Opening the Pandora's Box – Liberalised Input Trade and Wage Inequality with Non-traded Goods and Segmented Unskilled Labour Markets

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Abstract

This paper, using a full-employment general equilibrium model with internationally non-traded goods and international fragmentation in skill-intensive production, illuminates how liberalised input trade, by enhancing demand for skills in the skill-intensive service sectors, could affect the unskilled wages prevailing in the informal sectors and employment conditions in those sectors, through the existence of finished non-tradable and the corresponding domestic demand-supply forces. The underlying developing economy is characterised by dual unskilled labour market with unionised formal and non-unionised informal sectors. Quantitative analyses have also been performed to simulate how the changes in elasticities of factor substitution in production of different sectors account for the movement in informal wage and therefore the movement in skilled–unskilled wage gap. Extending the basic model with involuntary unemployment of the skilled workforce, it is again found that the relative wage inequality in a developing country like India with rigid organised sector labour market has not been governed only by the increase in the skilled wages.

Keywords: Input trade reform; non-traded goods; informal wage; informal employment; wage inequality; general equilibrium.

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I. INTRODUCTION

One popular issue of research in the context of developing countries (DCs hereafter) 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. However, peculiarities such as exporting both skill-intensive manufacturing and unskilled labour intensive agricultural products, coexistence of organised and informal labour markets and the production of internationally non-tradables – have rarely been taken up in general equilibrium classical trade-theory models. This paper has taken up an issue of input trade reform in the skill-intensive industries of a DC like India where a particular capital-intensive input gets imported from the world market for another exportable input produced in the home country, inducing access to greater varieties of capital goods at a cheaper rate leading to the improvement in industry's overall productivity with the increased real skilled wage. What this paper has done is to channelize implications of such changes in the skill-intensive formal industries on the real unskilled wage received by the relatively marginalised workers working under informal arrangements in terms of a comprehensive classical general equilibrium model of production and trade incorporating the above-mentioned peculiarities for a dual developing country (like India).

The incidence of labour market rigidity, as observed typically in the formal industrial sectors of India has been documented in a number of empirical literature (such as Topalova 2010; Besley and Burgess 2004), hinders free mobility of unskilled and skilled labourers across sectors. Robbins (1996), Sanchez-Paramo and Schady (2003), Attanasio et al. (2004) on DCs like Argentina, Brazil, Mexico, Chile and Colombia, and Topalova (2010) for Indian districts, provide grounds for the proponents of specific-factor model of Ron Jones (1971) by concluding that the skilled labour-intensive sectors do not substitute away skilled labour for the unskilled labour. But the specific factor model too, unless modified, cannot explain the symmetric changes in the wage gap in the trading nations due to the negligence of the role of the informal establishments (producing mainly non-tradables) in the production linkage. The

share of the informal sector in total employment is typically quite high in DCs (Razmi 2009). Agenor (1996) cites an average figure of more than 70% for DCs. The share of the informal sector in total output can also be quite high. For example, Nagaraj (2004) reports a figure of 40% for India. Unfortunately, most of the relevant literature in this context has neglected the special nature of the informal sector in developing countries' labour markets.

Liberalised economic policies generally shift resources away from the non-traded sectors to the traded sectors of the economy. Since the non-traded production by definition must match its domestic demand, trade liberalisation induced expansion of activities in the traded sectors will be possible only through a fall in the demand for and supply of non-tradable. In fact, as pointed out by Acharyya and Marjit (2000) and Marjit and Acharyya (2003) and also as will be demonstrated in this paper that whether non-traded production is organised in the informal or in the formal sector[1] could be crucial to determine the impact on wage inequality. Typically, the formal non-traded sector produces internationally non-tradable including all public services, hotel accommodation, real estate, construction, hair-cut and commodities produced to meet special customs or conditions of the country. Similarly, the non-tradable produced in the unorganised informal sectors include items such as small domestic industries, services provided by petty traders or street-side vendors and so on.

As defined in Feenstra and Hanson (1996), Jones and Kierzkowski (2001) and others, a sharp decline in transportation and communication costs during liberalisation makes it easier for the DCs to specialise in part of the production chain and outsource other parts of the production process to countries where factor prices and intensities are appropriate for that particular fragment. This gives birth to the input trade where this particular input gets exchanged in the world market for another exportable input produced in the home country. Das (2012) found that in developing countries such as India, China, South-East Asia and Latin America a higher percentage of trade has been attributed to production-sharing in hi-technology products, service(s) and capital goods. As found in Goldberg et al. (2009), trade liberalisation in India also involves reduction in barriers to trade on imported inputs and thereby providing access to more and newer varieties of cheaper inputs from other countries. Goldberg et al. (2010) estimated that input tariffs declined on average by 24 percentage points during 1989-1997. Arora and Chakrabarti (2004) provide empirical evidence of the significant impact of

[1] Typically we shall confine ourselves in this paper characterising the informal sector as the sector with unorganised unskilled labour market in line with other theoretical papers such as Marjit and Acharyya (2003), Acharyya and Marjit (2000), Chaudhuri and Banerjee (2010) and so on.

outsourcing of skill-intensive production on widening skilled-unskilled wage gap in Indian context. Therefore, an important agenda of research becomes to examine the implications of input trade liberalisation on wage inequality, with explicit considerations of the salient features of a developing dual open economy like India, namely informalisation and presence of non-tradable in a sector-level classical general equilibrium model of production and trade.

The importance of non-traded goods in theoretical models determining the direction of skilled-unskilled wage gap has been documented by Marjit and Acharyya (2003), Chaudhuri and Yabuuchi (2008) who have used a four-sector general equilibrium model to study the consequences of import liberalization on skilled-unskilled wage gap, highlighting the significance of dualism in the labour market and role of non-tradable commodities in driving the results. Gupta and Dutta (2011) incorporated involuntary unemployment of both skilled and unskilled labour in a three-sector model with non-traded goods to understand the implications of trade liberalisation-induced changes on skilled-unskilled relative wage and on the unemployment rates. This paper contributes to this research arena by sketching out the implication of input trade liberalisation on wage inequality with dual labour markets, large informal sectors and non-traded goods. The purpose of such a comparative static exercise is two-fold. Firstly, the accelerated growth in Indian manufacturing and service sectors has largely been attributed to dramatic reduction in tariffs and NTBs on the imports of intermediate inputs as emanates from recent empirical evidence (Goldberg et al. 2009; 2010). Secondly, the recent empirical literature (Panagariya 2004; Kotwal et al. 2011) suggests that skill-intensive manufacturing and service industries such as communication services, financial services and business services in India experienced significant growth in exports during the liberalised regime, where software accounted for the highest share of all service exports, at least up to the recent financial crisis (Kotwal et al. 2011). Dehejia and Panagariya (2012) argued that imports of capital-intensive foreign inputs (embodying foreign technology) by the skill-intensive service sectors (primarily software services and IT-enabled services) facilitated the growth of these sectors in India in the post-reform period. At the same instance, Hasan (2002) provided evidence from panel data on Indian manufacturing firms in favour of a significant effect of imported technology on productivity. Hence, access to newer varieties of foreign inputs owing to trade reform has fuelled such growth in India's service industries during the liberalised regime. Therefore, there should be an increased demand for skilled labour, due to the increase in demand by the skill-intensive service industries both at the extensive margin and due to the skill-biased technological change at the intensive margin

owing to the increased skill content of imported inputs that are then assembled for export. Therefore, the contribution of this paper is to adopt a tractable but encompassing general equilibrium structure to trace out the implications of such productivity surges in the skill-intensive service sector, brought about by tariff reform on the imports of capital-intensive inputs, on the non-traded sector and subsequently on the unskilled labour market and informal unskilled wage.

