact, majority (about 70 per cent) of the informal workers are employed in the unorganised smaller enterprises (not covered under the Annual Survey of Industries (ASI) and employ less than six workers) of urban or semi-urban areas, at lower competitive wages to produce and sale domestically (National Sample Survey Report No. 557, 2011–12). Therefore, in the developing economy under consideration, the informal sector with unorganised labour market produces the finished non-tradable. In this sector with unorganised labour market, unskilled labour receives market-determined (flexible) nominal wage (W). Typically, such non-tradable include items like products produced in small domestic industries, services provided by petty traders or street-side vendors and so on. Therefore, similar to Oladi and Beladi (2008), changes in the demand for non-tradable are due to the changes in both production and price of the non-traded good.

The paper is streamlined as follows: section 2 illustrates the basic model with full employment and the numerical analysis based on the basic model. In section 3, the model has also been extended to incorporate involuntary unemployment of skilled labour. Finally, section 4 concludes.

2. The full-employment framework

Let us consider a small, open dual economy comprising of four sectors: sector A , vertically integrated sector U (and sector I), sector S and sector N .

Sector A is the rural agricultural sector (with informal or unorganised labour market for the unskilled labourers) producing a tradable agricultural good using unskilled labour (L) and land-capital (T). The input ‘land-capital’ broadly includes land and other durable assets. See Mukherjee (2012; 2014) and the references therein in this context.

Sector U is an unskilled labour-intensive formal manufacturing sector (with organised labour market for unskilled workers) in the urban area, producing with unskilled labour, capital (K) and an internationally non-traded intermediate input (examples of such non-traded intermediate input include electricity, water supply, local transportation, goods with very high transportation costs such as gravel and so on. See Mukherjee, 2016 in this context), which is, in turn, produced in one segment of the formal sector U (sub-sector I) using unorganised unskilled workers and capital.

The skill-intensive services sector (S) uses skilled labour (L_S), capital and a hi-technology-intensive imported intermediate input produced abroad (M). Examples of such imported inputs include computer data storage units, automatic data processing machines and so on. Consistent with empirical evidence (see for example Alvarez & Lopez, 2005; Lopez, 2015; and so on), I assume that only the relatively skill-intensive firms use imported intermediate inputs and consequently pay for foreign technology licences or foreign technical assistance. Furthermore, there is an *ad valorem* tariff (t) imposed on the import of M .

Sector N produces finished non-tradable (internationally) goods using only unskilled labour (L). We are making a simplifying assumption that a non-traded final good is produced in the urban area using only unskilled labour.

Unskilled labourers in the unorganised labour market of the rural agricultural sector and in the urban non-traded good producing sector get competitive (market-determined) money wages at the rate W , while their counterparts working in the organised labour markets of sectors I and U receive contractual money wages at the rate W^* , determined owing to prior unionised negotiation,¹ with $W < W^*$.

The skilled workers receive wages at the rate W_S . The rental to land-capital is denoted as R and the interest rate on capital is denoted as r . The price the non-traded intermediate input I , P_I , is determined domestically by demand-supply mechanism. a_{ji} denotes the amount of the j^{th} input used in per-unit production of the i^{th} good. P_i^* denotes the internationally given price of the i^{th} commodity owing to the small, open economy assumption ($i = A, U, S$).

All markets, except the organised labour market for the unskilled workers working in sectors I and U , are perfectly competitive. All production follows the constant returns to scale (CRS) technology. There are diminishing returns to the variable factors in each sector, except for the production of non-tradable.

The price-unit cost equality conditions (the so-called ‘zero-profit conditions’) for the competitive producers are mentioned below

¹ We assume the organised sector wages are institutionally given and we do not explicitly model the wage-bargaining here. For a discussion on how unionised wages are determined through collective bargaining, see Chaudhuri and Mukhopadhyay (2010); Mukherjee (2014) and so on.

$$Wa_{LA} + Ra_{TA} = P_A^* \quad (1)$$

$$W^* a_{LI} + ra_{KI} = P_I \quad (2)$$

$$W^* a_{LU} + ra_{KU} + P_I a_{IU} = P_U^* \quad (3)$$

$$W_S a_{SS} + ra_{KS} + P_M^* (1 + t) a_{MS} = P_S^* \quad (4)$$

$$Wa_{LN} = P_N \quad (5)$$

I assume that

(i) Per-unit requirement of the non-traded intermediate input in the production of sector U (a_{IU}) is constant

and.

(ii) Per-unit requirement of the imported input in sector S (a_{MS}) is also constant.

Although these two assumptions are simplified assumptions, they are not without any basis. If we think of sector U as a Television-making industry that always uses one Brown Tube to make a TV set; and sector S as a software industry that always has a fixed requirement of automatic data processing machine or computer data storage units in the production process, then these two assumptions are perfectly legitimate.

Full-employment in the factor market suggests

$$a_{TA}A = \bar{T} \quad (6)$$

$$a_{KI}I + a_{KU}U + a_{KS}S = \bar{K} \quad (7)$$

$$a_{SS}S = \bar{L}_S \quad (8)$$

Domestic demand-supply equality condition in the market for non-traded intermediate input implies

$$a_{IU}U = I \quad (9)$$

Or,

$$\hat{U} = \hat{I} \quad (9.1)$$

where the $\hat{\cdot}$ indicates proportional change. The unskilled labour-endowment equation is

$$a_{LA}A + a_{LU}U + a_{LI}I + a_{LN}N = \bar{L} \quad (10)$$

For the sake of analytical simplicity, let us also assume that α -proportion of the total urban income is spent on the non-traded good N (Marjit & Acharyya, 2003; Marjit, Kar, & Chaudhuri, 2011; and so on). This is also consistent with the assumption that urban consumers have Cobb-Douglas preferences over consumption bundle of tradable goods T (consumption vector of U & S) and non-traded consumption bundle N .

