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Abstract

This paper shows that trade weakens bargaining power and thereby reduces labour share under strategic competition and firm heterogeneity. Market size and competition effects of trade jointly can raise the share. But, specialization arising out of heterogeneous productivity distribution between trading partners dampens them unambiguously with the union, but not without the union. Autarky wage cannot be achieved from a competitive policy under trade unless both of them adopt. This encourages trade restrictions that result in lower output. A stronger bilateral collaboration can better off the workers at higher output driven by the competitive policy under trade.

JEL Code: F16, L11

Key words: Trade, Union, Generalized Oligopoly, Market Imperfection, Labor Share

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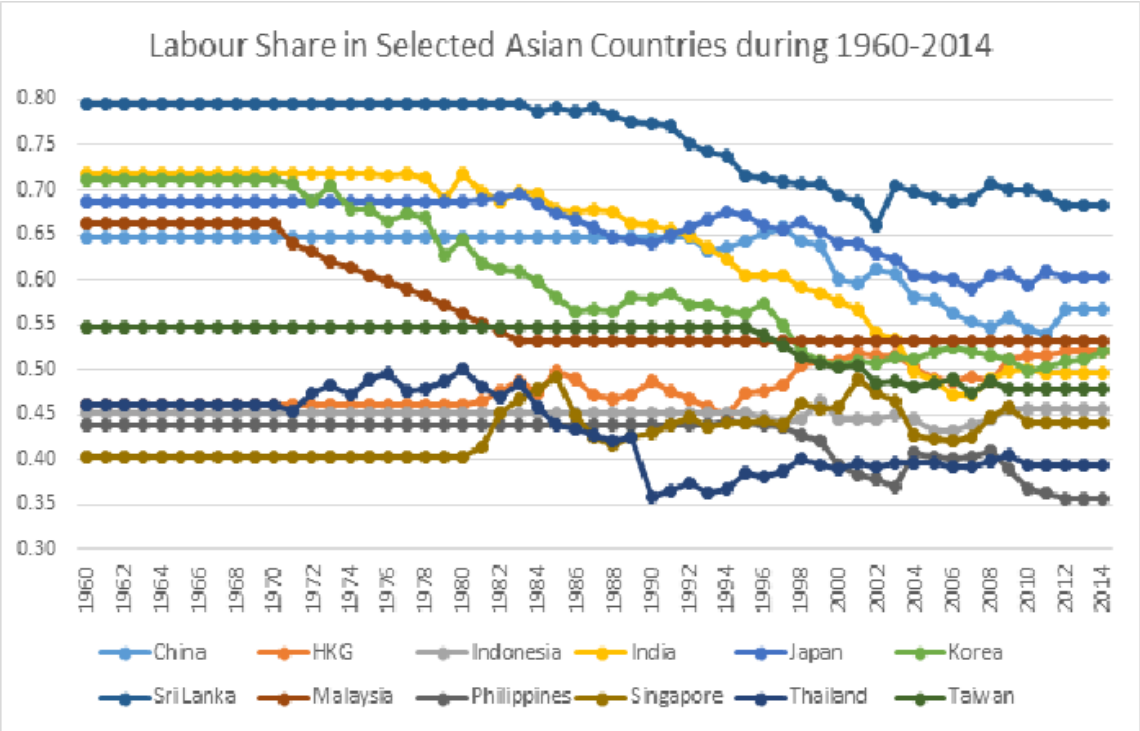
1 Introduction

Trade can influence both product and labor market conditions in such a way that could affect the distributive share of labor. Whether trade affects labor share adversely has been a growing concern among scholars and policy makers in the recent years. It is evident that the labor share of workers engaged in the industrial sector as well as national economy has been declining sharply in most of the countries including the developed world. A recent study conducted by IMF highlights a sharp downward trend of the share in large number of the countries and that has led to recognize an important economic and social issue of the present time. In the advanced economies, the share began to trend down from early 1980s and hit the lowest level in the past half century prior to the global financial crisis of 2008-09 (Dao et al., 2017). According to an ILO study in 2017, the labor share of national income, in terms of total earnings for all employees and self-employed persons, in Europe has declined from 75 percent on 1970s to 65 percent in the recent years. On average, OECD countries have experienced a sharp fall from 64 percent to 59 percent during the same period (Sweeney, 2017). The IMF study also shows a sharp drop from a much lower, 55 percent of national income to 50 percent, for some advanced countries. In a sample of 35 advanced economies between 1991 and 2014, the labour share declined in 19 of them, which accounted for 78 percent of GDP in 2014. The drop is not confined to the developed countries. In a sample of 54 emerging and developing economies on average, the labour share declined in 32 economies, which accounted for about 70 percent of emerging market GDP in 2014. The decline in these countries has been concentrated in the early 1990s to a large extent. It was also observed that the sharpest decline in the labour share was in manufacturing sector, followed by transportation and communication, while some sectors (food and accommodation, agriculture) witnessed an increase. In the emerging and developing economies, the sharpest decline was observed in agriculture. However, there has been substantial deviation of the pace and pattern of labor share across countries (Dao et al., 2017). The declining labor share of national income is, of course, accompanied by the huge rise in the share going to the owners of capital and a small proportion of elite employees within the labor share. The rising unemployment across over the world, after the global financial crisis, prompted scholars to investigate the pace and pattern of labor share across countries and driving forces working behind the trend. Now, it is evident that countries are increasingly protecting to arrest declining labor share. BREXIT is one such example. So, the immediate questions are whether trade explains the declining labor share, and if so, whether protection can distributive share of workers without sacrificing their income when product and labor markets are

imperfect.