The general equilibrium framework used in this paper follows the available empirical evidence that low-skilled workers cannot afford to remain unemployed and the retrenched unskilled workers from the organised formal sectors get absorbed in the unorganised informal sectors at market-determined lower wages. Our modelling approach, closely follows Marjit and Acharyya (2003) with organised (formal) and unorganised (informal) non-traded sectors respectively to enlighten the role of non-tradable in determining the implications on unskilled informal wage and consequently on the relative wage gap. The framework used in this paper can be viewed as a generalisation of Marjit et al. (2007) with additions of skill-intensive sector and non-traded final good producing sector.

II. THE FULL-EMPLOYMENT MODEL

Let us consider a small, open dual economy comprising of four sectors: sector A, vertically integrated sector U ($\&$ sub $-$ 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).[2]

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)

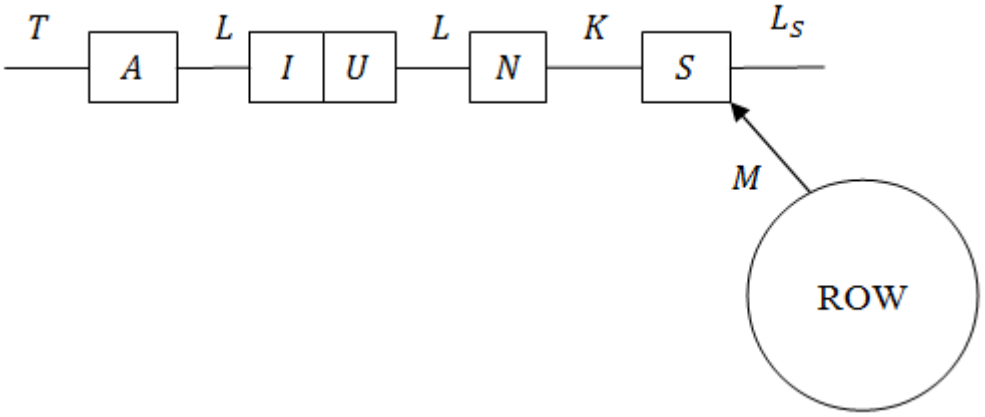
[2] The input 'land-capital' broadly includes land and other durable assets. See Bardhan (1972) and Mukherjee (2012, 2014) in this context.

and an internationally non-traded intermediate input[3], which is, in turn, produced in one segment of the formal sector U (sub-sector I) using unionised unskilled workers and capital.

The skill-intensive manufacturing sector (S) uses skilled labour (L_S), capital and a hi-technology-intensive imported intermediate input produced abroad (M)[4]. Consistent with empirical evidence[5] 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 *advalorem* tariff (t) imposed on the import of M. [6]

Sector N produces finished non-tradable (internationally) goods using only unskilled labour (L). Similar to Marjit and Acharyya (2000, 2003), this model also makes a simplifying assumption that a non-traded final good is produced in the urban area using only unskilled labour in a fixed proportion.

Figure 1: The Model Structure



Unskilled labourers in the unorganised labour market of the rural agricultural sector get competitive (market-determined) money wages at the rate W, while their counterparts

[3] 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.
[4] Examples of such imported inputs include computer data storage units, automatic data processing machines and so on.
[5] See for example Alvarez and Lopez (2005), Lopez (2015) and so on.
[6] This should be interpreted here as the *advalorem* equivalence of tariff and non-tariff barriers (NTBs).

working in the organised labour markets of the formal sectors receive contractual money wages at the rate W^*, determined owing to prior unionised negotiation[7], 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 markets for the unskilled workers working in the formal sectors, are perfectly competitive. All production is subject to constant returns to scale. Except for the non-traded production and production in the input tier, there are diminishing returns to the variable factors in each sector.

1. CASE I: Non-tradable Production in Organised Sectors with Institutionally Given Wages

Let us first assume that this finished non-tradable is produced in the formal sector where unskilled labour is hired at a contracted nominal wage (institutionally given by prior negotiations), as considered in Marjit and Acharyya (2003) and in Acharyya and Marjit (2000). Examples of such non-tradable include services such as construction, hair-cut, infrastructure (comprising telecommunications, electricity, water and sewerage, natural gas and transportation) and so on – where one observes existence of higher institutionally given nominal wage. Therefore, only the agricultural sector is modelled as the informal sector[8] where the unskilled labour gets a lower market-determined nominal wage. However, the price of non-traded final commodity N, P_N, is determined in this case by the labour cost given W^* and therefore the production of the non-traded good N is determined by the domestic demand for N.

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

[7] 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.
[8] See footnote 1 in this context.

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

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

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

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

$$W^* a_{LN} = P_N \quad (5)$$

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

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

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

$$a_{SS}S = \overline{L_S} \quad (8)$$

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 ^ indicates proportional change. The unskilled labour-endowment equation is

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

Following Marjit and Acharyya (2003) and Marjit et al. (2011) let us make a simplifying assumption that α-proportion of the total urban income is spent on the non-traded good N. 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)

$$\alpha({P_U}^*U + {P_S}^*S) = (1-\alpha)P_N N \qquad (11)$$

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. On the other hand, the price of the non-traded good is given by the labour cost, which is the product of fixed input-coefficient and the contracted unskilled-wage, independent of the demand for non-traded good. Once the nominal skilled wage and the rate of return to capital are determined, total skilled labour force determines the skill-intensive manufacturing production and this together with the total domestic capital stock yields 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).

The non-traded output, on the other hand, is demand-determined given the equilibrium values of W_S,r and U (and I), as evident from the market-clearing condition in Equation (11). Therefore, the formal sectors form an independent subsystem of the economy under consideration.

The output and prices of the factors used in production of U,I,S and N are all determined independent of the informal agricultural sector in this set-up. But the informal wage rate, the rental to land-capital and production in sector A are determined once the equilibrium values in the formal sectors of the economy are obtained. In this set-up, the production activities in sector A will be constrained by the outputs and hence by the demand for unskilled labour in the formal sectors. This depicts the importance of the non-traded good N. Because of the presence of the non-traded final good N, production of agricultural exports and the consequent demand for unskilled labour are constrained by the demand for N, which otherwise could have been satisfied through imports. Finally, given such an output level of agricultural exports, the informal competitive wage and the return to the specific factor, land-capital, must satisfy the zero-profit condition given by Equation (1) and full employment condition for land in Equation (6).

i. Comparative Static Exercise – Tariff Reduction on Imported Intermediate Input[9]

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 '^' (i.e. $\hat{X} = dX/X$), the expression for change in skilled wage is:

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

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

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 $T = t/(1+t)$.

How does W change? The agricultural sector with an informal labour market employs only those unskilled labourers that are not employed in the formal sectors of the economy (that is not employed in sectors *U* and *N*). Therefore, it is obvious that production activities in the agricultural sector (*A*) will be constrained by the demand for unskilled labour in the formal sectors and hence by the outputs in the formal sectors. So the effect on W depends on whether the organised sectors using unskilled labour contracts or not.