Thus, the domestic market clearing of non-traded good (assuming rural population cannot avail N)

$$\alpha(P_U^*U + P_S^*S) = (1 - \alpha)P_NN \quad (11)$$

Noting that here we have $a_{MS}S = M^*$ = the amount of imported M ; in the post-trade steady-state equilibrium situation, the domestic market for N always clears and the endogenous variables are always adjusted to maintain the trade-balance at the overall level.

The above equation system consists of eleven unknowns or endogenous variables of the system ($W, W_S, R, r, P_I, P_N, A, U, S, I, N$) and eleven equations. The input-coefficients, a_{ji} s, except the per-unit requirements of the imported and non-traded intermediate inputs (a_{IU} and a_{MS}) and the unit labour coefficient in the production of non-traded final good N (a_{LN}), are determined once the factor prices are known.

The model is solved as follows: Equations (2) and (3) simultaneously solve for r and P_I for exogenously given W^* and P_U^* . Once r is determined, zero-profit condition for the skilled labour-intensive manufacturing sector determines W_S given P_S^*, P_M^* and the ad-valorem rate of tariff imposed on the import of M , t . For a given P_N , Equation (5) yields the unskilled wage, W , which then solves for the rental to land-capital, R , from the zero-profit condition in Equation (1). Once the nominal skilled wage and the rate of interest to capital are solved, total skilled labour force yields the skill-intensive manufacturing production. This, together with the total domestic capital stock

give the production of the unskilled labour-intensive manufacturing good and consequently the production of the non-traded intermediate input, I , by dint of the complementarity in production process between these two sectors as given by Equation (9).

Given the values of W, R and the relevant input coefficients, the output choices of the agricultural product (A) and non-tradable N , are determined from Equations (6) and (10) respectively. This yields a supply curve for the non-tradable, N as $N^S = S(P_N)$. A hike in P_N increases W and reduces R . Higher W/R induces lower use of unskilled labour - to - land ratio in per-unit production of A , which lowers the agricultural output and releases some unskilled labour. Accordingly the production of non-tradable increases. Hence, there is a positive association between P_N and N^S , implying positively sloped supply curve.

On the other hand, the demand relationship for the non-traded good N in Equation (11) is a rectangular hyperbola (see, for instance, Marjit & Acharyya, 2003).

2.1. Comparative static exercise – tariff reduction on imported intermediate input²

The key comparative static exercise in this paper is to consider a reduction in the *ad valorem* rate of tariff (t) on the import of the intermediate input M .

Since interest rate on capital in the formal sector, r , is already determined by solving the zero-profit conditions given in Equations (2) and (3) simultaneously, r does not change and hence skilled wage goes up as an immediate impact of the reduction in tariff on the imported input, as evident from the zero-profit condition for the skill-intensive sector described in Equation (4). Therefore, denoting the proportional change by $\hat{\cdot}$ (i.e. $\hat{X} = dX/X$), the expression for change in skilled wage is:

$$\widehat{W}_S = -(\theta_{MS}T\widehat{t}/\theta_{SS}) > 0, \quad \text{since } \widehat{t} < 0 \tag{12}$$

where θ_{ji} denotes cost-share of the j^{th} input in the production of the i^{th} good (for example, $\theta_{SS} = (W_S a_{SS}/P_S^*)$) and $T = t/(1+t)$.³

How does W change? The agricultural sector and the non-tradable sector with informal labour markets employ only those unskilled labourers that are not employed in sectors U and I . Therefore, it is obvious that production in these two sectors is constrained by the demand for unskilled labour in the formal labour markets and hence by the outputs in the formal sector. With a simplifying assumption that sector N uses the unskilled labour in a fixed proportion, the input substitution effect is relevant only in sector A .

In algebraic terms,

$$\frac{\sigma_A \lambda_{LA}}{\theta_{TA}} \widehat{W} = (1 - \lambda_{LA} - \lambda_{LN}) \widehat{U} + \lambda_{LN} \widehat{N} \tag{13}$$

where λ_{ji} denotes share of the j^{th} input in the production of the i^{th} good (for example, $\lambda_{LA} = (A a_{LA}/\bar{L})$) and σ_A denotes elasticity of substitution between unskilled worker and land-capital in sector A .

However, as sector S expands, producers in sector S demand more capital that must come from the vertically integrated sectors U and I , leading to contraction of both sectors.

$$\widehat{U} = \widehat{I} = [\sigma_S \lambda_{KS}/\theta_{SS}(1 - \lambda_{KS})] \theta_{MS} T \widehat{t} < 0 \tag{14}$$

Hence, $(1 - \lambda_{LA} - \lambda_{LN}) \widehat{U} < 0$ implying fall in demand for unskilled labour due to contraction of U and I . Therefore, the changes in urban income and consequently the demand for the non-tradable can tilt in either direction. Given (5), i.e., proportionality between P_N and W , it is understandable that the movement in the relative wage gap owing to the tariff cut on imports of M depends crucially on the movement of P_N .

$$\theta_{LN} \widehat{W} + \widehat{N} = \mu \widehat{U} - \theta_{MS} T \widehat{t} \frac{\sigma_S (1 - \mu) \theta_{KS}}{\theta_{SS}} \tag{15}$$

where $\mu = \{\alpha P_U^* U / (1 - \alpha) P_N N\}$ and $(1 - \mu) = \{\alpha P_S^* S / (1 - \alpha) P_N N\}$ and σ_S is the elasticity of substitution between skilled labour and capital in the skill-intensive sector S .

$\mu ((1 - \mu))$ denotes the share of urban income spent by the people working in sector U (sector S) on the non-traded good. Therefore, $\mu ((1 - \mu))$ can be viewed as the demand for the non-traded good by the people working in sector U (sector S). It intuitively follows that higher (lower) value of μ means people in the urban areas earning from sector U (sector S) spend relatively more on the good N .

Equation (15) suggests given supply, the direction of change in the demand for non-tradable and subsequently on its production is ambiguous. The ambiguity stems from two alternative forces: one is increased demand by the skilled workers due to rise in their real earnings, another is reduced demand by the unskilled workforce in the urban area due to reduction in their real income owing to contraction of sector U . Therefore, the price of the non-tradable may move in any direction.

