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The New Ricardian Specific Factor Model

Abstract

This paper explores the implications on trade and wage inequality of introducing financial capital or credit in the standard Ricardian model of production, where a given amount of start-up credit is used to employ sector specific skilled and unskilled workers following the Wage Fund approach of classical economists. Thus, we have the Specific Factor (SF) structure of Jones (1971) in a new Ricardian model (NRM) with credit and two types of labour. With an *entirely different mechanism* from the conventional Neo-Classical structure, distributional consequences of changes in endowments, commodity prices, and financial capital are established. Comparisons with Jones (1971) show that unlike SF model, credit expansion affects wages and nominal costs without affecting trade patterns, while rise in the relative price of the skill-intensive good causes skilled wage to hike less than proportionately, and may cause return to capital to inflate more than the wages. We extend the basic model to analyse immigration, unemployment and imperfect credit market.

JEL-Codes: B120, B130, B170, F110, F630, F650, F160, O120.

Keywords: wage-fund, specific factor, Ricardo, inequality, credit, general equilibrium.

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I am dedicating this paper to Ronald Jones, my teacher and one of the pioneer builders of Trade Theory. The paper has been benefitted by comments from Biswajit Chatterjee, Arye Hillman, Nori Nakanishi and Ramprasad Sengupta and from the participants at invited webinar presentations at the St. Xaviers College, Kolkata, Indira Gandhi Institute of Development Research, Mumbai. IISER, Bhopal, India and Indian Institute of Foreign Trade. The usual disclaimer applies.

1. Introduction:

In the discipline of international trade theory, although the Heckscher-Ohlin model and its variants have gained attention (see Jones and Kenen 1984, Jones 2018), the significant contribution in trade theory encompasses multi-dimensional extensions using general equilibrium framework covering multi-faceted issues in different contexts. Jones (1965, 1971) is a pioneering contribution and one of the chief architects in this area. However, the Specific Factor (henceforth, SF) model of Jones (1971) is one of the most cited papers in trade theory, which has been extended by many in several sub-disciplines of economics. Jones (1985, 2012, and 2018) discusses delineating features of such workhorse of models of trade theory. Interested readers may also look at Samuelson (1971), Musa (1974, 1982), Ruffin and Jones (1975), Neary (1978), etc. Apart from these, applications or extensions of SF model can be found in Beladi and Marjit (1992), Eaton (1987), Hillman and Ursprung (1988), Jones and Marjit (1985, 2003, 2009), Jones and Dei (1983), Marjit (1991), Marjit and Kar (2018), Mayer (1984), Marjit, Broll and Mitra (1997), Sanyal and Jones (1982), Das (2018)-to name a few. Even the model has been used as a popular pedagogical tool (Caves, Frankel and Jones 2007, Tohamy and Mixon Jr. 2003).

However, the literature on trade has ignored the implications of credit—financial capital or, entrepreneurial finance--in financing the expansion of an industry of importance. Wage-fund theory –in the history of economic thought –is developed in the classical model where unemployment (surplus labor) prevails at a given fixed real wage. This has been ascribed to Ricardo (1817), Mill (1848), and later extended in a Neo-Classical framework by Hicks and Hollander (1977), Steedman (1979), Mansechi et al. (1983), Egger and Keuschnigg (2015) etc.—to name a few. Using typical Neo-Classical assumptions of diminishing marginal returns (DMR, henceforth) to factors of production, such as, labor, and the marginal productivity theory (MP, henceforth) with Constant Returns to scale (CRS), they captured the wage-unemployment nexus. Jones and Weder (2017) have analysed the evolution of 200-years' old history of Ricardian theory of comparative advantage[1] and the latest research extending the theory. Ours is a contribution blending Ricardo and SF model.

Our point of departure--on a different angle--is based on: (i) incorporating the notion of wage-fund in a Ricardian trade model with full employment; (ii) setting aside the features of DMR and/or, DMP; (iii) ruling out the scope of factor substitution (measured by elasticity of substitution) due to factor-price changes. Thus, based on the recent introductory model of

[1] In fact, Ricardo's 1817 original 'On Foreign Trade' is included in the book.