In algebraic terms,

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

Where λ_{ji} denotes share of the j^{th} input in the production of the i^{th} good (for example, $\lambda_{LA} = (Aa_{LA}/\bar{L})$) and σ_A denotes elasticity of substitution between unskilled worker and land-capital in the agricultural sector. LHS measures change in labour demand in sector A due to input substitution effect in sector A, but induced by change in W, which in turn, depends on how demand for unskilled labour by the rest of the economy changes; or in other words, how productions of U (consequent upon change in I) and N change. 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.

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

Hence, $(1-\lambda_{LA}-\lambda_{LN})\widehat{U} < 0$ implying fall in labour demand due to contraction of U and I. Therefore, the changes in urban income and consequently the demand for the non-tradable can be in either direction. *W* falls unequivocally only if *N* contracts. Here lies the significance of the role of non-tradable. When the non-tradable is produced under contractual wages, the variation in demand for non-tradable only affects the production of non-tradable.

Totally differentiating domestic market-clearing condition for the non-traded good and simplifying

$$\widehat{N} = \mu\widehat{U} - \theta_{MS}T\hat{t}\,\frac{\sigma_S(1-\mu)\theta_{KS}}{\theta_{SS}} \qquad (15)$$

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. 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 (14) suggests direction of change in the demand for non-traded good and consequently 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.

ii. Quantitative Analysis

Figure 2: Movements in Non-traded Production (N) & Informal Wage (W) following 24% Tariff-cut on Imports of M, for Different σ_S at $\mu = 0.3$ & $\mu = 0.7$, under Contractual Wage in Sector N

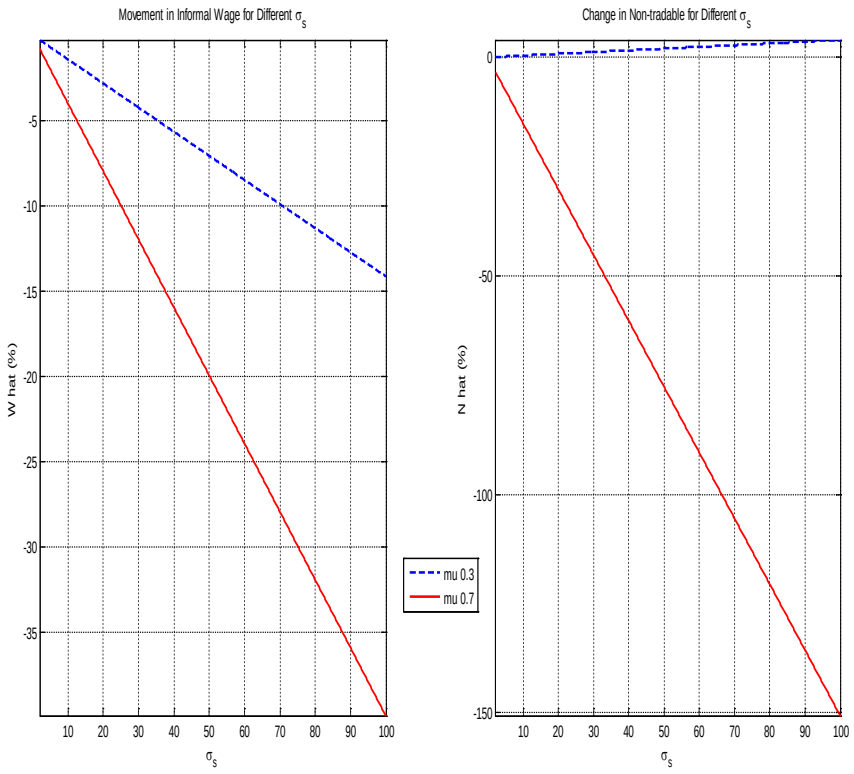


Figure 2 quantifies in the two panels respectively the changes in the production of non-tradable N and the consequent movement in informal wage for different values of σ_S in two different scenarios: $\mu = 0.3$ and $\mu = 0.7$, owing to a reduction in tariff on the imported input by 24 percentage points (as estimated by Goldberg et al. 2010 during 1989-1997 in India).[10] When the skilled wage increases owing to a tariff cut of 24% on the import of input M, with increase in the elasticity of substitution between skilled labour and capital, producers in sector S would be more tempted to substitute capital for skilled labour and sector S would expand even more and consequent contractionary impact on the vertically integrated sector U would be higher as well since additional units of capital sector S demands must come from sectors I and U, thereby both direct and indirect capital usage by sector U would decline at higher rate. Therefore income from sector S (sector U) increases (decreases) at an increasing rate with increase in σ_S.

μ =0.3 yields the scenario when urban population earning from sector S would spend relatively larger share of their income on the non-tradable, N, compared to the urban population earning from the vertically integrated sector U. Sector S expands more with the increase in σ_S; when the share of urban income from sector S spent on the non-tradable N is relatively higher, the decrease in the demand for N by the urban people earning from the vertically integrated sector U would be outweighed by the increase in demand for N by the people receiving income from sector S and consequently one should observe a modest increase in the production of sector N with increase in σ_S for μ =0.3. Therefore, for μ =0.3, there would be two forces operating on the demand for unskilled workers in the formal sectors and consequently on the informal wage: one is decrease in demand for the unskilled workers at a higher rate by sector U with the increase in σ_S and another is the increased demand by the non-traded sector N, which is however, modest. Therefore, demand for unskilled workers in the formal sectors is not increased as a net effect and informal wage would decline, but the rate of decrease in informal wage is quite modest.

However, when μ =0.7, share of urban income from the vertically integrated sector U spent on N is much higher compared to the people earning from sector S. So the contractionary impact on the vertically integrated sector U would now be much more pronounced in determining the demand for N by the urban population with the increase in σ_S. Therefore, demand for non-tradable N would now decline as a net effect with the increase in σ_S.

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

Consequently, demand for unskilled workers in the formal sectors would unambiguously fall and the informal wage would fall at a much higher rate compared to the case with μ =0.3.

iii. Implications on the Employment in the Informal Sector

Totally differentiating the full-employment condition in the unskilled labour market and substituting values it is obtained as

$$\widehat{L_A} = \hat{a}_{LA} + \hat{A} = -\frac{\sigma_A}{\theta_{TA}}\widehat{W} \qquad (16)$$

Since informal unskilled wage falls, total employment of unskilled workers in sector A rises in this scenario with unionised wage in sector N. This is because, the reduction in flexible unskilled wage does not have any impact on determining the production in sector N (due to the unionised unskilled labour market in sector N) and thus, all the retrenched workers from sectors U, I and N now join sector A.

2. CASE II: Non-traded Production in Unorganised Informal Sector

However, 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, another alternative feature of the underlying economy should be to consider the scenario where the finished non-traded good being produced in the informal sector with unorganised labour market where unskilled labour receives market-determined (flexible) nominal wage (W). Typically, the non-tradable produced in the unorganised informal sectors[11] include items such as small domestic industries, services provided by petty traders or street-side vendors and so on. Therefore, variations in the demand for non-tradable are followed by the changes

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in both production and price of the non-tradable. The implications of input trade liberalisation in sector S on the wage earnings of the informal sector workers will be guided accordingly.