Therefore, one can get expression for \widehat{W} under tariff reduction on the imported input M by solving Equations (13)–(15) simultaneously.

² Detailed derivations of key algebraic expressions have been put aside in Appendix 2.

³ $\frac{d(1+t)}{1+t} = \frac{dt}{1+t} = \frac{dt}{t(1+t)} = \frac{t}{1+t} = T\widehat{t}$ - is the resulting expression of a proportional change in the domestic price of the imported input (P_S^* is exogenously given, by the small open economy assumption). Hence question of change in $T = \frac{t}{1+t}$ does not arise.

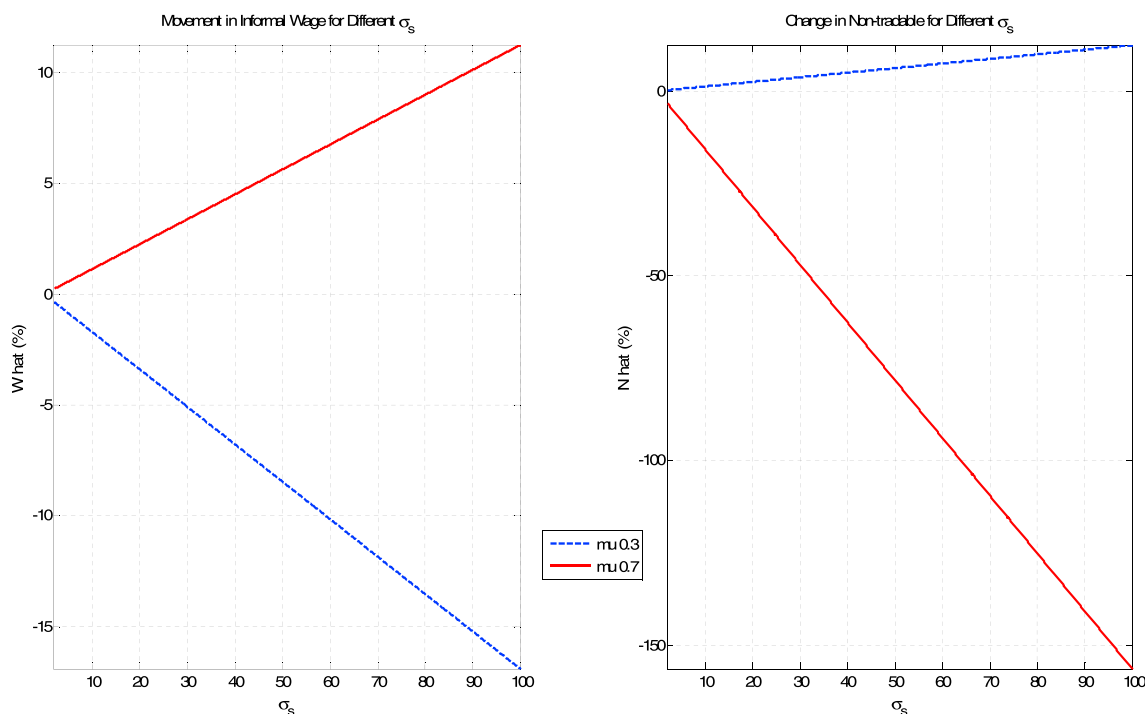


Fig. 1. Movements in non-traded production (N) & informal wage (W) following 24% tariff-cut on imports of M , for different σ_S at $\mu = 0.3$ & $\mu = 0.7$.

2.2. Quantitative analyses

The above figure quantifies in the two panels respectively the changes in the production of non-tradable N and the consequent movement in informal wage for different values of σ_S (the elasticity of substitution between skilled labour and capital in the skill-intensive sector S) in two different scenarios: $\mu = 0.3$ and $\mu = 0.7$, owing to a reduction in tariff on the imported input by 24 percentage points (as estimated by Goldberg, Khandelwal, Pavcnik, & Topalova, 2010 during 1989–1997 in India).⁴ The objective of this exercise is to show that below the benchmark value of $\mu = 0.5$, W falls for different σ_S and wage-inequality worsens (i.e. wage-gap widens) while above the benchmark, wage-inequality improves. Hence, for the sake of brevity, I shall consider only two different scenarios: one below the benchmark value of μ , i.e. $\mu = 0.3$; and another above the benchmark value of μ , i.e. $\mu = 0.7$.

When $\mu = 0.3$, share of total urban income from sector S spent on non-traded good N is relatively high and hence there is a net increase in the demand for N (since sector S expands at the expense of sector U) and therefore the supply of N at initial P_N . However, the contracting vertically integrated sector U releases additional unskilled labour to sectors A and N . This additional supply effect increases supply of N more than the increase in demand for N . This depresses W and therefore the price of non-tradable (P_N). Therefore, under $\mu = 0.3$, as σ_S rises, expansion of sector S and consequent contraction of the vertically integrated sector U induce expansion in non-traded production, but reduction in W , as depicted by the blue lines in Fig. 1.

However, when $\mu = 0.7$, share of urban income from the contracting vertically integrated sector U spent on non-tradable is relatively higher. Therefore, there is a net decline in the demand for and supply of non-tradable at initial P_N . Hence sector N contracts, and since the unskilled workers are now leaving the contracting sector N , the reduction in supply of N at initial P_N is more than the reduction in its demand. This leads to an increase in P_N . Given the proportional relationship between competitive unskilled wage and P_N , as laid in Equation (5), one should observe a net increase in W but a decline in non-traded production for $\mu = 0.7$, with the increase in σ_S , as depicted by the red lines in Fig. 1.