Marjit (2020) with one homogeneous type of labor, we extend the framework to distinguish labour-types as per skill content, trace the dynamics of wage-inequality and other contemporary issues, such as, role of trade-technology interactions for driving inequality, and provide reinterpretation of Piketty (2013). Crucial thing is the assumption that given the size of the labor force in general, and the wage-fund that finances hiring of workers, supply of credit determines the wage (flexibly) as full employment prevails. Thus, real wage is endogenous. In this paper, we show how it affects pattern of trade, returns to factors under different comparative-statics scenarios. Next section develops the model. Section 3 derives equations of change. Section 4 considers some extensions, viz., immigration, unemployment and the case of imperfect credit market. Section 5 concludes.

2. The Model

We assume perfect competition in both the product and factor markets so that each agent is atomistic in their respective domains. Consider two sectors producing X and Y with only labour and the structure of production and market are the same as in Marjit (2020). Nevertheless, the labour required is sector specific. X uses skilled labour (S) with a given supply of them and Y uses fixed amount of unskilled labour (L), with wages W_s and W respectively. Also, assume a small open economy.

Following notations are used:

S: skilled labor with wage W_s,

L: Unskilled labor with wage W,

K: Wage-fund, or Credit or Entrepreneurial Finance

X = Production of Skilled sector

Y = Production of Unskilled sector

P_i = Price of the i^{th} good, $\forall$ i = X, Y

a_x: Unit skilled-labor requirement for X-sector

a_y: Unit unskilled-labor requirement for Y-sector

"$\wedge$" = proportional changes for a variable, *say V*, such that generically $\widehat{V} = \frac{dV}{V}$.

As K is the wage-fund that has to be allocated in two sectors, therefore,

$$K = W_sS + WL \qquad (1)$$

The competitive price conditions in two sectors are given by,

$$W_s a_x(1+r) = P_x \qquad (2)$$

$$W a_y (1+r) = P_y \qquad (3)$$

Full-employment in labor markets implies:

$$\frac{S}{a_x} = X \qquad (4)$$

$$\frac{L}{a_y} = Y \qquad (5)$$

We choose price of the second good (Y) as the *numeraire*, set it equal to 1, and ***'r'*** is the return to K. We measure everything in the units of 'Y'. Thus, '**P**' is the relative price in terms of the numeraire (**=** $\mathbf{P_X/P_Y}$). Regarding relative Demand (RD), we assume negatively sloped homothetic demand as below:

$$\frac{D_x}{D_y} = f(P) \qquad (6)$$

The upward-sloping relative supply (RS) is given by:

$$f(P) = \frac{X}{Y} \qquad (7)$$

We have (7) equations to solve for W_s, W, (1+r), X, Y, and P. RS-RD jointly determine market-clearing condition or equilibrium. Given P, we need to solve for wages and return (r) to K. P will be determined by relative labour coefficients as in a standard Ricardian model and remain frozen there. Note that we have already internalized the demand and supply of workers by (1). This is actually summary of demand for workers of types S and L and two full employment conditions matching demand and supply for S and L. From (1) – (5), we get

$$K = W_s a_x X + WL$$

From (2) and (3), we write:

$$\frac{W_S a_x}{W a_y} = P \qquad (8)$$

$$\Rightarrow K = PWa_y X + WL \Rightarrow$$

$$K = PWa_y \frac{S}{a_x} + WL \qquad (9)$$

Further, assuming $A = {a_y}/{a_x}$ and using (8) we can infer:

$$K = W(PAS + L) \qquad (10)$$

$$W_s = W.A.P \qquad (11)$$

Unlike Marjit (2020), here unit labour coefficients are not unity[2]. Outputs depend on endowments of S, L, and technological coefficients (or, productivity), and prices (not on 'K' directly). 'K' remains '***outside***' the production process unlike the traditional Neo-Classical model where it remains '***inside***' allowing for input-substitution being triggered by relative

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[2] Without loss of generality, we can assume that $\widehat{A} \neq 0$ when we have technical progress with differential rates across heterogeneous labor types (e.g., Skill-Biased Technical Change-SBTC) on which more to follow in subsequent discussions.

factor-price movements. Therefore, outputs (X and Y) are *independent* of K as in Marjit (2020), and are determined entirely by the supply of S and L.