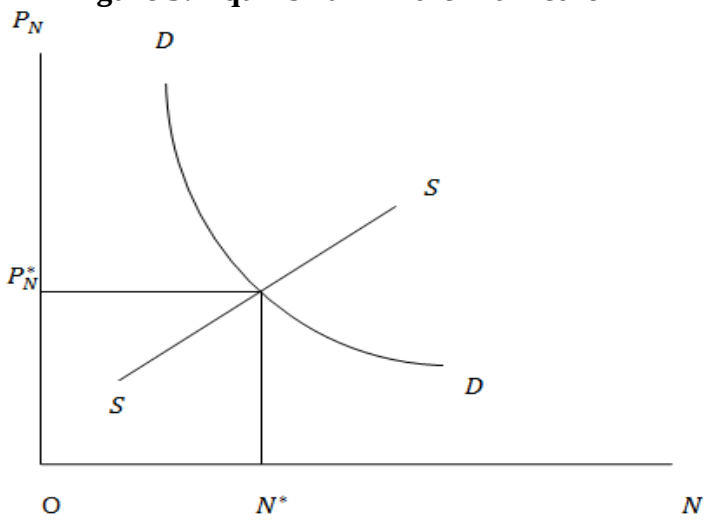
In case of contractual wages in the formal non-traded sector N, non-traded price was held fixed by the unionised unskilled money wage. But in case of non-traded good being produced in the informal sector with unorganised labour market where unskilled labour receives market-determined (flexible) nominal wage, production of N is no longer demand-determined. Consequently, P_N is not just cost-determined. Let me continue to assume a_{LN} is fixed (simplifying assumption). Therefore, the zero-profit condition for sector N in Equation (5) can now be re-written as

$$Wa_{LN} = P_N \qquad (5.1)$$

The prices and output levels in the formal sectors (U, I, S) can still be determined independent of the informal sectors (A, N). The remaining variables can be determined as follows. For a given P_N, Equation (5.1) determines the unskilled wage, W, which then solves for the return to land-capital, R, from the zero-profit condition in Equation (1). Given these values of W, R and the consequent input choices, the output levels of the agricultural exports (A) and non-tradable N, are determined from Equations (6) and (10) respectively. This yields a supply curve for the non-tradable, N as $N^S = S(P_N)$. An increase in P_N raises W and lowers R. The subsequent increase in intensity of land-capital usage lowers the agricultural output, which, along with the less intensive use of unskilled labour due to the higher unskilled-wage, releases some unskilled labour; accordingly the non-traded output increases. We, therefore, have a positive association between P_N and N^S. So the supply curve is positively sloped.

On the other hand, the demand relationship for the non-traded good N in Equation (11) now becomes a rectangular hyperbola in this case.

Figure 3: Equilibrium in the Market for N



i. Comparative Static Exercise – Decline in Tariff on Imports of M under Flexible Wage Production in Non-traded Sector

This interaction of demand for and supply of non-tradable N in determining its price and output levels has important implications on the wage gap between skilled and unskilled labour. Given (5.1), i.e., proportionality between P_N and W, it is immediate that whether the wage gap widens or declines following tariff cut on imports of M depends crucially on the movement of P_N. In the earlier case of the production of N with contractual unskilled money wage, it was only the demand-determined production of N, which was crucial. But now with the price of N no longer determined by the contracted unskilled nominal wage, supply of N is of no less importance in determining the movement in unskilled-wage.

Equation (15) now changes to

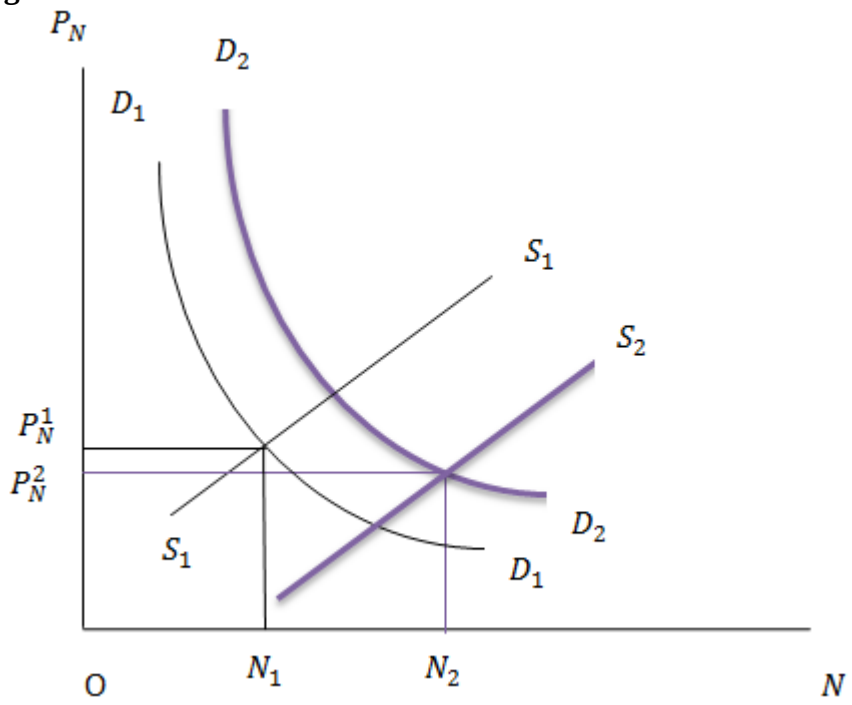
$$\theta_{LN}\widehat{W} + \widehat{N} = \mu\widehat{U} - \theta_{MS}T\hat{t}\,\frac{\sigma_S(1-\mu)\theta_{KS}}{\theta_{SS}} \qquad (15.1)$$

Therefore, when non-tradable is produced in the unorganised informal sector, one can get expression for $\widehat{W}$ under tariff reduction on the imported input M by solving Equations (13), (14) and (15.1) simultaneously.

From Equation (15.1) it can be inferred that given supply, the demand for non-tradable N is ambiguous for the same reason mentioned before while discussing Equation (15). Therefore,

the price of the non-traded good now may move in either direction. On the other hand, the supply effect depresses the non-traded price: At the initial P_N and hence at the initial W and A, unskilled labour released from the contracting sectors U and I relaxes the (net) labour constraint for the non-traded sector and thereby raises its supply. This additional supply effect imposes a downward pressure on unskilled wage and therefore reduces P_N. Figure 4 demonstrates the possibility where both demand for and supply of non-traded good increase but since supply increases by more than the increase in demand, price of the non-tradable falls from P_N^1 to P_N^2 while production of non-tradable rises from N_1 to N_2.