2.3. Employment of unskilled workers in the informal sector

Note that, now we have two sectors with ‘informal’ labour market: one is sector A and another is sector N . The total employment of unskilled workers in the informal sectors is therefore, given by

⁴ The benchmark parameter values used for the sensitivity analysis are presented in Table A3 in Appendix.

$$\widehat{L}_A + \widehat{L}_N = \left(\theta_{LN} - \frac{\sigma_A}{\theta_{TA}} \right) \widehat{W} \tag{16}$$

Therefore, if unskilled labour and land-capital are less than perfect substitutes in sector A (i.e. $\sigma_A < 1$), informal employment changes in the same direction of change in W if $\theta_{LN}\theta_{TA} > \sigma_A$. However, if $\sigma_A > 1$, direction of change in informal employment would be opposite to that in W . This is because, when W falls P_N falls and that reduces demand for the non-tradable, which, in turn, affects non-traded production; while if $\sigma_A > 1$, producers in sector A would be quite willing to minimise production cost by substituting retrenched unskilled labour for capital and that can boost employment of unskilled workers in the informal labour market of sector A. However, for low values of σ_A sector A producers would also be unwilling to employ additional units of retrenched worker for capital. Therefore, total employment in the informal sector also falls in that case.

2.4. Expression for relative wage inequality

Since the unskilled labourers are entitled to receive either the flexible wage in the informal unorganised (finished non-tradable producing) sector or the institutionally fixed wage in the organised sector, one can define an average unskilled wage of the economy and can consequently define the ratio of skilled wage over the average unskilled wage of the economy as the expression for relative wage gap in the economy under consideration. Hence one may define $W_A = W^* - (W^* - W)\lambda_{LA}$ as the average unskilled wage of the economy wherein one can show

$$\widehat{W}_A = (W/W_A) \widehat{W}(\lambda_{LA} + \lambda_{LN}) + \{ (W^* - W)/W_A \} (1 - \lambda_{LA} - \lambda_{LN}) \widehat{U} \tag{17}$$

Since $\widehat{U} < 0$, $\widehat{W}_A < 0$ if W falls as a consequence of tariff reduction on the imports of M . Therefore, the expression for wage inequality would be

$$\Omega = W_S/W_A$$

Or,

$$\widehat{\Omega} = \widehat{W}_S - \widehat{W}_A \tag{18}$$

Wherein an increase (decrease) in Ω means a deterioration (improvement) in wage inequality. As evident from the above discussions, the degree of substitutability between skilled labour and capital is of utmost importance to determine the fate of sector N and the consequent implication for the unskilled informal wage. Therefore, let us summarise the implications of liberalisation of input trade and the consequent demand-driven rise in skill-premium on the relative wage inequality for different σ_S in the following table (Table 1), on the basis of the observations from Fig. 1:

$\mu = 0.3$	$\widehat{\Omega} > 0$ and getting magnified
$\mu = 0.7$	$\widehat{\Omega} > 0$ or < 0 , $\widehat{\Omega}$ gets smaller even if > 0

3. Extended model with unemployment of skilled labour⁵

The reason for inclusion of this section is to depict the more realistic picture of a developing economy like India with full employment of unskilled labour but unemployment of skilled labour within the classical general equilibrium model of production and trade with informalisation and non-traded goods. I have incorporated unemployment of skilled labour using efficiency wage hypothesis, where efficiency of a skilled labourer changes positively with its wage rate and the rate of unemployment in the skilled labour market (See in this context, Gupta & Dutta, 2011; and the references therein). A higher wage rate encourages the skilled worker to work hard; and a higher unemployment rate accentuates the disutility in the presence of a threat of being fired and subsequently makes the skilled worker more disciplined.

Zero-profit condition for sector S changes in the following way

$$(W_S/h)a_{SS} + ra_{KS} + P_M^*(1+t)a_{MS} = P_S^* \tag{4.1}$$

where (W_S/h) is the effective unit cost employing skilled labour, or nominal skilled wage paid per efficiency unit, with $h = h(W_S, v)$ being

⁵ See Appendix 2 for detailed derivations of the key algebraic expressions. I am grateful to the anonymous referee (Reviewer 1) for his/her constructive comments, which has led to the inclusion of this section.

the efficiency of the skilled worker with $h_1 > 0, h_2 > 0, h_{11} < 0, h_{22} < 0$ (i.e. positive and concave in all arguments).

Interestingly, the presence of non-traded final good implies in this framework that the skilled wage *per efficiency unit*, unemployment rate of skilled labour and competitive unskilled wage should simultaneously be affected by any perturbation in non-traded production and equilibrium price of the non-traded final good.

For micro foundations of such an efficiency function, see Shapiro and Stiglitz (1984), Pisauro (1991), Gupta and Gupta (2001) and so on. Minimising (W_S/h) with respect to W_S the following first-order condition of minimisation can be obtained as

$$(\partial h/\partial W_S)(W_S/h) = 1 \tag{19}$$

This is the modified Solow (1979) condition implying that wage elasticity of efficiency is equal to unity in market for skilled labour. Also I have

$$\widehat{W}_S - \widehat{h} = -\varepsilon_v \widehat{v} \tag{20}$$

where $\varepsilon_v = (\partial h/\partial v)(v/h) > 0$ is the elasticity of $h(\cdot)$ with respect to v .

However, totally differentiating the new zero-profit condition for sector S , for $\widehat{t} < 0$

$$\widehat{W}_S - \widehat{h} = -(\theta_{MS}/\theta_{SS})T\widehat{t} > 0 \tag{21}$$

Therefore, using Equations (20)–(21) it is straightforward to obtain

$$\widehat{v} = (\theta_{MS}/\varepsilon_v\theta_{SS})T\widehat{t} < 0 \tag{22}$$

While differentiating the modified Solow condition and performing a little algebraic manipulation yields (note that $h_{11} < 0$ by the concavity of efficiency function)

$$\widehat{W}_S = [\varepsilon_v h/h_{11}(W_S)^2]\widehat{v} > 0 \tag{23}$$

Therefore, skilled wage increases while unemployment rate of skilled labour falls.