In fact, given such relative supplies of outputs a homothetic demand function defined over two goods would yield an equilibrium P that clears the market. Given equilibrium P, Equation (10) determines W and then from (2) and (3), W_s is determined as it is equal to WAP (Eq. 11). Then we determine 'r'. This completes the description of the equilibrium.

The model looks exactly like the SF model or the Ricardo-Viner model of Jones (1971) and Samuelson (1971) based on Neo-classical production theory. Just to recall, in these models if we plug in the full employment condition of specific labour into the capital constraint, we get a similar condition as in (1). However, notion of capital and production here are very much different. Now from (10), we get—given 'A', S and L endowments—'W' is endogenously determined by 'K' as:-

$$W = \frac{K}{PAS + L} \tag{12}$$

Hence, the allocation of K is divided into two sectors and the amounts are: 'WPAS' for skilled sector X and 'WL' for unskilled Y-sector. Correspondingly, Capital-Labour ratios for X and Y are: [PKA/(PAS + L)] and [K/(PAS + L)] respectively. These can be construed as per capita credit allocation across labor types. Given this allocation (with fixed K) and given the respective wage rates for each skill categories, it will determine the demand for S and L. For instance, using (12) we can write '*K/W*' (=PAS+L) as unskilled labor demand, so that with given supply, we get equilibrium for L-market. Analogously, using (8) we get:

$$W_s = \frac{PAK}{(PAS + L)} \tag{13}$$

Thus, 'K/Ws' [=(PAS+L)/PA] is demand for skilled workers.

From (12) and (13), we find share of skilled workers in K: $\lambda_{SK} = \frac{W_S S}{K} = \frac{PAS}{PAS + L}$ and share of unskilled laborers in K: $\lambda_{LK} = (1 - \lambda_{SK}) = \frac{WL}{K} = \frac{L}{PAS + L}$.

Section 3 offers comparative-statics results for changes in S, L, and P.

3. Comparative Static Results

Assuming a small open economy, we consider parametric changes and compare the outcomes of the SF model and the new Ricardian specific factor model (NRM) for a given *P*.

3.1 The Endowment Effects

Proposition 1: *Given* $\overline{S}, \overline{L}$ *and* $\overline{P}$, *if* $\widehat{K} > 0$ *then* $\widehat{W_s} > 0$ *and* $\widehat{W} > 0$ *as well, whereas* $\widehat{(1+r)} < 0$. *On the other hand, given* $\overline{K}$, *if* $\hat{S} > 0, \hat{L} > 0$ *then* $\widehat{W_s} < 0$ *and* $\widehat{W} < 0$, $\widehat{(1+r)} > 0$.

Proof: The results are straightforward from Eqs. (12) and (13).

Here $\widehat{K} > 0, \widehat{S} = 0 = \widehat{L}$ and $\widehat{P} = 0$. From Eq. (12) and (13), using 'hat' calculus (Jones 1965), we derive: $\widehat{W_s} = \widehat{W} = \widehat{K} > 0$. This is alike Quantity theory postulates without any changes in relative wages. Given (2) and (3), we write the following change-equations as:

$$\widehat{W_S} + \widehat{(1+r)} = \widehat{P} \text{ (being numeraire, } P_Y = 1) \quad (14)$$

Hence, $\widehat{P} = 0 \Rightarrow \widehat{(1+r)} = -\widehat{W_s} = -\widehat{W}$

This implies: $\widehat{(1+r)} = \dfrac{\hat{r}r}{(1+r)} < 0$. This proves that given 1>r>0, $\hat{r} < 0$. (QED.)