Figure 4: Comparative Static Response in the Domestic Market for N under Flexible Unskilled Wage



ii. Quantitative Analyses

Figure 5: Movements in Non-traded Production (N) & Informal Wage (W) following 24% Tariff-cut on Imports of M, for Different σ_S at μ=0.3 & μ=0.7, under Flexible Wage in Sector N

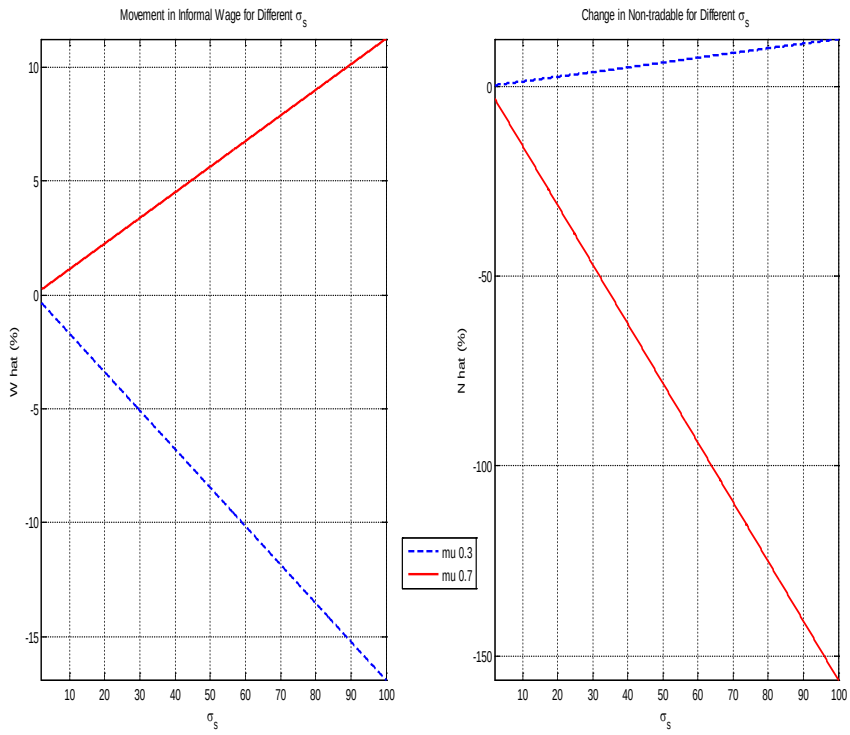
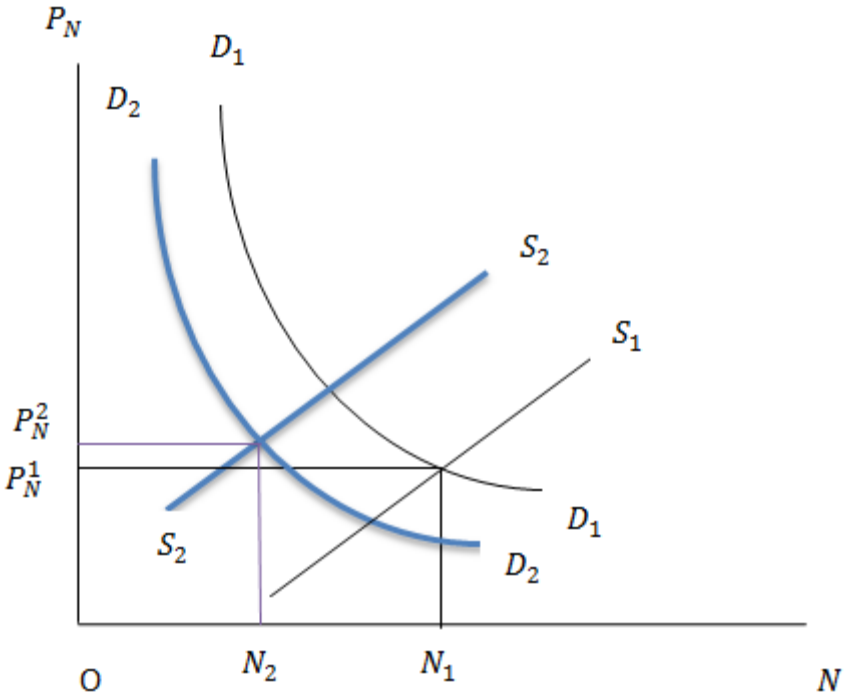


Figure 5 represents similar kind of sensitivity analysis as performed in Figure 2, however now **under the assumption of flexible unskilled wage in the non-tradable sector**. When μ =0.3, share of total urban income from sector S spent on non-traded good N is relatively high and hence there is a net increase in the demand for N (since sector S expands at the expense of sector U) at initial P_N. However, the increases in the supply of unskilled labour to sectors A and N depress W and therefore price of non-tradable. This yields the same scenario as the one depicted in Figure 4. Hence, as σ_S rises, expansion of sector S and consequent contraction of sectors U and I induce increase in non-traded production by dint of higher supply of unskilled labour, but reduction in W.

However, when μ =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. But this dominant supply effect leads to

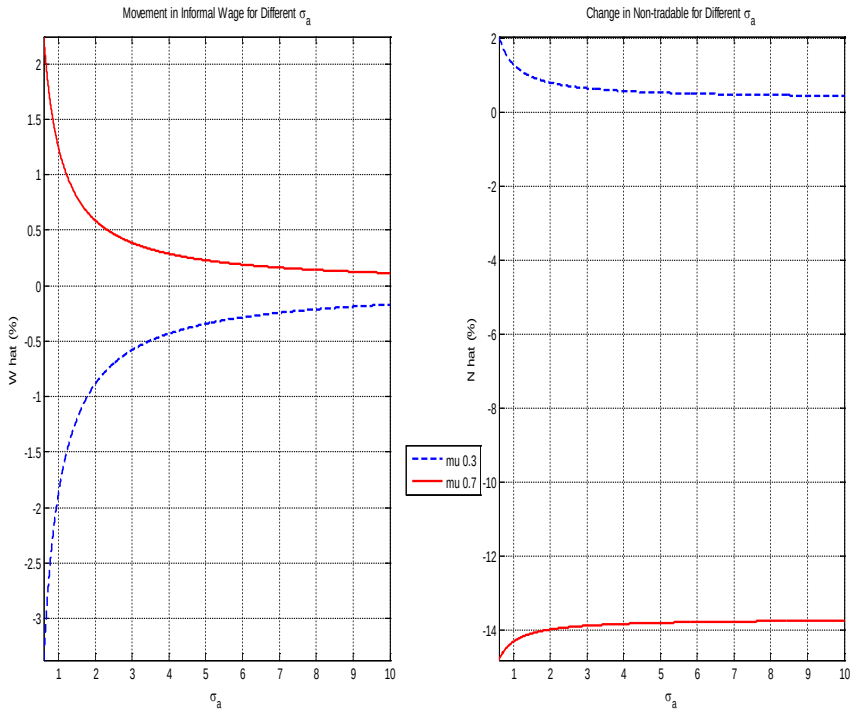
an increase in P_N (supply curve shifts upwards by more than the downward shift in demand curve, as shown in Figure 6 below). Given the proportional relationship between competitive unskilled wage and P_N, as laid in Equation (5.1), this latter effect outweighs the former impact on W and one should observe a net increase in W but a decline in non-traded production in Figure 5 for μ =0.7.

Figure 6: Comparative Static Response in the Domestic Market for N under Flexible Unskilled Wage with μ =0.7



Another interesting exercise has been tracing out the movements of production of N and resulting movement of W under flexible wage in the non-traded sector owing to a 24% tariff reduction on the imports of M by changing σ_A, the elasticity of substitution between unskilled labour and land-capital in the agricultural sector, from 0.6 to 3. This analysis has been motivated by an interesting observation in Golder et al. (2014) who have reported that σ_A can either be approaching to or more than unity, with preferred estimated value as 1.2 (obtained by direct estimation of CES production function using non-linear least squares approach) that has been taken as the benchmark value in the earlier analyses for varying σ_S. For the sake of brevity this paper only examines this under flexible W assumption in sector N, since that renders seemingly counter-intuitive results.