The skilled labour endowment equation will now be modified as (with fixed economy-wide physical endowment of skilled labour, \overline{L}_S)

$$a_{SS}S = \overline{L}_S(1 - v)h \tag{8.1}$$

Totally differentiating Equation (8.1) with Equation (7) one can obtain by simple algebraic manipulations and substituting values (note that now $a_{jS} = a_{jS}(\frac{W_S}{h}, r)$, where $j = S, K$)

$$\widehat{U} = \widehat{T} = \{\lambda_{KS}/(1 - \lambda_{KS})\} \left[\left\{ \left(\frac{v}{1 - v} \right) + (\sigma_S - 1)\varepsilon_v \right\} \widehat{v} - \widehat{W}_S \right] \tag{24}$$

And

$$\widehat{S} = \widehat{W}_S + \left[- \left(\frac{v}{1 - v} \right) - (\sigma_S\theta_{KS} - 1)\varepsilon_v \right] \widehat{v} \tag{25}$$

Therefore, if $\sigma_S \geq (1/\theta_{KS})$, $\widehat{S} > 0$ and $\widehat{U} (= \widehat{T}) < 0$ as $\widehat{W}_S > 0, \widehat{v} < 0$. That is, for a sufficiently higher degree of elasticity of substitution between skilled labour and capital in sector S , sector U contracts while sector S expands.

In this case, it will be appropriate to consider a Gini index of wage inequality,⁶ derived as $\Delta = (W_S/W_A)$, as before:

$$G = \frac{\overline{L}_S v \left\{ \overline{L}_U + \overline{L}_S(1 - v)\Delta \right\} + (\overline{L}_S) (\overline{L}_U) (1 - v)(\Delta - 1)}{(\overline{L}_S + \overline{L}_U - 1) \left\{ \overline{L}_U + \overline{L}_S(1 - v)\Delta \right\}} \tag{26}$$

The intuitions are fairly straightforward. A decline in tariff on the imported input M encourage sector S producers to expand by hiring more skilled labour, since skilled labour is specific input used in sector S . This raises wage received by every skilled worker *per efficiency unit*. Consequently, effective rate of unemployment of skilled labour also falls. Thus, there are two effects operating on the efficiency of each skilled worker employed: one is the positive impact of higher money wage received; the other is a negative effect due to decline in the effective rate of unemployment. Therefore, the producers in sector S can now economise production costs by paying higher money wages only to the efficient skilled workers and replacing the relatively less efficient workers by cheaper capital. However,

⁶ In the full-employment case considered before, $G = \frac{(\overline{L}_S/\overline{L}_U)(\Delta - 1)}{(\overline{L}_S + \overline{L}_U - 1)(\overline{L}_U + \overline{L}_S\Delta)}$. This can be verified by putting $v = 0$. It can be shown that $(dG/d\Delta) > 0$ in a full-employment model (see Gupta & Dutta, 2011), where $\Delta = (W_S/W_A)$, as considered in the earlier scenario. So without any loss of generality, one can take skilled wage relative to the average unskilled wage of the economy as the measure of wage gap in a full-employment model.

this is possible only if the substitutability between capital and skilled labour is sufficiently high. In that case, sector S will expand but sector U and I contract by releasing additional units of capital to sector S .

Equation (15) is changed to

$$\theta_{LN}\widehat{W} + \widehat{N} = \left(1 - \left(\mu/1 - \lambda_{KS}\right)\right) \begin{bmatrix} \{h/h_{11}(W_S)^2\} - \\ (v/1 - v) \\ (\lambda_{KS}1 - \lambda_{KS})\sigma_S(1 - \theta_{KS}) \end{bmatrix} \varepsilon_v(\theta_{MS}/\varepsilon_v\theta_{SS})T\widehat{t} \quad (27)$$

As discussed earlier, tariff cut on imports of M creates more job-opportunities for the skilled workforce, at higher wages *per* efficiency units, but only to the relatively more productive workers from the unemployment pool. If the relative share of urban income from the vertically integrated sector U spent on N is sufficiently small ($\mu < (1 - \lambda_{KS})$), the resultant demand for the finished non-tradable will be guided by the increase in demand for the urban population working in the skill-intensive sector at higher effective wages. Solving this equation (27) together with Equation (13), one can solve for \widehat{W} under the scenario when the production in sector N is organised in informal (non-unionised) unskilled labour market. As in the full-employment scenario, there is an additional supply-effect that depresses informal unskilled wage and thereby P_N and thus adds to the ambiguity in non-traded production as well.

Hence it is easily understandable that one can obtain qualitatively similar results as that of the full-employment model, and this bolsters the results obtain under full-employment model.⁷

4. Concluding remarks

Growth acceleration in skill-intensive service sectors under the WTO has been one of the most prominent features of the liberalisation experience in India. On the other hand, liberalisation has facilitated import of capital goods and thus the foreign technology embedded within those imported inputs. To utilise those inputs, or equivalently, to use the foreign technology embedded within those inputs in the most effective way, demand for additional skills has been generated. This leads to increased demand for skilled workforce driving their wages up. This paper explores the general equilibrium impact of such trade-induced growth in the skill-intensive service sector on informal sector wages and employment and most importantly, how this impact is mediated through the existence of finished non-tradable and the corresponding domestic demand-supply forces. The numerical analysis performed in this paper also establishes the importance of the changes in demand for non-traded final good, with varying elasticities of factor substitution in skill-intensive and agricultural production respectively, in quantification of the impact on unskilled informal wage and subsequently, on the degree of wage inequality. Finally, an extended framework with unemployment of skilled labour has also been presented that yields qualitatively similar conclusions obtained under full-employment model and thus demonstrates the robustness of the full-employment results. This simplest possible general equilibrium model adopted in this paper has thus been able to precisely identify the channels of impact of trade on income distribution for a developing country like India. One future extension of this exercise could be introducing skill-formation and capital-adjustment costs into the basic full-employment static general equilibrium model under consideration.

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⁷ However, numerical simulation of the extended model is not performed because of the difficulty in finding suitable benchmark values for some additional parameters (for example, ε_v).

Appendix 1. The general equilibrium structure at a glance

Table A1
Full-employment Model.

Variables		Key equations describing full-employment model		Simplifying assumptions	
Endogenous	Exogenous	Policy-parameter(S)	Price subsystem (Price = unit COST) Eqs. (1)–(4), (5.1)	Quantity (output) subsystem (full utilisation of factors) Eqs. (6)–(11)	Constancy OF a_{IU} & a_{MS}
$W, W_S, R, r, P_I, P_N, A, U, S, I, N$		$P_A^*, W^*, P_U^*, P_M^*, P_S^*, \bar{K}, \bar{L}, \bar{L}, t$			

Table A2
Structure of the Extended Model.