When $\widehat{S} > 0, \widehat{K} = 0 = \widehat{L}$ and $\widehat{P} = 0$, from Eq. (13) and (14) we derive:

$$\widehat{W_s} = -\frac{\widehat{S}.PAS}{(L + PAS)} < 0 \text{ (given } \widehat{S} > 0).$$

Also. $\widehat{P} = 0 \Rightarrow \widehat{(1+r)} = -\widehat{W_s} = -\widehat{W}$. This implies: $\dfrac{\hat{r}r}{(1+r)} > 0$ and $\hat{r} > 0$.

Analogously, for 'L' sector if $\widehat{L} > 0, \widehat{S} = 0 = \widehat{K}$ and $\widehat{P} = 0$.

Similarly, $\widehat{W} = -\dfrac{\widehat{L}L}{PAS + L} < 0$ (given $\widehat{L} > 0$) and $\widehat{(1+r)} > 0 \Rightarrow \hat{r} > 0$. (QED).

Here credit expansion triggers demand for labour types—as more K enables entrepreneur to engage in furthering production of X and Y—causing W_s and W to rise, inducing fall in 'r'. However, given demand for S from the credit side, increase in 'S' causes W_s to fall, 'r' rises (given P), consequently 'W' has to fall. The results are identical to the SF model (Jones 1971). In the NRM, without the assumptions of CRS flexible production technology as in a Neo-Classical framework, DMRS, MP theory and elasticity of factor substitution, we derive the same comparative static effects in a full-employment model. Consequently, the proofs are simpler than in the case of 2-sector×3-factor SF-model (Caves, Frankel and Jones, 2007). Thus, in the NRM model with fixed coefficient technology, labor as input, and wage-fund as capital remaining outside the production process (except supplying funds to support production), capital accumulation is necessary for 'wages' to increase. Capital-labor and wage-rental ratios move together. Increase in K has a positive effect on wage rates. Here prices and wages determine 'r'. Rise in 'r' causes share of labor income to fall. The *mechanism is entirely different* unlike SF model.

Corollary 1: Given fixed $\overline{S}, \overline{L}$, if $\widehat{K} > 0$, direction of inequality will depend on (relative) movements of price (P) vis-à-vis the ratio of technology coefficients (A).

Proof: Following from Proposition 1, we can easily infer the followings:-

With $\widehat{P} = 0 = \widehat{A}$, endowment changes causes return to factor incomes to rise or decline depending on which factor expands. Given K, the results of augmentation of skilled as well as unskilled workers are uniform, viz., $\widehat{W_s} < 0, \widehat{W} < 0, \hat{r} > 0$. Further Eq. (11) implies: $\widehat{\left(\frac{W_s}{W}\right)} = (\widehat{P} + \widehat{A}) \Rightarrow \widehat{\left(\frac{W_s}{W}\right)} > 0$, iff $(\widehat{P} + \widehat{A}) > 0 \Rightarrow \widehat{W_s} > \widehat{W}$.

That is, this holds if either, $\widehat{P} > 0, \widehat{A} = 0; \widehat{P} = 0, \widehat{A} > 0;$ or, both holds. Therefore, trade and technology unambiguously could raise wage inequality.

Proposition 2: *Given* $\overline{S}, \overline{L}$, *if* $\widehat{K} > 0$, *then,* $\widehat{X} = 0$, $\widehat{Y} = 0$, *that freezes P(* $\widehat{P} = 0$ *). On the other hand, given K and P, if* $\hat{S} > 0$, *then both* $\widehat{W} < 0$ *and* $\widehat{W_S} < 0$, $\hat{r} > 0$. *Also,* $\widehat{X} > 0$, *and* $\hat{Y} = 0$, $\widehat{P} < 0$. *Similarly, given K and P, when* $\hat{L} > 0$, $\widehat{W} < 0$ *and* $\widehat{W_S} < 0$, $\hat{r} > 0, \hat{Y} > 0$ $\widehat{X} = 0$.