When we look at the trend of labor share in a sample of developed and developing countries in Asia for a period from 1960 to 2015, it registers a sharp fall in all systemically from around 1980s (Figure 1). This is the period when the trade has accelerated at a faster rate worldwide. Whether the trade has been responsible for this is not yet clear in the empirical literature. No doubt, the trade definitely changes the market conditions and thereby redistributes the resources in so that it would make an impact on the labor share. This work attempts to investigate whether the trade plays any role in explaining the trend of wage and labour share when both product and labour markets are imperfect in a generalised oligopoly framework. The trade is assumed to affect the market size as well as the competition between the domestic and foreign firms. In addition, the most productive firms in the distribution in both countries could lower the demand for labour that captures the specialization effect. The combination of these three forces must depend on the labour and product market conditions. The conventional trade theories do not account for these factors. Neary (2016) develops a framework but ignores labor market imperfections as well as the existence of unemployment and informal sector. This paper includes labour market imperfection in this framework to examine the impact of trade on labour share.

Figure 1: Labor Share in Selected Asian Countries 1960-2014



Source: Peen World Table Version 9.0

The distributive conflict between labor and capital is a perennial problem in the literature. Several factors have been put-forward for its explanation in the contemporary literature (e.g., technological progress, automation, global integration, off-shoring, regulatory reforms etc.), but they do not seem to be strictly disjointed from each other. Rather, the productivity or technological change remain at the heart of the discussion on the degree of substitutability between labour and capital. In an old and influential work, Arrow et al. (1961) argue that when capital is highly substitutable for labour (the elasticity of substitution is larger than one), a decline in the relative cost of capital drives firms to substitute capital for labour to such a high degree that, despite the lower cost of capital, the labour share of income declines. This is much pronounced in the

current phase of technological progress led by information and telecommunications innovations and automations. In a recent article, Acemoglu and Restrepo (2018) argue that automation of those tasks that were previously performed by labour is the root cause for a permanent reduction in the labour share. Even if the price of capital goods declines as a result of the innovations, the technological progress still could substitute workers disproportionately to some extent so that the labour share falls even faster (Karabarbounis and Neiman 2014). This apart, Piketty (2014) offers an argument for accumulation view. According to him, for a variety of reasons, the aggregate savings have grown globally relative to the national incomes and that has accelerated capital-to-output ratios. Autor et al. (2017) and Kehrig and Vincent (2017) further argue that the fall in the labour share is driven by the rising industry concentration and growing dominance of superstar firms. Grossman et al. (2018) find that a one percentage point slowdown in the growth rate of per capita income can account for about one half of the observed decline in global labour shares. These results indicate that the labour share is somehow correlated to the dynamics of labour productivity or technological change. While the large volume of these literature see whether growth technological change and productivity rise replace labor in order to understand its implication on the distributive share, the current paper attempts to investigate the role of trade as a driving factor.

As far the trade implication is concerned, the adverse effect of trade on labor share is quite evident in the contemporary literature. Rodrik (1997) and later Slaughter (2001) find that trade weakens the bargaining position of workers, causing a drop of labor share. It is because, the unionization rates and labours bargaining power might have been declined as a result of trade integration (Rodrik, 1997; Elsby et al., 2013). Using more than 80 countries data for the period 1970 to 2001, Joyadev (2007 showed that the increase in trade openness negatively impacts the share. Keil et al. (2007) undertook a study for Belgium firms and found that the rise in liberalization has led to a reduction in the union bargaining power and improved the share of distributive rents in favour of firm owners. In the case of India, the empirical evidences are quite mixed and ambiguous. Using the three-digit industry data from India, Ashan and Mitra (2011)suggest that, on average, trade liberalization led to an increase in the share of wages in total revenue for small, labor-intensive firms but a reduction in this share in the case of larger, less labor-intensive firms. On the other hand, Dutt (2007) showed that workers employed in industries with higher tariffs received higher wages than apparently identical workers in low-tariff industries during 1983-2000. On the other hand, there are also studies which contradict such findings. Feenstra (2007) finds a substantial improvement in wage

earnings in the USA and Canada during the 1980s and 1990s, following tariff reduction. Cragg and Epalbaum (1996) observe a high growth of skilled wage in Mexico during the phase of tariff reduction in 1990s. Guerriero and Sen (2012) found, from a study on mix of 89 developed and developing countries for the period 1970 to 2009, that the trade openness along with technological innovation has positive and significant impact on the labor share. A small firm-level study on China indicates that firms in the industries experienced tariff cuts raising labors share relative to economy-wide trends, both through input choices and rent sharing (Kamal et al., 2015). Blanchard and Giavazzi (2003) find that product market deregulation raises the real wage of the workers to the extent that it reduces barriers to entry and, thus reduces unemployment. Using a panel data for 87 countries, Deon and Wan (2017) found that the increase in imports has a positive impact, but not the exports. So, the empirical results do not support the adverse effect of trade on labor share unambiguously.

While the empirical results are quite mixed, the theoretical result on how trade affects labor share depends very much on market conditions and firm heterogeneity (discussed details in section 2). According to the modern theories, whether workers would be benefited from trade depends on its pro-competition effects and labour reallocation effects across sectors (Melitz and Redding, 2014). The results of pro-competitive are highly influenced by the assumptions on the market conditions, in particular. Moreover, the result shown on perfectly and monopolistically competitive markets can be highly contested. It is evident that the firms enjoy a certain degree of market power. Using a disaggregated information at the country level over 43 countries, Loecker and Eeckhout (2018) estimate that the average mark-up exceeds one for all the countries in 2016. It ranges from 2.84 (Denmark) to 1.19 (Portugal). Moreover, the mark-up has gone up in most of the countries during the last two decades. Using a different dataset, two more recent studies (namely Weche and Wambach, 2018 and Calligaris, Criscuolo, and Marcolin, 2017) also find similar results. Collecting the evidences from publicly listed firms in 33 advanced economies, Dez et al. (2018) confirm that corporate market power has increased. Markups have been rising steadily since the 1980s, and at an accelerated pace since the mid-2000s. These trends have been driven by a relatively small number of superstar firms in the upper tail of the distribution that are able to extract increasingly large markups. Measures of firm-level profitability have mirrored this increase in markups. Similarly, Barkai (2016) and De Loecker and Eeckhout (2017) find that gains in the profit share is reflected in the increased markups. While modelling the trade theories, although heterogeneity has become an integral part, the assumption of monopolistic or

perfectly competitive framework to a large extent is driving the the result, which does not capture strategic competition. Hence, they are no longer realistic to investigate the impact of trade on the distributive conflict.