Figure 7: Movements in Non-traded Production (N) & Informal Wage (W) following 24% Tariff-cut on Imports of M, for Different σ_A at μ=0.3 & μ=0.7, under Flexible Wage in Sector N



Although the retrenched unskilled workers from sectors U and I flow to sectors A and N, when μ =0.3, producers in sectors N demand more of the unskilled workers. This will raise the demand for unskilled workers in sector N, imposing an upward pressure on informal wage ($\widehat{W}$ starts becoming less negative in Figure 7). Given Equation (5.1), this leads to an increase in non-traded price and subsequent reduction in the supply of N. This additional supply effect induces sector N to release some unskilled labour to sector A. For low values of σ_A, even with the increase in W producers in sector A would be relatively less willing to substitute unskilled labour by land-capital and continue to demand unskilled labour for the expansion of sector A. Thus, W continues to go up for low values of σ_A, but after a certain level, for relatively higher values of σ_A, producers in sector A substitute land-capital for relatively costlier unskilled labour that imposes a downward pull on W and consequently on P_N. These retrenched unskilled workers from sector A will now migrate to sector N and that exerts an upward push on non-traded production.

Therefore, the resultant trajectory of $\widehat{N}$ takes a convex (to the origin) pattern while that of $\widehat{W}$ **takes a concave (from the origin) pattern from lower to higher values of σ_A** for μ =0.3.

For μ =0.7, demand for N falls by the urban consumers as a net effect whereas retrenchment of unskilled workers from sectors U and I leads to an excess supply of unskilled labour in the competitive unskilled labour market of sector N and thereby reducing W. However, with the increase in σ_A, producers in sector A are going to substitute land-capital by labour in production that imposes a consequent upward pressure on W, which, in turn, would increase P_N, implying a subsequent reduction in supply of N. Therefore, **exactly mirror images to those for μ =0.3 in the trajectories of $\widehat{N}$ and $\widehat{W}$** (i.e. concave from the origin for $\widehat{N}$ and convex to the origin for $\widehat{W}$) are observed from lower to higher values of σ_A for μ =0.7.

iii. 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

$$\widehat{L_A} + \widehat{L_N} = \left(\theta_{LN} - \frac{\sigma_A}{\theta_{TA}}\right)\widehat{W} \qquad (16.1)$$

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.

3. Expression for Relative Wage Inequality

Since the unskilled labourers are entitled to receive either the flexible wage in the informal unorganised sector or the 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.

i. Non-tradable Production under Contractual Wage

With flexible wage in sector A but unionised wage in sectors U, I and N the expression for the average unskilled wage in the economy becomes the weighted average of total money wage paid in respective sectors, when the weights are employment shares of respective sectors.

$$W_A = W\lambda_{LA} + W^*(\lambda_{LI} + \lambda_{LU} + \lambda_{LN})$$

$$\text{Or, } W_A = W^* - (W^* - W)\lambda_{LA}$$

Since $\sum_i \lambda_{Li} = 1$, where $i = A, I, U, N$.

Therefore,

$$dW_A = dW\lambda_{LA} - Wd\lambda_{LA}$$

Or,

$$\widehat{W_A} = (W\lambda_{LA}/W_A)\widehat{W} - (W\lambda_{LA}/W_A)\left(\hat{a}_{LA} + \hat{A}\right)$$

Since $\lambda_{LA} = (a_{LA}A/\bar{L})$. Therefore,

$$\widehat{W_A} = (W\lambda_{LA}/W_A)\left(1 + \frac{\sigma_A}{\theta_{TA}}\right)\widehat{W} \qquad (17)$$

Therefore, $\widehat{W_A} < 0$ if W falls owing to tariff-cut on the imports of M.

ii. Non-tradable Production in the Informal Sector with Flexible Wages

Just like before, it can be shown that

$$\widehat{W_A} = (W/W_A)\widehat{W}(\lambda_{LA} + \lambda_{LN}) + \{(W^* - W)/W_A\}(1 - \lambda_{LA} - \lambda_{LN})\widehat{U} \qquad (18)$$

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 in both CASE I and CASE II would be

$$\Omega = W_S/W_A$$

Or,

$$\widehat{\Omega} = \widehat{W_S} - \widehat{W_A} \tag{19}$$

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, on the basis of the observations from Figure 2 and Figure 5:

Table 1: Tariff-cut on Imports of M and Directions of Relative Wage Inequality for Rising σ_S

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

III. EXTENDED MODEL WITH UNEMPLOYMENT OF SKILLED LABOUR[12]

The reason for inclusion of this section is to demonstrate the readers a more realistic scenario with full employment of unskilled labour but unemployment of skilled labour within the

[12] See Appendix 2 for detailed derivations of the key algebraic expressions. I am grateful to Prof Oliver Morrissey (University of Nottingham, UK) for his constructive comments, which has lead to the inclusion of this section.

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, in a similar fashion of Gupta and Dutta (2011) where efficiency of a skilled labourer varies positively with its wage rate and the unemployment rate in the skilled labour market.[13] A higher wage rate motivates the skilled worker to work hard; and a higher unemployment rate accentuates the disutility in the presence of a threat of firing and subsequently makes the skilled worker more disciplined.

[13] In this context, one may also consult works of Agell and Lundborg (1992, 1995), Gupta (2000), Chaudhuri and Banerjee (2010) and so on.

Table 2: Structure of the Extended Model

<table>
<tr><th rowspan="2">No. of Primary Sectors</th><th colspan="4">Sector-definitions</th><th rowspan="2">Skilled Labour Market</th><th rowspan="2">Unskilled Labour Market</th><th rowspan="2">Particulars regarding other Inputs</th><th rowspan="2">Simplifying Assumptions</th></tr>
<tr><th>Name of the Sectors</th><th>Tradability of the Sectors</th><th>(In)Formality of the Sectors</th><th>Factor Usage</th></tr>
<tr><td rowspan="4">4</td><td>A</td><td rowspan="3">Internationally traded</td><td>Informal</td><td>L, T</td><td rowspan="3">There exists unemployment of skilled labour at the rate $v > 0$. Efficiency of a skilled worker, $h = h(W_S, v)$, with $h_1 > 0, h_2 > 0, h_{11} < 0, h_{22} < 0$. Skilled wage per efficiency unit = $\left(\frac{W_S}{h}\right)$.</td><td rowspan="2">Formal Sectors: Unionised labour market, with institutionally given wages set by prior negotiations.</td><td>Capital (K) perfectly mobile between U (with sub-sector I) & S</td><td rowspan="3">Constancy of a_{LN}, a_{MS} & a_{IU} are retained.</td></tr>
<tr><td>U (with sub-sector I)</td><td rowspan="2">Formal</td><td>L, K</td><td>Land (T) is specific to sector A.</td></tr>
<tr><td>S</td><td>L_S, K, M</td><td>Informal Sector(s): Non-unionised labour market with flexible competitive wages.</td><td>There is an advalorem rate of tariff (t)on imports of M.</td></tr>
<tr><td>N</td><td>Internationally non-traded</td><td>Formal/Informal</td><td>L</td></tr>
</table>

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

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

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 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 terms of every argument).