Proof: From Eq (12), we can easily see that as $\widehat{K} > 0$, $\widehat{W} > 0$ given (PAS+L). Using Eq. (3), $\hat{r} < 0$ and from Eq.(2), $\widehat{W_s} > 0$. Also, via Eq. (13), $\widehat{W_s} > 0$, and using Eq.(2), $\widehat{(1+r)} < 0$ and correspondingly $\widehat{W} > 0$. Given fixed supply of S and L, via (4) and (5), $\widehat{X} = 0$, $\widehat{Y} = 0$. Thus, availability of more wage-fund--without changes in endowments of workers--does not affect output or P. This is *unlike in the SF*-model, where X and Y rise.

On the other hand, given K and P, (i) if $\hat{S} > 0$, similarly (via Eq. 12 and 13) $\widehat{W} < 0, \widehat{W_s} < 0$, and $\hat{r} > 0$. From (4), given a_x, $\widehat{X} > 0, \hat{Y} = 0$. (ii) in case of $\hat{L} > 0$, $\widehat{W} < 0, \widehat{W_s} < 0$, and $\hat{r} > 0$. Via Eq. (5), we see that given a_y, $\hat{Y} > 0, \widehat{X} = 0$.

'P' will behave as per changes in X/Y. Clearly, given no expansion of credit more skilled workforce will cause diversion of wage-fund to the skilled sector so that output expands at the expense of the unskilled sector while putting upward pressure on interest rate for scarcer fund. Given RD, increase in relative supply of 'X' drives down the price. In contrast, in the Neo-classical SF model, we see an increase in K will reduce r and increase both wages. However, outputs will also increase due to improvement in marginal productivity of labor as capital stock increases. If either of L or of S rises both wages will fall, r will rise, output using the expanded factor will rise. Eventually relative price of the expanding output will fall. The results are similar, though the underlying assumptions and the mechanism are entirely different.

Another point to be noted is that the rise or fall in K only affects wages but not quantities of outputs; hence, it cannot affect the pattern of goods trade, as the relative price will remain the same. But higher S or L will affect relative supplies of X and Y and hence the relative price under autarky. Hence, pattern of trade will be affected. This result will change with unemployment. One key observation is regarding inequality, to which we turn next.

3.2 The Price Effect and Inequality

Proposition 3: *Given* $\overline{S}, \overline{L}$ *and* $\overline{K}$, *if* $\hat{P} > 0$ *then* $\widehat{W_S} > 0, \widehat{W} < 0,\ \hat{r} > 0$. *But,* $\widehat{W_S} < \hat{P},\ \hat{r} > \widehat{W_s}$

Proof: From (14), as none of them can exceed $\hat{P}$, $0 < \widehat{W_S} < \hat{P}$ and $\widehat{(1+r)} < \hat{P}$

Rewriting Eq (13) as: $W_s = \dfrac{K}{S + L/PA}$ we derive: $\widehat{W_s} = -\widehat{\left(S + \dfrac{L}{PA}\right)} = \hat{P}(1 - \lambda_{SK})$,

From (3), $\widehat{W} + \widehat{(1+r)} = 0$ (15)

Simplifying $\widehat{(1+r)} = -\widehat{W} = \lambda_{SK}.\hat{P}$ and $\hat{r} = \lambda_{SK}.\hat{P}\left(\dfrac{1+r}{r}\right)$.

On further simplification: $\hat{r} > \widehat{W_s}$ iff $\left(\dfrac{1+r}{r}\right) > \dfrac{(1-\lambda_{SK})}{\lambda_{SK}} \Rightarrow \lambda_{SK} > \lambda_{LK}$

Thus in this case: $\hat{P} > 0 \Rightarrow \hat{P} > \widehat{(1+r)} > \hat{r} > \widehat{W_S} > 0 > \widehat{W}$ (QED).