No. of Primary Sectors	Sector-definitions			Skilled Labour Market	Unskilled Labour Market	Particulars regarding other Inputs	Simplifying Assumptions	
	Name of the Sectors	Tradability of the Sectors	(In) Formality of the Sectors	Factor Usage				
4	A	Internationally traded	Informal	L, T	There exists unemployment of skilled labour at the rate $\nu > 0$. Efficiency of a skilled worker, $h = h(W_S, \nu)$, with $h_1 > 0, h_2 > 0, h_{11} < 0, h_{22} < 0$. Skilled wage per efficiency unit = $\left(\frac{w_s}{h}\right)$.	Formal Sectors: Unionised labour market, with institutionally given wages set by prior negotiations.	Capital (K) perfectly mobile between U (with sub-sector I) & S Land (T) is specific to sector A. There is an <i>ad valorem</i> rate of tariff (t) on imports of M.	Constancy of a_{IN}, a_{MS} & a_{IU} are retained.
	U (with sub-sector I)		Formal	L, K				
	S	Internationally non-traded	Informal	L_S, K, M		Informal Sector(s): Non-unionised labour market with flexible competitive wages.		
	N			L				

Appendix 2. Detailed algebraic derivations

The Full-employment Model

Total differentiation of Equation (6.4) allows one to write

$$\begin{aligned} & (W_S a_{SS} / P_S^*) (dW_S / W_S) + (W_S a_{SS} / P_S^*) (da_{SS} / a_{SS}) + (r a_{KS} / P_S^*) (dr / r) + (r a_{KS} / P_S^*) (da_{KS} / a_{KS}) \\ & = -[t / (1 + t)] [P_M^* (1 + t) a_{MS} / P_S^*] (dt / t) \end{aligned} \tag{A.1}$$

Since, $dP_S^* = 0$.

Using the ‘hat’ algebra of Ron Jones (1965), Jones et al. (1971), one can write Equation (A.1) as

$$\left(\theta_{SS} \widehat{W}_S + \theta_{KS} \widehat{r} \right) + \left(\theta_{SS} \widehat{a}_{SS} + \theta_{KS} \widehat{a}_{KS} \right) = -\theta_{MS} T \widehat{t} \tag{A.2}$$

Cost-minimisation by the competitive producers in sector S leads to the condition that the weighted average of changes in unit factor coefficients (with the weights being the cost-share of each factor; e.g., $W_S a_{SS} / P_S^*$ is the cost-share of skilled labour in sector S) along the unit isoquant in each sector must vanish near the cost-minimisation point. This implies an isocost line is tangent to the unit isoquant, which is algebraically expressed as

$$\theta_{SS} \widehat{a}_{SS} + \theta_{KS} \widehat{a}_{KS} = 0 \tag{A.2.1}$$

This is known as ‘envelope condition’.

Substitution of Equation (A.2.1) into Equation (A.2) yields

$$\theta_{SS} \widehat{W}_S + \theta_{KS} \widehat{r} = -\theta_{MS} T \widehat{t} \tag{A.3}$$

Since r gets already determined from Equations (2)–(3) in the text, r does not change as a consequence of tariff reduction on the imports of M. Therefore, substituting $\widehat{r} = 0$ in Equation (A.3) it is straightforward to obtain \widehat{W}_S as in Equation (12) of the main text.

By the definition of elasticity of factor substitution in sector S,

$$\sigma_S \widehat{W}_S = \widehat{a}_{KS} - \widehat{a}_{SS} \quad (\text{A.4})$$

Solving Equation (A.4) and Equation (A.2.1) simultaneously we obtain (note that $\theta_{SS} + \theta_{KS} = 1$)

$$\widehat{a}_{SS} = -\sigma_S \theta_{KS} \widehat{W}_S \quad (\text{A.5})$$

Totally differentiating Equation (8), one can obtain

$$(da_{SS}/a_{SS}) + (dS/S) = d\overline{L}_S/\overline{L}_S = 0 \quad (\text{A.6.1})$$

Or,

$$\widehat{S} = -\widehat{a}_{SS} \quad (\text{A.6.2})$$

Therefore, substituting \widehat{a}_{SS} from Equation (A.5) into Equation (A.6.2) we obtain

$$\widehat{S} = \sigma_S \theta_{KS} \widehat{W}_S \quad (\text{A.7})$$

Since $\widehat{W}_S > 0$ when $\widehat{t} < 0$, $\widehat{S} > 0$.

Similarly, totally differentiating Equation (6) we obtain

$$\widehat{A} = -\widehat{a}_{TA} \quad (\text{A.8})$$

Therefore,

$$\widehat{L}_A = \widehat{a}_{LA} + \widehat{A} = \widehat{a}_{LA} - \widehat{a}_{TA} \quad (\text{A.9})$$

Just like before, using the definition of elasticity of factor substitution in sector *A* we obtain

$$\widehat{a}_{LA} - \widehat{a}_{TA} = -\sigma_A (\widehat{W} - \widehat{R}) \quad (\text{A.10})$$

But totally differentiating the zero-profit condition in Equation (1) and applying envelope condition for competitive producers in sector *A* we obtain

$$\theta_{LA} \widehat{W} + \theta_{TA} \widehat{R} = 0 \quad (\text{A.11})$$

Since, $\theta_{LA} = (1 - \theta_{TA})$, simple rearrangement of terms in Equation (A.11) yields

$$(\widehat{W} - \widehat{R}) = \widehat{W} / \theta_{TA} \quad (\text{A.12})$$

Substituting $(\widehat{W} - \widehat{R})$ from Equation (A.12) into Equation (A.10), it is easy to obtain

$$(\widehat{a}_{LA} - \widehat{a}_{TA}) = -(\sigma_A \widehat{W} / \theta_{TA}) \quad (\text{A.13})$$

This is the same expression as in Equation (16).