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.

Micro foundations of such an efficiency function are available in several well-known works including Shapiro and Stiglitz (1984), Pisauro (1991), Gupta and Gupta (2001) etc. Minimising (W_S/h) with respect to W_S the following first-order condition of minimisation can be obtained as

$$(\partial h/\partial W_S)(W_S/h) = 1 \qquad (20)$$

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

$$\widehat{W_S} - \hat{h} = -\varepsilon_v \hat{v} \qquad (21)$$

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

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

$$\widehat{W_S} - \hat{h} = -(\theta_{MS}/\theta_{SS})T\hat{t} > 0 \qquad (22)$$

Therefore, using Equations (21) – (22) it is straightforward to obtain

$$\hat{v} = (\theta_{MS}/\varepsilon_v\theta_{SS})T\hat{t} < 0 \qquad (23)$$

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

$$\widehat{W_S} = [\varepsilon_v h / h_{11}(W_S)^2]\hat{v} > 0 \qquad (24)$$

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, $\overline{L_S}$)

$$a_{SS}S = \overline{L_S}(1-v)h \qquad (8.1)$$

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

$$\widehat{U} = \hat{I} = \{\lambda_{KS}/(1-\lambda_{KS})\}\left[\left\{\left(\frac{v}{1-v}\right) + (\sigma_S - 1)\varepsilon_v\right\}\hat{v} - \widehat{W_S}\right] \qquad (25)$$

And

$$\hat{S} = \widehat{W_S} + \left[-\left(\frac{v}{1-v}\right) - (\sigma_S\theta_{KS} - 1)\varepsilon_v\right]\hat{v} \qquad (26)$$

Therefore, if $\sigma_S \geq (1/\theta_{KS})$, $\hat{S} > 0$ and $\widehat{U}\left(=\hat{I}\right) < 0$ as $\widehat{W_S} > 0, \hat{v} < 0$. 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,[14] derived as $\Delta = (W_S/W_A)$, as before:

$$G = \frac{\overline{L_S}v\{\overline{L_U}+\overline{L_S}(1-v)\Delta\}+(\overline{L_S})(\overline{L_U})(1-v)(\Delta-1)}{(\overline{L_S}+\overline{L_U}-1)\{\overline{L_U}+\overline{L_S}(1-v)\Delta\}} \qquad (27)$$

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*

[14] 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 (one can see Gupta and 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.

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, 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.

Likewise the full-employment scenario, in case of production under unionised wage, the expression in Equation (15) changes to

$$\widehat{N} = \left(1 - \left({}^{\mu}/_{1-\lambda_{KS}}\right)\right)\begin{bmatrix} \{h/h_{11}(W_S)^2\} - \\ \left({}^{v}/_{1-v}\right) \\ \left({}^{\lambda_{KS}}/_{1-\lambda_{KS}}\right)\sigma_S(1-\theta_{KS}) \end{bmatrix}\varepsilon_v(\theta_{MS}/\varepsilon_v\theta_{SS})T\hat{t} \qquad (28)$$

Since $h_{11} < 0$, the bracketed expression is negative. So Equation (28) yields $\widehat{N} \lessgtr 0$ when $\hat{t} < 0$ iff $\mu \gtrless (1-\lambda_{KS})$. Therefore, as in the full-employment case, under contractual wage in the finished non-tradable producing sector (N), the resultant impact on the production of N depends on the magnitude of μ (and/or equivalently, on $(1-\mu)$), or in other words, on the relative domestic demand for the non-tradable by urban population working in vertically integrated sector U (and sector I) and/or sector S. As discussed above, 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. Thus, Equation (28) states that 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.

Substituting $\widehat{N}$ in Equation (13), one can solve for $\widehat{W}$ under the scenario when the production in sector N is organised in a unionised unskilled labour market. Assigning λ_{KS} the benchmark value of 0.4 as before,[15] μ =0.3 and μ =0.7 mimic exactly the similar trajectories for the

[15] See Table A3 in Appendix.

changes in non-traded production and informal wage as in Figure 2 (however, non-linearity would be observed due to the presence of quadratic terms in the expressions).

In case of non-traded production with flexible unskilled wage, Equation (28) is changed to

$$\theta_{LN}\widehat{W} + \widehat{N} = \left(1 - \left({}^{\mu}/_{1-\lambda_{KS}}\right)\right)\begin{bmatrix} \{h/h_{11}(W_S)^2\} - \\ \left({}^{v}/_{1-v}\right) \\ \left({}^{\lambda_{KS}}/_{1-\lambda_{KS}}\right)\sigma_S(1-\theta_{KS}) \end{bmatrix}\varepsilon_v(\theta_{MS}/\varepsilon_v\theta_{SS})T\hat{t} \qquad (29)$$

Solving this equation 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.

Therefore, as before, the effect on real income of the urban population and the demand for the non-tradable will be ambiguous. Consequently, the direction of change in competitive informal wage (W) and thereby the direction of change in Gini will also be ambiguous in this extended model as well for either of the scenarios – with unionised unskilled labour market in sector N and with flexible unskilled wage in sector N.

Therefore, in qualitative terms, the resultant implications on unskilled informal wage and the relative income-inequality are very similar to the results obtained under the full-employment model considered in Section 2, which demonstrates the robustness of the results obtained under the full-employment model.

IV. CONCLUDING REMARKS

Growth acceleration in skill-intensive sectors 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 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 re-establishes the claim put forward by Marjit and Acharyya (2003) that the organisation of production of the non-traded final good, with varying elasticities of factor substitution in skill-intensive and agricultural production respectively, is indeed important in quantification of the impact on unskilled informal wage and subsequently, on the degree of wage inequality. Therefore, this paper challenges the view that the relative wage inequality in a DC like India with rigid organised sector labour market has unequivocally been governed only by the increase in the skilled wages. The sector-level general equilibrium approach adopted in this paper has not only been able to enlighten the role of various degrees of factor substitutability in production organised in different sectors, but also to highlight the role of non-traded consumption goods in determining the supply of unskilled labour to the informal (unorganised) sector and consequently the implication on competitive unskilled wage and subsequently, the direction of the relative wage gap. Finally, an extended framework with unemployment of skilled labour has also been presented that effectively yields similar conclusions obtained under full-employment model and thus demonstrates the robustness of the full-employment results. Therefore, the relationships and results are indeed important to formulate policies aiming at betterment of the position of the unskilled poor workers. However, 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.[16]

APPENDICES

Appendix 1: The General Equilibrium Structure at a Glance

[16] This is now work in progress.