Clearly, if $\lambda_{SK} \to 1$, then, $\hat{r} \to \hat{P}$ eating up the entire rise in price. Here rise in P increases demand for ‘S’, causing rise in ‘W_S’, and given a_x, a_y, higher amount of K is drawn from the L-sector, ‘r’ must rise and ‘W’ must fall. Though $\widehat{(1+r)} < \hat{P}$, ‘r’ can rise faster than ‘P’ under certain conditions as explained above. Therefore, the results are different in the NRM model unlike the conventional SF-model.

In the conventional SF model, a rise in the relative price of skilled good will increase the wage gap between the skilled and the unskilled and skilled wage will increase relative to the return to capital as the capital intensity of this sector becomes higher. W_S rises more than proportionately with respect to price while ‘r’ less than proportion, and W falls. In addition, with mobile capital, CRS and DMP, the cost-shares of capital in each sector matter. This is likely to happen if greater share of the wage fund (K remaining outside) is engaged in the skilled sector (a different mechanism), a result that contradicts the standard approach.

Section 4: Possible extensions of the NRM Model

4.1 Immigration

Proposition 4: *Let S* and L* be the endowments for labor types for the Foreign country such that K=K*, S=S*, L=L*,* $\hat{K} > 0$ *will open up factor trade.*

Proof: Denote foreign variables by *. In the full employment model, with identical endowments of S and L in both the Home and the foreign country, RS of X and Y will be the same, and P being the same, no goods trade will take place. Suppose $\hat{K} > 0$ in the Home. Thus, $\widehat{W_s} > 0, \widehat{W} > 0,$ and $\widehat{(1+r)} < 0$, but $\widehat{W_S^*} = 0, \widehat{W}^* = 0$. As labor becomes dearer in the Home, this will open up immigration into Home. As $\widehat{(1+r)} < 0$, *without control*, capital flight will take place.[3] When 'K' becomes scarcer in the Home, 'r' will rise; W_s and W will decline causing immigration to cease. *If there is capital control* (restricting 'K' outflow), with immigration due to arbitrage, W_s and W will fall and 'r' might rise with rise in demand for K.

However, immigration might cause relative price movements, affecting RS (X/Y).

4.2 Unemployment

Proposition 5: Let $W = \overline{W}$, L_e (employment in L) such that $\overline{L} > L_e$. If $\widehat{K} > 0$, $\hat{S} = 0, \hat{L} = 0$ $\widehat{P} = 0$ then changes in L_e determine trade pattern.

Proof: Here unemployment = $L - L_e$ at fixed (rigid) $W = \overline{W}$. From (10), we invoke: $K = W_s S + \overline{W} L_e = \overline{W}(PAS + L_e)$. Hence, $L_e = K / \overline{W} - PAS$. Thus, K determines L_e and Y so that $\Delta K = \overline{W} \Delta L_e$ and $\Delta Y = a_y \Delta L_e$. Hence, the country is likely to export Y as $\frac{Y}{X}$ rises. However, as $\overline{(1+r)} = \frac{1}{\overline{W} a_y}$ is fixed, $\widehat{W}_s = \widehat{P}$ unlike full employment model discussed above.

In a full-employment macro model, increase in money supply cannot alter relative prices due to quantity theory postulates (long-run neutrality). Here in NRM, it is similar as credit (K) is like cash-in-advance. Increased availability only inflates nominal costs with no real change such as, relative wages, or, trade pattern. However, in the unemployment model, alike Keynesian case, greater 'K' is like extra cash that increases employment, and determines output (i.e., real changes or non-neutrality). Therefore, in a way, we are incorporating money in a general equilibrium micro model with a different mechanism. This is an added theoretical feature. Now higher K will mean greater employment and higher output of the unskilled good. Thus, two countries identical in all respects to start with even with the same unemployment levels would not trade to start with. If now K rises in one country, it will start exporting the unskilled good. So higher unemployment economy will export the skilled good. But price changes or changes in levels of K will not affect wages.