Moreover, the labor reallocation effect of trade seems to be highly limited by the degree of labor market imperfections. It is also evident that workers are not symmetrically affected by trade liberalization across countries. This is because, they are not identical and the labor market is not frictionless. Dumont et al. (2006) found substantial bargaining power of workers in ve European countries. Besley and Burgess (2004) showed that workers engaged in manufacturing activities enjoy sufficient bargaining power in a typical developing economy like India. Abraham et al. (2009) estimated that union bargaining power is roughly 0.2 to 0.3 in Belgium firms. Using the similar method, Maiti (2014) suggested that it varies from 0.1 to 0.5 across Indian formal sector firms. It is evident that scholars attempted to include the labor market rigidity in the number of alternative frameworks, namely workforce composition (Yealpe, 2005), search and matching frictions (Davidson et al., 2008), efficiency wages (Amiti and Davis,2012) etc. These models recognise the existence of unemployment or informal sector unlike the conventional works. In an interesting study, Helpman and Itskhoki (2010) show how trade affects unemployment through reallocations of resources across sectors in a heterogeneous setting. In the model, the differences in labour market institutions across countries and industries provide the sources of comparative advantage and shape the impact of trade liberalization on aggregate unemployment. Therefore, inclusion of strategic competition and labor market imperfections seems to have implication of trade on labor income and share.

Neary (2016) accommodated strategic competition in oligopoly framework, but ignored the labor market imperfections. Using the 'generalised oligopoly framework', this paper attempts to include strategic competition in sector with a continuum set of heterogeneous firms who face union that counts 'right-to-manage' the production. The sectors are arranged in terms of productivities. There are fixed number of competitors in each sector. Trade increases competition among the rivals as well as raises market size for the domestic firms. The resultant impact of these two forces jointly depend on the labour income, which further depend on whether labor market is unionised or not. If the joint effects increase the production and thereby raise the labor demand. It essentially fuels wage when there is no union. In the presence of union, the workers earn additional power and bargain for extra rent. As a result, the benefit accrued by the firms tends to be lower when the labor market is rigid enough not to accept a lower employment and wage to be paid to the workers. The profitability of firm and rate of capital formation depend

on the degree of labor market rigidity (Blanchand and Giavazzi, 2003). However, the union wage tends to rise in response to the additional demand arising with the integration. The higher wage raises cost and thereby discourages production leading a fall in labor demand. The demand for labor is finally adjusted to the level where the wage rate remains as before.

In addition, each economy would enjoy a certain level of comparative advantage due to the difference in technology distribution between the countries in the presence of heterogeneous productivities and labor union. After the trade, the market of the most productive firms expands, who require less labor. As a result, this depresses the wage income of workers. But, the actual level depends on the strength of the joint effects of market size, competition and comparative advantage. It is found that the effect of trade on the wage is ambiguous in the absence of labor market frictions. However, it unambiguously depresses wage when workers are unionised. The bargaining power plays very vital role in determining the level of impact on the wage. On the other hand, the implication of trade on the distributive share is not straight-forward. The change in market condition after trade influences employment in the presence of union, not otherwise. Counting the employment effect, it is observed that the distributive share of workers falls in both cases. Neary (2016) observed that when trade takes place the higher productive firms contribute a lot. If this prevails, it could dominate other forces to affect the demand for workers.

This paper finds that the trade unambiguously has negative effect on both wage and labor share when both product and labour markets are imperfect. The market size effect arising out of trade cannot exceed the competition effect in the domestic economy when union is prevailed, because the union sets monopsony wage which is independent of number of rivals in the absence of heterogeneity. However, the degree of comparative advantage originated from the productivity difference across firms between trading partners plays the detrimental role in this regard. Since the most productive firms receive greater share of market after trade, the demand for labor shrinks and this inevitably reduces the bargaining power of workers. This is similar to the findings highlighted by Dier at al. (2018). In the absence of union, since the market size effect can increase the wage, the net effect is ambiguous. However, an increase in domestic entry due to various competitive policies may lead to an increase in domestic wage, but cannot push it upto the level of auturky. Moreover, the wage rise in the presence of union may not necessarily be higher than that without union. An attempt has been made to empirically investigate the results. An expression for labor share is derived from country-level of production

function using translog type and two additional terms capturing market and labor bargaining powers are added there. Regression results of a panel data from cross-country data during 1954-2014 support that the trade weakens the bargaining power and hence could be a responsible factor for declining labor share.

The rest of the paper has been organized as follows. Section 2 outlines literature relevant for the topic. The theoretical basic model is discussed in section 3. The effect of trade on the labor share is dealt with in section 4. The entry effect on wage is discussed in section 5. Then, the empirical framework of estimation of mark-up and bargaining powers on the labor share are discussed in section 6. Section 7 ends with concluding remarks.