Now totally differentiating the full-employment condition for unskilled labour in Equation (10) we obtain

$$\left(\frac{Aa_{LA}}{L}\right) [(dA/A) + (da_{LA}/a_{LA})] + \left(\frac{Ia_{LU}}{L}\right) (dI/I) + \left(\frac{Ua_{LU}}{L}\right) (dU/U) + \left(\frac{Na_{LN}}{L}\right) (dN/N) = 0 \quad (\text{A.14})$$

Since (W^*, r) are unchanged and a_{LU} is constant, $\widehat{a}_{LI} = \widehat{a}_{KI} = \widehat{a}_{LU} = \widehat{a}_{KU} = 0$. Also, $\widehat{a}_{LN} = 0$ by the simplifying assumption we have made and total endowment of unskilled labour \overline{L} is parametrically given.

Rewriting Equation (A.14) as

$$\lambda_{LA} (\widehat{A} + \widehat{a}_{LA}) + \lambda_{LI} \widehat{I} + \lambda_{LU} \widehat{U} + \lambda_{LN} \widehat{N} = 0 \quad (\text{A.15})$$

Using Equations (9.1) and (16), Equation (A.15) yields Equation (13) in the text (note that $\lambda_{LI} + \lambda_{LU} = 1 - \lambda_{LA} - \lambda_{LN}$). Similarly, totally differentiating Equation (7) and utilising Equation (9.1) and (A.4) we obtain

$$(\lambda_{KI} + \lambda_{KU}) \widehat{U} = -\lambda_{KS} \sigma_S \widehat{W}_S \quad (\text{A.16})$$

Substituting for \widehat{W}_S from Equation (12) into Equation (A.16) it is straightforward to obtain $\widehat{U} = \widehat{I}$ as in Equation (14). Totally differentiating Equation (11) in the text, we obtain

$$\mu \widehat{U} + (1 - \mu) \widehat{S} = \widehat{P}_N + \widehat{N} \tag{A.17}$$

Putting $\widehat{P}_N = \theta_{LN} \widehat{W}$ yields Equation (15) in the text.
 Extended Model with Unemployment of Skilled Labour.
 Solving Equation (19), we have

$$W_S = W_S(v) \text{ with } (dW_S/dv) < 0 \tag{A.18}$$

Optimum efficiency of skilled workers is then given by

$$h^* = h^*[W_S(v), v] \tag{A.19}$$

Thus, totally differentiating the modified Solow (1979) condition in Equation (19) we have

$$(\partial W_S/\partial v) = (h_2/W_S h_{11}) < 0 \tag{A.20}$$

Totally differentiating the expression for optimum efficiency of skilled labour in Equation (A.19) (assuming that the function is of Cobb-Douglas type) and substituting for $(\partial W_S/\partial v)$ from Equation (A.20), we have

$$(dh/dv) = (h_2/W_S h_{11})(h_1 + W_S h_{11}) < 0 \tag{A.21}$$

Now differentiating both sides of Equation (19) we have

$$\frac{\partial^2 h}{\partial W_S^2} \frac{dW_S}{W_S} \frac{(W_S)^2}{h} + \frac{\partial h}{\partial W_S} \frac{dW_S}{W_S} \frac{W_S}{h} - \frac{\partial h}{\partial W_S} \frac{W_S}{h^2} \left[\frac{\partial h}{\partial W_S} \frac{dW_S}{W_S} W_S + \frac{\partial h}{\partial v} \frac{dv}{v} \right] = 0 \tag{A.22}$$

Using Equation (19) and (A.22) we have

$$h_{11} \frac{(W_S)^2}{h} \widehat{W}_S - \varepsilon_v \widehat{v} = 0 \tag{A.23}$$

Solving Equation (A.23) it is now straightforward to obtain \widehat{W}_S as in Equation (23).

Totally differentiating Equation (8.1) (note that now $a_{jS} = a_{jS} \left(\frac{W_S}{h}, r \right)$, where $j = S, K$)

$$\widehat{a}_{SS} + \widehat{S} = \widehat{h} - \widehat{v} \left(\frac{v}{1-v} \right) \tag{A.24}$$

Similarly, total differentiation of Equation (7) and substituting from Equation (A.24) yields

$$\lambda_{KS} \left\{ \left(\widehat{a}_{KS} - \widehat{a}_{SS} \right) + \widehat{h} - \widehat{v} \left(\frac{v}{1-v} \right) \right\} + (\lambda_{KL} + \lambda_{KV}) \widehat{U} = 0 \tag{A.25}$$

Since now we have $(\widehat{a}_{KS} - \widehat{a}_{SS}) = \sigma_S (\widehat{W}_S - \widehat{h})$, therefore, Equation (A.25) gives Equation (24) in the text.

Similarly, substituting $\widehat{a}_{SS} = \sigma_S \theta_{KS} (\widehat{W}_S - \widehat{h})$ in Equation (A.24) and a little algebraic manipulation yields Equation (25) in the text.

Appendix 3

Table A3
 Parameter Values for Sensitivity Analyses.

Parameters	Description	Values
θ_{LN}	Cost-share of labour in sector N	0.5
θ_{LA}	Cost-share of labour in sector A	0.6
θ_{TA}	Cost-share of land-capital in sector A	0.4 = (1 - θ_{LA})
θ_{SS}	Cost-share of skilled-labour in sector S	0.6
θ_{MS}	Cost-share of imported input in sector S	0.1 (constant)
θ_{KS}	Cost-share of capital in sector S	0.3
λ_{KS}	Share of capital used in sector S	0.4
λ_{LN}	Share of unskilled labour employed in sector N	0.3
λ_{LA}	Share of unskilled labour employed in sector A	0.5
σ_S	Elasticity of substitution between skilled labour and capital in sector S	[1.5, 3.7, 100]
σ_A	Elasticity of substitution between labour and land-capital in sector A	1.2

Source: Abraham, 2010, Berman, Somanathan, & Tan, 2005, Marjit & Kar, 2008, Marjit et al., 2011, Seker and Rodriguez-Delgado (2011), Broda, Greenfield, and Weinstein (2006) (for the ranges of σ_S) and Goldar, Pradhan, and Sharma (2014) (for benchmark value of σ_A).