4.3 Imperfect Credit Market

We consider two types of labor-entrepreneurs for X and Y sectors, respectively having K_s and K_u as internal finance (i.e., own capital) as well as external finances, B_s and B_u (i.e., borrowing from the financiers or banks, etc.). With no other use or investment, the opportunity cost of former is 0, while 'r'-as before-is the cost of borrowing. Hence, we write:

$$W_s a_x X = W_s S = K_s + B_s \tag{16}$$

$$W a_y Y = WL = K_u + B_u \tag{17}$$

[3] This kind of argument echoes with the growth-development literature in macroeconomics. In particular, Lucas (1990) has discussed the impediments in a neoclassical framework with Cobb-Douglas CRS technology.

Borrowing constraints for total available external finance is: $B_s + B_u = \overline{B}$ (18)

Collateral is (K_i+B_i), $\forall i = s,u$. We assume that B_s and B_u are allocated endogenously to X and Y sectors respectively via credit rationing depending on risks of default. In other words, financiers collateralize assets of potential defaulters by appropriating $0<\theta<1$ of (K_i+B_i) $\forall i = s,u$, when the probability of default is, say, 'q'. Unlike benchmark model, greater 'B_s' (i.e., additional B flowing only to S-sector) will only increase 'W_s' and hence, W_s/W. Typically, (B_s, B_u) will be increasing in (K_s, K_u)-see Antras and Caballero (2009).

Let $\lambda_i = \frac{K_i}{K_i + B_i} \forall i = s,u$ is proportion of finance available at r=0 for the i[th] sector, and $1-\lambda_i = \frac{B_i}{K_i + B_i} \forall i = s,u$ is available at rate 'r'. Therefore, it boils down to:

$$W_s a_x [(1+r) - \lambda_s r] = P \qquad (19)$$

$$W_u a_y [(1+r) - \lambda_u r] = 1 \qquad (20)$$

Further, alike section 2, competitive price conditions are:

$$W_s a_x (1+\widetilde{r_s}) = P, \text{ where } 1+\widetilde{r_s} = (1+r) - \lambda_s r \qquad (21)$$

$$W a_y (1+\widetilde{r_u}) = 1, \text{ where } 1+\widetilde{r_u} = (1+r) - \lambda_u r \qquad (22)$$

Higher λ_s, λ_u ensures saving of cost for borrowing capital.

Proposition 6: If $\lambda_s > \lambda_u$ Wage gap $\frac{W_s}{W}$ is higher given P, a_y, a_x, and 'r'.

Proof: (21) and (22) simplifies to: $\frac{W_s}{W} = \frac{a_y}{a_x} \frac{1+\widetilde{r_u}}{1+\widetilde{r_s}} P$. Hence $W_s > W$ *iff* $(1+\widetilde{r_u}) > (1+\widetilde{r_s}) \Rightarrow \widetilde{r_u} > \widetilde{r_s} \Rightarrow \lambda_s > \lambda_u$ Thus, with no change in P or A, unlike the benchmark model where $\lambda_s = \lambda_u = \lambda$, in this case if the S-sector has greater internal resources to invest compared to the L-sector, their effective cost of financing capital will decline ($\widetilde{r_u} > \widetilde{r_s}$) and hence, wage gap will be higher. (QED).

In case of high risk of default and aggregate constraint on borrowing, collateral is important for credit expansion in order to finance trade. Financiers will want to cut back risk by charging higher 'r' for higher risk of default. Thus, a relation between maximum loan (borrowing) and 'r' will determine endogenously B_s and B_u. As K_s rises, λ_s, B_s will also rise because K_s can be used as collateral in case of default, and W_s rises more than W.

Proposition 7: As long as $q\theta$ are same across sectors, $\lambda_s = \lambda_u$. Also, most general expressions for W_s, W involve K_s, K_u, (1+r) and $\lambda_s \neq \lambda_u$. Given 'q' and θ, $\lambda_s \neq \lambda_u$,

$$B_s^{\max} = \frac{q\theta}{(1+r) - q\theta} K_s, B_u^{\max} = \frac{q\theta}{(1+r) - q\theta} K_u$$

Proof: For the skilled sector, the no-default constraint can be written as:

$$PX - B_s(1+r) \geq PX - q\theta(K_s + B_s) \qquad (23)$$

This simplifies to: $B_s \leq \frac{q\theta}{(1+r)-q\theta}K_s$ and $B_u \leq \frac{q\theta}{(1+r)-q\theta}K_u$. (QED).