2 Literature

As far as the impact of trade on wage and labor share is concerned there is substantial dis-aggrement among the scholars in the theoretical literature and a renewed interest with the surge in research on firm heterogeneity. The results depend very much on the assumption of market conditions. The leading trade theories can be grouped into four types that are relevant for the analysis on distributive share of workers. The favourable impact of trade on the share has been predominant in the existing literature. First, the Ricardian model accounted for the effect of comparative advantage arising out of technology difference in a perfectly competitive environment. But, this is ill-suited to address this question of distributive conflict, because all national income accrues to labour. However, the Heckscher-Ohlin theory argues that the comparative advantage arising out the difference in factor abundance enables to derive the favourable effect from trade by the workers even in a perfectively competitive environment if it is the abundant factor in the economy (Jones, 1965). But, they fail to account for competition and size effects of trade. Second, the trade could benefit labour under homogeneous conditions in two forms of market imperfections - monopolistically competitive and oligopoly. However, the results they found are highly influenced by the market types. Krugman (1980) offers a pioneering framework, using Dixit-Stiglitz utility setting of differentiated goods, to account for market size and competition effects in the presence of economies of scale. The worker is expected to be better off in real term after trade as the competitive force depresses the product price. So, even if the trade takes place between two countries with similar conditions it could still improve the distributive share of workers (in real term) if the joint effect of market size and competition reduces the price level sufficiently compared

to that of wage (Anderson et al., 1989). Following this tradition, Brander and Spencer (1988) show, however, how union limits the benefits from trade under strategic competition. Huizinga (1993) and Sorensen (1993) show that the unionised wage is higher under autarky than under free trade. According to Acemoglu et al. (2001), unions benefit by productive training, and such training is incentive compatible for firms only when the wage structure is compressed. Alternatively, collective decision within the union may reflect the preferences of its median voter, and if this median voter is an unskilled worker, the unskilled wages may rise at the expense of skilled wages. It is also possible that union members choose to compress wages because of ideological reasons or for social cohesion purposes. On the other hand, the theoretical works by Naylor (1998 and 1999), Munch and Skaksen (2002), Bastos and Kreickemeier (2009), and Bastos et al. (2009) show the positive effects of trade reform on unionized wage and they go against Brander and Spencer (1988). Naylor (1998 and 1999) show that two-way trade reform may raise the unionized wage. Bastos and Kreickemeier (2009) find a similar result in two-way trade liberalization in a general equilibrium model with unionized and non-unionized sectors. They argue that trade liberalization may increase unionized wage by affecting the disagreement utility of the firms if the union is an open shop, where all the workers are not union members. Maiti and Mukherjee (2013) show that trade reform might lead to a rise of union wage if the firm has a strategic choice of subcontracting to the informal sector. Since the union effect is uncertain, it is difficult to predit the labor share.

Third, this tradition is often criticised that they rely on either partial equilibrium framework or the homogeneity assumption. If the firms are assumed heterogeneous in terms of productivities in differentiated goods markets, the Krugmen effects of competition and scale seem to be absent from trade impact (Melitz, 2003). This led to incorporate variable mark-ups across industries (McCalman, 2018). Melitz (2003) elegantly adopted the framework of monopolistic competition (Dixit and Stiglitz, 1977) to show how the selection of firms from a pool of heterogeneous firms in terms of productivity distribution plays a detrimental role in the gain. However, such favourable impact of trade on the wage and distributive share of workers has not been uniform across all sectors and types of labors. It depends not only on the relative strength of market size and competition effects but also on the extent of labor reallocation within the industries and across industries (Melitz and Ottaviano, 2008). Since the final price declines after trade, the workers tend to benefit in real terms at the aggregate level.

The modelling with heterogeneity becomes workhorse in the modern theoretical exercises to find answer to various questions arising out of trade. More importantly, this

allows to capture variable mark-up of pro-competitive effects. At the firm level, trade liberalization intensifies foreign competition, reducing market power of local producers and forcing them to decrease their markups (Melitz and Ottaviano, 2008; Arkolakis et al., 2015)). Restuccia and Rogerson (2008) and Hsieh and Klenow (2009) provided empirical supports for lower markup dispersion associated with less extensive distortion across firms. On the other hand, Edmond et al. (2015) and Arkolakis et al. (2015) point out negative possibility of pro-competitive effects of trade liberalization that occurs through reallocation of labor towards more productive exporting firms. This internalizes the drop in trade costs and hence could raise mark-ups. As a result, whether trade liberalization leads to a rise in welfare or drop depends on the joint movement of labour reallocation and markup distribution.

The trade leads to an increase in the zero-profit cut-off, resulting to a rise in the average productivity of the comparative advantaged sector than that in the disadvantaged sector. This influences the real reward of each factor by changes in product variety (as in Helpman and Krugman, 1985) and the reward may rise with average productivity in each sector (Melitz and Redding, 2014). Hence, it is quite possible that trade liberalization can raise rather than reduce the real reward of the scarce factor (as seen in Stolper-Samuelson model). Harrigan and Reshef (2011) investigate the complementarity between heterogeneous firm productivity and skill intensity, and show that this affects the impact of trade liberalization on wage inequality. In a setting of variable mark-ups, Melitz and Ottaviano (2008) argue that sectors with tougher competition has a downward shift in distribution of mark-ups across firms. In parallel, there are other frameworks that attempted to show the effect of trade using heterogeneity and variable mark-ups. They model heterogeneity with, for example, Bertrand competition (Bernard et al., 2003), Constant Absolute Risk Aversion (CARA) preferences (Behrens and Murata, 2012), translog preferences (Feenstra, 2003), and general additively separable utility (Zhelobodko et al., 2012), variable mark-ups in a CES demand form (Edmund et al., (2012) etc. However, they do not specifically model labor market frictions.

Four, while analysing the pro-competitive effect of trade in a monopolistically competitive environment, they account for heterogeneity but fail to include the effect of strategic competition that exists in oligopolistic market along with the heterogeneity (Neary, 2016). Since there is no strategic competition, such a framework could not even prescribe any specific policy suggestion required on market reform to derive the desired outcomes. If the firms enjoy sufficient market powers, one can safely conclude that they must be engaged in strategic competition. If so, there seems to be lest two issues that

affect both conceptual and analytical framework used in the works mentioned above. The competition reduces the market share of the domestic market, but the market size rises. These two forces could go against each other without the consideration of heterogeneity. However, the outputs of most productive firms would be driven more by the trade (due to comparative advantage) and this leads to a shrink of the market share for labor intensive industries. Neary (2016) demonstrates that if the competition and comparative advantage effects dominate the market size effect of trade under identical situations between trading partners, the net effect could raise the wage but may even tilt down the labor share. But, Neary (2016) neither considers labor market frictions nor recognizes the existence of unemployment.