References

- Abraham, V. (2010). *The effect of information technology on wage inequality: Evidence from Indian manufacturing sector*. CDS working papers, no.437, Trivandrum, CDS.
- Alvarez, R., & Lopez, R. A. (2005). Exporting and performance: Evidence from Chilean plants. *Canadian Journal of Economics*, 38, 1384–1400.
- Beladi, H., & Batra, R. (2004). Traded and nontraded goods and real wages. *Review of Development Economics*, 8, 1–14.
- Bensidoun, I., Jean, S., & Sztulman, A. (2011). International trade and income distribution: Reconsidering the evidence'. *Review of World Economics*, 147(4), 593–619.
- Berman, E., Somanathan, R., & Tan, H. W. (2005). *Is skill-biased technological change here Yet? Evidence from Indian manufacturing in the 1990s*. World Bank Policy Research Working Paper 3761.
- Broda, C., Greenfield, J., & Weinstein, D. E. (2006). *From groundnuts to globalization: A structural estimate of trade and growth*. NBER Working Paper No. w12512.
- Caselli, M. (2012). 'Does wealth inequality reduce the gains from trade?'. *Review of World Economics*, 148(2), 333–356.
- Chaudhuri, S., & Mukhopadhyay, U. (2010). The harris–todoraro migration model and introduction of the informal sector.'. In *Revisiting the informal sector*. Springer, New York.
- Dehejia, R., & Panagariya, A. (2012). Services growth in India: A look inside the black box. In J. Bhagwati, & A. Panagariya (Eds.), *Reforms and economic transformation in India* (pp. 86–118). New York: Oxford University Press.
- Goldar, B., Pradhan, B. K., & Sharma, A. K. (2014). *Elasticity of substitution between capital and labour in major sectors of the Indian economy*. Institute of Economic Growth Working Paper No. 335.
- Goldberg, P., Khandelwal, A., Pavcnik, N., & Topalova, P. (2009). Trade liberalization and new imported inputs. *American Economic Review*, 99, 494–500.
- Goldberg, P. K., Khandelwal, A. K., Pavcnik, N., & Topalova, P. (2010). Imported intermediate inputs and domestic product growth: Evidence from India. *The Quarterly Journal of Economics*, 125, 1727–1767.
- Gupta, M. R., & Dutta, P. B. (2011). Skilled–unskilled wage inequality and unemployment: A general equilibrium analysis. *Economic Modelling*, 28, 1977–1983.
- Gupta, M. R., & Gupta, K. (2001). Tax policies and unemployment in a dynamic efficiency wage model. *Hitotsubashi Journal of Economics*, 42, 65–79.
- Hasan, R. (2002). The impact of imported and domestic technologies on the productivity of firms: Panel data evidence from indian manufacturing firms. *Journal of Development Economics*, 69, 23–49.
- Jones, R. W. (1965). The structure of simple general equilibrium models. *Journal of Political Economy*, 73(6), 557–572.
- Jones, R. W. (1971). A three-factor model in theory, trade and history. In J. Bhagwati, et al. (Eds.), *Trade, Balance of Payments and growth*. Amsterdam: North-Holland.
- Kijima, Y. (2006). Why did wage inequality increase? Evidence from urban India 1983–99. *Journal of Development Economics*, 81, 97–117.
- Leamer, E. E. (1992). *Wage effects of a US-Mexican free trade agreement*. National Bureau of Economic Research. No. w3991.
- Lopez, R. A. (2015). Trade and firm performance. In Morrissey, et al. (Eds.), *Handbook on trade and development*. United Kingdom: Edward Elgar Publishing Limited.
- Marjit, S., & Acharyya, R. (2003). *International trade, wage inequality and the developing economy: A general equilibrium approach*. Physica-Verlag, Springer, Heidelberg.
- Marjit, S., & Kar, S. (2008). Labor productivity growth, informal wage and capital mobility – a general equilibrium analysis. In R. Kanbur, & J. Svejnar (Eds.), *Labour markets and economic development*, NY: Routledge, 2008.
- Marjit, S., Kar, S., & Chaudhuri, S. (2011). Recession in the skilled sector and implications for informal wage. *Research in Economics*, 65, 158–163.
- Mukherjee, S. (2012). Revisiting the apparent paradox: Foreign capital inflow, welfare amelioration and 'jobless growth' with agricultural dualism and non-traded intermediate input. *Journal of Economic Integration*, 27(No. 1), 123–133.
- Mukherjee, S. (2014). Liberalisation and 'jobless growth' in developing economy – some extended results. *Journal of Economic Integration*, 29(No. 3), 450–469.
- Mukherjee, S. (2016). Technology, trade and 'urban poor' in a general equilibrium model with segmented domestic factor markets. *International Review of Economics and Finance*, 45, 400–416.
- Oladi, R., & Beladi, H. (2008). Non-traded goods, technical progress and wages. *Open Economic Review*, 19(4), 507–515. <http://dx.doi.org/10.1007/s11079-007-9057-1>.
- Pisauro, G. (1991). 'The effects of taxes on labour in efficiency wage models. *Journal of Public Economics*, 46(No. 3), 329–345.
- Seker, M., & Rodríguez-Delgado, J. D. (2011). *Imported intermediate goods and product Innovation: Evidence from India*. Mimeo.
- Shapiro, C., & Stiglitz, J. (1984). Equilibrium unemployment as a worker-discipline device. *The American Economic Review*, 74(No. 3), 433–444.
- Sharma, K., & Morrissey, O. (2006). Trade, growth and inequality in the era of globalisation. In K. Sharma, & O. Morrissey (Eds.), *Trade, Growth and Inequality in the Era of globalisation*. Routledge.
- Solow, R. (1979). 'Another possible source of wage stickiness. *Journal of Macroeconomics*, 1, 79–82.
- Wood, A. (1994). *North-south trade, employment, and inequality: Changing fortunes in a skill-driven world*. Oxford: Clarendon Press.