Using (16) and (17), we find $\lambda_s = \frac{(1+r)-q_s\theta_s}{(1+r)} \neq \lambda_u = \frac{(1+r)-q_u\theta_u}{(1+r)}$ and

$W_s = \frac{K_s}{S}\left(\frac{1}{1-\frac{q_s\theta_s}{1+r}}\right)$ and $W = \frac{K_u}{L}\left(\frac{1}{1-\frac{q_u\theta_u}{1+r}}\right)$.

Hence, the most general expressions for wages are:
$W_s = W_s(\underset{+}{K_s}, \underset{-}{S}, \underset{-}{1+r})$ and $W = W(\underset{+}{K_u}, \underset{-}{L}, \underset{-}{1+r})$.

However, using competitive price conditions, plugging in $\lambda_s, W_s a_x[(1+r) - \frac{(1+r)-q\theta}{1+r}.r] = P$

which simplifies to: $W_s a_x[1+\frac{q_s\theta_s}{1+1/r}] = P$. Similarly, $Wa_y[(1+\frac{q_u\theta_u}{1+1/r}] = 1$

5. Concluding remarks:

A two-sector-three factor SF-model with immobile skill and unskilled laborers, and capital as sources of wage-funds for the workers is developed. The model retains the Ricardian flavour (i.e., based on labour theory of value and fixed coefficients technology). Without the Neo-classical assumptions of CRS flexible technology, DMR and scope of factor substitution, the model offers a different mechanism. In a full-employment model, it shows: (i) unlike SF model, *ceteris paribus* credit expansion or fall affects wages (in the same direction) but not outputs (and relative prices) and hence, does not affect patterns of trade. Return to capital falls. With credit expansion, starting from autarky, immigration could occur as wages rise in the home country. Depending on restrictions on capital flow, return to capital will move affecting immigration. However, identical to the SF model, *with no credit expansion* higher endowments of both worker types will cause wages to fall, 'return' on capital to rise, and change relative supplies and prices of outputs, affecting trade patterns. Output of the sector with expanded factor rises causing its relative price to decline; however, the mechanism is entirely different without the DMP theory. (ii) On the contrary, with higher share of wage-fund devoted to the skilled sector, an increase in the relative price of the skilled good—unlike in the conventional model—will cause skilled wage to rise *less than* proportionally and even, under certain scenarios return to capital could increase more than both the wages, whereas unskilled workers unambiguously suffer. These reflect similar sentiments as in Piketty (2013). One could easily prove that shortage of financial capital (i.e., K), as in a financial crisis, and/or technological progress, both increase the income gap between capital and labour in our framework.

Increasing availability of credit is the only source which unambiguously raises the relative income of the workers.

(iii) However, with differences in credit availability across worker-entrepreneurs due to unequal access to external and internal sources, wage gap rises as the greater internal finance in a sector reduces its external borrowing cost. In case of risks of default, asset collateralization permits the financiers to 'ration' credit up to a certain maximum amount (loan or external borrowing) depending on chances of default, availability of internal finance, and interest rate.

Apart from the delineating mechanism, the model has an added theoretical feature. The mechanism replicates quantity theory postulates in a full-employment macro model. Credit construed as 'cash-in-advance' shows that credit expansion has no real effects on wages, or trade patterns. On the other hand, in an unemployment model with wage rigidity, credit expansion functions like 'extra cash' increasing employment and hence, bringing in real changes in output (non-neutrality), so that trade kicks in. Thus, in a general equilibrium micro model, we incorporate money via embedded wage-fund mechanism into a new Ricardian specific-factor framework and replicate 'classical dichotomy' (Patinkin 1965).

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