3 The Model

This paper applies the generalised oligopoly model in the presence of product and labor market imperfections to capture the effects of strategic competition along with market size and specialisation, unlike monopolistic competitive market (Melitz, 2003). The basic characteristics that differentiate the demand function from the one used in monopolistically competitive environment must capture the effect of retaliation from rivals. For this, we assume that the consumer holds 'continuum-Pollak' preference over goods, denoted by z, ranging from 0 to 1 (see Neary, 2016). A fixed number of firms is assumed producing the homogeneous goods in each sector, z. The entry to each sector is restricted and hence the strategic competition is confined within the limited number of firms in each sector. This allows them to draw positive surplus and hence the labor union finds scope to bargain for a pie from the surplus as well. The utility function of a representative consumer can be represented as follows:

$$U[x(z)] = \int_0^1 u(x(z))dz \tag{1}$$

where $u(x(z)) = ax(z) - \frac{1}{2}bx(z)^2$.

This specifies to derive 'Frisch' demand function that accommodates consistent oligopoly behaviours in general equilibrium setting. In each zth sector, a limited number of firms compete strategically between them and find an equilibrium price, $p(z)$, endogenously by playing Cournot competition. Note that this takes marginal utility of income as given. A small change in the production of a single firm within the sector has a retaliation effect on other rival firms, routed through the price change. Such change is assumed to be too small to affect prices of the other sectors. However, the prices of all the sectors in the

economy as a whole endogenously determine the marginal utility of money. Hence, the fixed and endogenously determined Lagrangian multiplier serve effectively as the base of 'perceived' and 'actual' demand functions in the general equilibrium framework. With the use of Lagrangian multiplier λ and income I, the inverse and direct demand functions are derived as follows:

$$p(z) = \frac{1}{\lambda}[a - bx(z)]; x(z) = \frac{1}{b}[a - \lambda p(z) \tag{2}$$

Integrating the direct demand function, we can solve the value of λ, the marginal utility of money.

$$\lambda = \frac{a\mu_1^p - bI}{\mu_2^p} \tag{3}$$

where I represents income. The effect of price on λ is captured by the following two terms:

$$\mu_1^p = \int_0^1 p(z)dz; \mu_2^p = \int_0^1 p(z)^2 dz \tag{4}$$

This expression suggests that a rise in income and uncentered price variation, and a fall in the average prices leads to a drop in the marginal utility of money. This derivation endogenizes the income effect. Since the size of demand in autarky would essentially be different from the trade, this specification can capture the effect of strategic competition along with the market size on the labor market separately in the two environments. We choose λ as nummeraire. Moreover, in response to the price change after trade, the utility levels are supposed to be different. The level can be derived easily with the use of equilibrium price (Mrazova and Neary, 2014).

3.1 Autarky

Since the price is formed by the interaction of product and labour market competitions, the resultant wage seems to be the key in determining the extent of changes. In other words, whether labor union is present or not is supposed to be the key in influencing the resultant labor income and its distributive share. Let us specify the market conditions so that the wage can be solved distinctively. There are n number of firms producing similar goods in the zth sector within the range of continuum. Each of them has an exogenously fixed labor requirement per unit of output, denoted by $\alpha(z)$ in the domestic economy. If each produces $y_i(z)$ and w being wage paid to the workers, the profit of a representative firm in the sector can be expressed as follows (with the help of demand expression in (2):

$$\pi_i(z) = p(z)y_i(z) - \alpha(z)y_i(z) \tag{5}$$

Assuming $\acute{a} = a/\lambda$ and $\acute{b} = b/\lambda$, we find that the sectoral output and price are:

$$y(z) = n\frac{\acute{a} - w\alpha(z)}{\acute{b}(n+1)}; p(z) = \frac{\acute{a} + nw\alpha(z)}{n+1} \tag{6}$$

Note that the outputs at the sectoral-level are inversely related to the wage rate. If wage rises, the outputs decline. Moreover, higher the labor requirements, lower is the productivity and sectoral output. There must be some sectors where labor requirement is so high that leads the firms non-profitable. Then, they cannot survive in the market. On the other hand, the prices are same for all firms within the sectors and positively related to the wage rate. The prices are higher for the firms who are less productive (or higher labour requirement).

Substituting the value of output and price, the aggregate profit of firms in the zth sector can be expressed as follows:

$$\Pi = \int_0^1 n\pi(z)dz = b(y(z))^2 \tag{7}$$

Where $\pi(z) = [p(z) - w\alpha(z)]y(z)$. So, higher the output higher would be the sectoral profit. It essentially suggests that the formation of wage plays the detrimental role in determining the level of the price, output and profit. Therefore, the degree of labor market imperfection is supposed to show differential outcomes under the autarky and trade. In order to investigate them, two cases will be compared between with and without union. For the sake of conveniences, we assume that the workers from each sector take part in a centralized union. We can consider sector specific decentralized union. This will offer an intermediate solution between these two extreme cases and hence can be ignored here. The existence of a strong centralized union is evident in the developed European countries (Chowdhury,1994). Evidences of centralized collective bargaining are also observed in the developing world, specifically in Latin American countries (Lamarche, 2013).