Table A1: Full-employment Model

VARIABLES			KEY EQUATIONS DESCRIBING FULL-EMPLOYMENT MODEL WITH UNIONISED UNSKILLED LABOUR MARKET IN SECTOR N		KEY EQUATIONS DESCRIBING FULL-EMPLOYMENT MODEL WITH FLEXIBLE UNSKILLED WAGE IN SECTOR N		SIMPLIFYING ASSUMPTIONS
ENDOGENOUS	EXOGENOUS	POLICY-PARAMETER(S)	PRICE SUBSYSTEM (PRICE = UNIT COST)	QUANTITY (OUTPUT) SUBSYSTEM (FULL EMPLOYMENT/UTILISATION OF FACTORS)	PRICE SUBSYSTEM (PRICE = UNIT COST)	QUANTITY (OUTPUT) SUBSYSTEM (FULL EMPLOYMENT/UTILISATION OF FACTORS)	CONSTANCY OF a_{IU} & a_{MS}
$W, W_S, R, r, P_I, P_N, A, U, S, I, N$	$P_A^*, W^*, P_U^*, P_M{}^*, P_S{}^*\bar{T}, \bar{K}, \bar{L_S}, \bar{L}$	t	EQUATIONS (1) – (5)	EQUATIONS (6) – (11)	EQUATIONS (1) – (4), (5.1)	EQUATIONS (6) – (11)	

Table A2: Model with Unemployment of Skilled Labour

VARIABLES			KEY EQUATIONS DESCRIBING MODEL WITH UNIONISED UNSKILLED LABOUR MARKET IN SECTOR N		KEY EQUATIONS DESCRIBING FULL-EMPLOYMENT MODEL WITH FLEXIBLE UNSKILLED WAGE IN SECTOR N		SIMPLIFYING ASSUMPTIONS
ENDOGENOUS	EXOGENOUS	POLICY-PARAMETER(S)	PRICE SUBSYSTEM (PRICE = UNIT COST)	QUANTITY (OUTPUT) SUBSYSTEM (FULL EMPLOYMENT/UTILISATION OF FACTORS)	PRICE SUBSYSTEM (PRICE = UNIT COST)	QUANTITY (OUTPUT) SUBSYSTEM (FULL EMPLOYMENT/UTILISATION OF FACTORS)	CONSTANCY OF a_{IU} & a_{MS}
W, W_S $v, R, r, P_I, P_N, A,$ U, S, I, N	$P_A^*, W^*, P_U^*, P_M{}^*, P_S{}^*\bar{T}, \bar{K}, \bar{L_S}, \bar{L}$	t	EQUATIONS (1) – (3), (4.1), (5), (20)	EQUATIONS (6) – (7), (8.1), (9) – (11)	EQUATIONS (1) – (3), (4.1), (5.1), (20)	EQUATIONS (6) – (7), (8.1), (9) – (11)	

Appendix 2: Detailed Algebraic Derivations

(a) The Full-employment Model:

Total differentiation of Equation (6.4) allows one to write

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

Since, $dP_S^* = 0$.

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

$$\left(\theta_{SS}\widehat{W_S} + \theta_{KS}\hat{r}\right) + (\theta_{SS}\widehat{a_{SS}} + \theta_{KS}\widehat{a_{KS}}) = -\theta_{MS}T\hat{t} \quad \text{(A.2)}$$

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

$$\theta_{SS}\widehat{a_{SS}} + \theta_{KS}\widehat{a_{KS}} = 0 \quad \text{(A.2.1)}$$

This is known as 'envelope condition'.

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

$$\theta_{SS}\widehat{W_S} + \theta_{KS}\hat{r} = -\theta_{MS}T\hat{t} \quad \text{(A.3)}$$

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 $\hat{r} = 0$ 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 it is obtained (note that $\theta_{SS} + \theta_{KS} = 1$)

$$\widehat{a_{SS}} = -\sigma_S \theta_{KS} \widehat{W_S} \tag{A.5}$$

Totally differentiating Equation (8), one can obtain

$$(da_{SS}/a_{SS}) + (dS/S) = d\overline{L_S}/\overline{L_S} = 0 \tag{A.6.1}$$

Or,
$$\hat{S} = -\widehat{a_{SS}} \tag{A.6.2}$$

Therefore, substituting $\widehat{a_{SS}}$ from Equation (A.5) into Equation (A.6.2) it is found

$$\hat{S} = \sigma_S \theta_{KS} \widehat{W_S} \tag{A.7}$$

Since $\widehat{W_S} > 0$ when $\hat{t} < 0$, $\hat{S} > 0$. ■

Similarly, totally differentiating Equation (6) one should obtain

$$\hat{A} = -\widehat{a_{TA}} \tag{A.8}$$

Therefore,

$$\widehat{L_A} = \widehat{a_{LA}} + \hat{A} = \widehat{a_{LA}} - \widehat{a_{TA}} \tag{A.9}$$

Just like before, using the definition of elasticity of factor substitution in sector A one obtains

$$\widehat{a_{LA}} - \widehat{a_{TA}} = -\sigma_A\left(\widehat{W} - \hat{R}\right) \tag{A.10}$$

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

$$\theta_{LA}\widehat{W} + \theta_{TA}\hat{R} = 0 \tag{A.11}$$

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

$$\left(\widehat{W} - \hat{R}\right) = \widehat{W}/\theta_{TA} \tag{A.12}$$

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

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

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

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

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

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

Rewriting Equation (A.14) as

$$\lambda_{LA}\left(\hat{A} + \widehat{a_{LA}}\right) + \lambda_{LI}\hat{I} + \lambda_{LU}\hat{U} + \lambda_{LN}\hat{N} = 0 \quad \text{(A.15)}$$

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 Equations (9.1) and (A.4) it is found

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

Substituting for $\widehat{W_S}$ from Equation (12) into Equation (A.16) it is straightforward to obtain $\hat{U} = \hat{I}$ as in Equation (14). ■

Totally differentiating Equation (11) in the text, I find

$$\mu\hat{U} + (1-\mu)\hat{S} = \widehat{P_N} + \hat{N} \quad \text{(A.17)}$$

In case of unionised wage in the non-traded sector N, $\widehat{P_N} = 0$ that yields Equation (15) while in case of flexible wage in sector N, $\widehat{P_N} = \theta_{LN}\widehat{W}$ yielding Equation (15.1) in the text. ■

(b) Extended Model with Unemployment of Skilled Labour:

Solving Equation (20), 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 (20) 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 (20) we have

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

Using Equations (20) and (A.22) we have

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

Solving Equation (A.23) it is now straightforward to obtain $\widehat{W_S}$ as in Equation (24). ■

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

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

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

$$\lambda_{KS}\left\{(\widehat{a_{KS}} - \widehat{a_{SS}}) + \hat{h} - \hat{v}\left(\frac{v}{1-v}\right)\right\} + (\lambda_{KI} + \lambda_{KU})\widehat{U} = 0 \tag{A.25}$$

Since now we have $(\widehat{a_{KS}} - \widehat{a_{SS}}) = \sigma_S(\widehat{W_S} - \hat{h})$, therefore, Equation (A.25) gives Equation (25) in the text. ■

Similarly, substituting $\widehat{a_{SS}} = \sigma_S\theta_{KS}(\widehat{W_S} - \hat{h})$ in Equation (A.24) and a little algebraic manipulation yields Equation (26) 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*	$0.4 = (1 - \theta_{LA})$
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*	$[0.6, 1.2, 3]$

Source: Abraham 2010, Berman et al. 2005, Marjit and Kar 2008, Marjit et al. 2011, Seker & Rodriguez-Delgado (2011), Broda et al. (2006) (for the ranges of σ_S) and Golder et al. (2014) (for ranges of σ_A).

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