3.1.1 No Union

In the absence of union, there would be no rigidity in the labor market. Hence, all workers in the economy are employed. The issue of unemployment and informal sector does not arise then. If L is labor force available in the economy, the equality between labor demand and supply in equilibrium can be expressed as follows:

$$L = \int_0^1 n\alpha(z)y(z)dz \tag{8}$$

Substituting the value $y(z)$, we get

$$L = \frac{n}{b(n+1)}\int_0^1 \alpha(z)[a - w_a\alpha(z)]dz \tag{9}$$

From this equilibrium condition, one can easily solve the equilibrium wage. Then, we get

$$w_a^N = \big(a\mu_1 - \frac{1+n}{n}bL\big)\frac{1}{\mu_2} \tag{10}$$

where μ_1 and μ_2 present the first and second moments of the technology distribution in the domestic economy, $\mu_1 = \int_0^1 \alpha(z)dz$ and $\mu_2 = \int_0^1 \alpha(z)^2 dz$. Note that wage is directly related to average labor requirement per unit of output and inversely related to the productivity variation in the absence of union. On the other hand, market size, defined by n, encourages wage, but the competition between them depresses it. The increased market size raises the demand for workers and thereby improves wage.

3.1.2 Union

Now, assume that the workers participate in a union that takes members from all sectors and try to earn a rent from the surplus. When the market expands, the demand for workers rises and the union negotiates for higher wage. So, the presence of union raises the wage rate in response to the increased demand and vice versa. For simplicity, in order to incorporate this feature we assume that the workers have a utility function that counts 'right-to-manage' the production. They maximise wage rent with an outside option working in the informal sector and minimum social security available to unemployed workers, at a wage w_0. Then, the union's utility function can be expressed as follows:

$$H_a^U = (w - w_0)\int_0^1 \alpha(z)ny(z)dz \tag{11}$$

This expression suggests that the union utility rises directly with employment as well as with their rents. Maximizing this with respect to wage (w), we find equilibrium wage in the autarky with the union as follows:

$$w_a^U \equiv (\lambda w)_a = \frac{1}{2}\big(\frac{a\mu_1}{\mu_2} + \lambda w_0\big) \tag{12}$$

The wage rent is directly related to the level of total labour requirement per unit of production or inversely related to the average level of productivity. Moreover, this is inversely related to the extent of technology distribution. Note that if the variation of productivities across sectors is high, the less productive firms tend to survive. The workers in the low productive firms cannot negotiate much from low surplus. On the other hand, the productive firms do not demand labor much. These together pull down the union wage. This is different from the one used in the absence of union. Note that the number of rival firms competing in a particular sector does not influence the wage rate and

directly affect the wage rate unless it influences the average productivity. Union serves as a monopsonist to sell their labor and the equilibrium wage is higher than the outside wage directly. This would allow us to compare the wage levels between the presence and absence of union. Since the wage without union depends on market size, the union wage may not necessarily be higher than that without union.

***Lemma 1**: $w_a^U > w_a^N$ when $\frac{n+1}{n}bL - \frac{a\mu_1 - w_0\mu_2}{2} > 0$ or $n^a = \frac{2bL}{a\mu_1 - w_0\mu_2 - 2bL}$.*

The union wage would be higher if the wage rent exceeds the gain from market size in the absence of union. Higher the number of rivals in a sector (given same μ_1 and μ_2), greater would be demand for labor without union and lower would be the wage difference. If the number of rivals are sufficiently high and exceeds the critical number (say, n^a), the union wage would be always higher than the unionized wage (given the outside option, w_0). Because, more firms create additional demand for labor without union. In the presence of union, the increased demand encourages them to negotiate for higher wage. The increased wage shrinks the demand and hence the effect of additional benefits from market size is neutralised. So, w_a^N could be higher than w_a^U only when the number of competitors are sufficiently large.

Substituting the value of w_a^U, we find

$$y_a^U(z) = \frac{n}{b(n+1)}[(a - \alpha(z)w_a^U] \tag{13}$$

$$p_a^U(z) = \frac{1}{(n+1)}[(a + n\alpha(z)w_a^U] \tag{14}$$

Needless to say that the higher wage increases price and reduces production. Multiplying labor requirements with the sectoral outputs one can find employment at the sectoral level. Then, integrating sectoral outputs the total employment is found as follows:

$$L_a^U = \frac{n}{b(n+1)}[a\mu_1 - w_a^U\mu_2] = \frac{n}{2b(n+1)}[a\mu_1 - \lambda\mu_2 w_0] \tag{15}$$

The employment falls against higher union wage. Moreover, it increases first moment of technology distribution and this is negatively related to the second moment of the distribution. With the rise of first moment, the demand for labor rises. Higher the dispersion of technology in the presence of high productive firms along with low productive ones reduces the demand for labor and thereby shrinks employment level. Higher the outside option greater is the wage and lower is the employment level.

3.2 Trade

As the market expands and competition tends to rise, the wage and factor share would be expected to be highly influenced by the trade. There would be cournot competition

between domestic and foreign firms in each sector. Under the free trade, each firm faces increased demand (market size) and higher number of competitors. The combination of these two forces determines the impact on wage and labor share. This is similar to what is described by Krugman. In addition to them, an effect of comparative advantage, arising out of difference in productivity distribution between two countries, plays an important role. Because, firms who are highly productive receive less competition and demand less workers as well. Hence, it leads to differential outcomes in the labor market with and without union.

Under the free trade, the aggregate demand faced by each firm would simply be addition of demands from two countries at internationally determined sectoral market price, $p(z)$ and common marginal price, b. If $x^*(z) = \frac{1}{b}(a^* - \lambda^* p(z))$, the aggregate demand would be:

$$\bar{x}(z) \equiv x(z) + x^*(z) = \frac{\lambda + \lambda^*}{b}\big(\frac{a + a^*}{\lambda + \lambda^*}) - p(z)\big) \tag{16}$$

If this is expressed into demand function, we write $p(z) = \big(\frac{a+a^*}{\lambda+\lambda^*}\big) - \frac{b}{\lambda+\lambda^*}\bar{x}(z)$. Note that the slope of perceived demand curve has fallen from $\frac{b}{\lambda}$ to $\frac{b}{\lambda+\lambda^*}$. Moreover, $\bar{x}(z)$ is much bigger now than $x(z)$ under autarky. This allows foreign competitors to enter into the domestic market. These two changes definitely affect the market prices and hence influence the labor market so that one can see the differences. It is now also important to understand that the degree of product market competition affecting labor market depends on the level of specialization or competition to be seen over the continuum of sectors.

Sectoral specialization depends on the labor costs per unit of production, similar to the Ricardian definition of comparative advantage. The marginal cost of labor in a sector depends on labor requirement ($\alpha(z)$) and wage after trade (w_T^*). Since the labor requirement in the respective sector is assumed to be fixed, the degree of specialization or competition essentially depends on the market wage and technology. There is no other cost in regard to trade and transport the goods. We assume that each sector requires an exogenously fixed labor input per unit of output, denoted by $\alpha(z)$ and $\alpha^*(z)$ respectively in domestic and foreign countries. They are arranged in the continuum of z. We further assume that goods are ordered in such a way that the home country is more efficient in producing goods at lower values of z and foreign country is more efficient in producing goods at higher values of z. Similar to Dornbusch et al. (1977), it is assumed that the ratio $\frac{\alpha(z)}{\alpha^*(z)}$ is increasing in z. These specifications helps us to define degree of specialization and comparative advantage over sectoral productions across countries.

Let us now try to specify specialization patterns that are influenced by the marginal labor costs in home and foreign countries depending on the market conditions and the

union presence. Given the fixed labour per unit of production ($\alpha(z)$ and $\alpha^*(z)$), fixed number of firms (n and n^*) and fixed wage (w and w^*) engaged in zth sector both respectively in domestic and foreign economies, we can solve the equilibrium outputs and international market price for each sector using cournot competition. The outputs of representative firm in zth sector in the domestic and foreign economies are:

$$y_T(z) = \frac{\acute{a} - (n^* + 1)w\alpha(z) + n^* w^* \alpha^*(z)}{\acute{b}(n + n^* + 1)} \tag{17}$$

$$y_T^*(z) = \frac{\acute{a} - (n + 1)w^*\alpha^*(z) + nw\alpha(z)}{\acute{b}(n + n^* + 1)} \tag{18}$$

Note that the sectoral output in the domestic economy depends inversely on own labor cost and is directly related to the rival cost. These together give us total marketed output, $\bar{x}_T = ny(z)+n^*y^*(z)$. The equilibrium market price is $p_T^*(z) = \frac{\acute{a}+nw\alpha(z)+n^*w^*\alpha^*(z)}{n+n^*+1}$. With these outputs and market price, the sectoral level profits in domestic and foreign countries are found as: $\Pi_T(z) = n(y_T(z))^2$ and $\Pi_T^*(z) = n^*(y_T^*(z))^2$. According to these specifications, if the labor cost is high in a particular sector either due to higher wage or poor technology, the market price is higher and hence the sector output and profit must be lower. In other words, there could be some sectors at a lower level of technology who cannot derive sufficient marginal revenue to meet the marginal costs in order to remain in one market, but can remain in the other market. In this case, the economy which has better technology enjoys comparative advantage over other and will be fully specialised on those sectors.

In order to find the range of specialization and competition between the two rivals over the values of z, we find a boarder line sector that manages to survive respectively in domestic and foreign economies. They could be drawn from their respective profit expressions and we plotted them in figure for visual representation in a plane of marginal cost of domestic firms against that of foreign firms (Figure 2). In the plane, the foreign firms gradually looses comparative advantage along horizontal axis (representing marginal cost of foreign firms) and the domestic firms loose the same along the vertical axis (representing marginal cost of domestic firms). But, both are equally competitive along 45 degree line. We first plot the threshold cost in the plane of marginal cost ($w\alpha(z)$) of domestic economy against that ($w^*\alpha^*(z)$)of foreign economy (See Figure 2). Let us derive loci of the threshold marginal cost of domestic firm for a sector, z, against that of foreign rivals where the profit of domestic firm remains zero (along CC in Figure 2). We find,

$$w\alpha(z)|_{\Pi(z)=0} = \frac{\acute{a}}{n^* + 1} + \frac{n^*}{n^* + 1} w^*\alpha^*(z) \tag{19}$$

Note that the CC line originates from a positive value on the axis of marginal cost of domestic firms and then rises gradually thereafter along the marginal cost of foreign firm. For any sector z with marginal cost higher than the CC locus, the domestic firms cannot produce and survive in the market. Since the ratio of $\alpha(z)/\alpha^*(z)$ is higher above the locus, the foreign firms prefer to produce in this region (say F). In this region of z, the foreign firm specializes. If this critical z along the locus CC is defined by $\tilde{z}$, then the foreign country specializes on the sectors within $\tilde{z} > z > 1$.

Similarly, there could be sectors with lower range of z where the foreign firms cannot survive, but the domestic firms could. Such threshold value of domestic marginal cost against that of foreign firm can be drawn from the foreign firm profit expressions and this is represented as follows (along the locus C^*C^*):

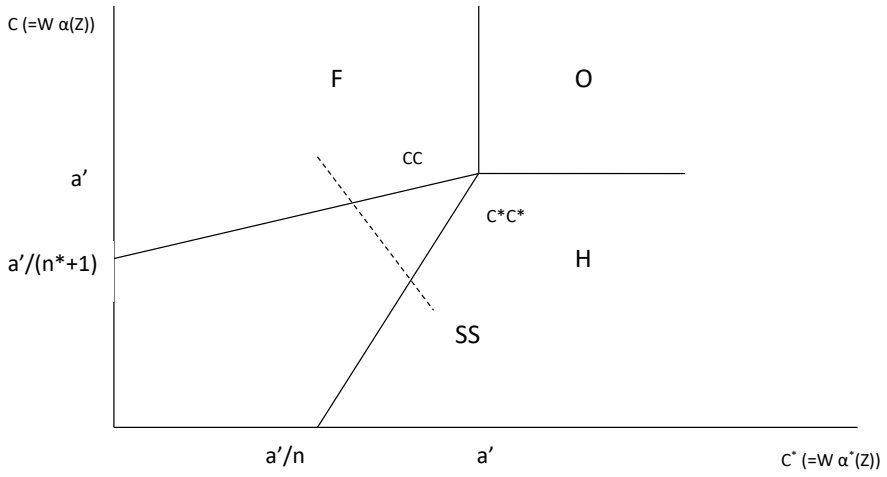
$$w\alpha(z)|_{\Pi^*(z)=0} = -\frac{\acute{a}}{n} + \frac{n+1}{n} w^*\alpha^*(z) \tag{20}$$

This condition is satisfied along the line C^*C^*, originating at a negative marginal cost of domestic firm (on the vertical line) and then monotonically rises thereafter. Since the negative value of marginal cost does not have any meaning, we ignore the range until it turns to zero (at the horizontal axis). Moreover, this locus is rising faster than CC. Because, $\frac{w\alpha(z)}{w^*\alpha^*(z)}|_{\Pi^*(z)=0} > \frac{w\alpha(z)}{w^*\alpha^*(z)}|_{\Pi(z)=0}$. It is also to be noted that the foreign firms become unprofitable for any z having marginal cost lower than the C^*C^* locus. However, the domestic firms on those sectors are still profitable due to their lower marginal costs of labour or better technology in this region. If the threshold value of z along the locus C^*C^* is defined by $\tilde{z^*}$, then the domestic economy specializes in the range, $0 < z < \tilde{z^*}$, shown in the region H. Within the region between two lines, CC and C^*C^*, both foreign and domestic firms compete within each sector of tge range $\tilde{z^*} < z < \tilde{z}$. In each sector, there will be Cournot competition between n domestic and n^* foreign firms.

The range of competition and specialization discussed above is very much influenced by the marginal costs of using labour in the respective economies. It essentially suggests that the degree of competition depends on the technology gap, product and labour market conditions that determine the level of marginal costs. Since we are interested to investigate the effect of trade on wage and labour share under different labor conditions, the level of technology differs across sectors but is assumed to remain fixed under various market conditions. The firms belonging to the level of z representing the 45 degree line have identical marginal costs in both countries and have same technologies with inverse distribution. Then, the market size and competition effects jointly determine the wages. For any other sector, where technologies differ, the degree of comparative advantage plays an additional role. In order to investigate the joint effects of these three forces on the fac-

tor income under different market conditions, we assume that both countries are almost identical. Then, we shall allow entry to see its implication on the degree of comparative advantage and competition and their resultant effect on the factor income and share.

Figure 2: Sectors for competition and specialization



In order to investigate the effect of comparative advantage, we assume that both

countries are symmetric, for simplicity without loss of generality. Hence, they have same labor force, $L = L*$; have similar tastes, $a = \acute{a}$; have the same industrial structure, $n = n*$; and the similar moments of technology distribution, $\mu_1 = \mu_1^*$ and $\mu_2 = mu_2^*$. In effect, they must have the same marginal utility of income, $\lambda = \lambda^* = \frac{1}{2}\bar{\lambda}$, and the same wage, $w = w^*$.

Even if both countries are assumed to be symmetric, but they could be different from each other at least on two grounds. One, the pattern of technology distribution across sectors may not be the same, rather inverse. This suggests that labor requirements, at least, for some sectors could be different between two countries, meaning that the comparative advantage of producing some goods would be higher in one country in comparison to the other. In order to specifically investigate the role of this, let us define the uncentered covariance of the two technology distribution as:

$$\gamma \equiv \int_0^1 \alpha(z)\alpha^*(z)dz \tag{21}$$

Similarly, we define the centered covariance as:

$$\omega \equiv \int_0^1 [\alpha(z) - \mu_1][\alpha^*(z) - \mu_1^*]dz = \lambda - \mu_1\mu_1^* \tag{22}$$

Given these specifications, we can define the degree of technology dissimilarity as:

$$\delta \equiv \int_0^1 \alpha(z)\big(\alpha(z) - \alpha^*(z)\big)dz = \mu_2 - \gamma \tag{23}$$

This captures the degree of technological dissimilarity between two countries or a measure of comparative advantage. Higher the value of δ, higher would be the measure of comparative advantage. When $\delta = 0$, the comparative advantage is zero and the countries are identical in all aspects.

Second, the aggregate demand functions faced by each firm would be different from the one seen in autarky. Under the similar conditions, the demand function can be represented as:

$$\bar{x}(z) \equiv x(z) + x^*(z) = \frac{2\lambda}{b}\big(\frac{a}{\lambda} - p(z)\big) \tag{24}$$

This expression suggests that, unlike autarky, the market would be different in two respects. (i) the domestic firm can now face the foreign market and vice versa. This is reflected in a drop of the slope in demand function, keeping the autonomous part identical, i.e., $a = a^* = \frac{1}{2}\bar{a}$. As a result, the size of proportional demand effectively goes up. The slope of perceived demand function falls within the range from $\frac{b}{\lambda}$ to $\frac{b}{2\lambda}$.

The sectoral output of domestic producers and price are solved respectively as follows:

$$y(z) = \frac{2n}{b(2n+1)}[a - \lambda nw[\alpha(z) - \alpha^*(z)] - \lambda w\alpha(z)] \tag{25}$$

$$p(z) = \frac{1}{\lambda(2n+1)}[a + \lambda n(w(\alpha(z) - \alpha^*(z)) + 2\lambda n] \tag{26}$$

It is interesting to note that the dissimilarity of technology or comparative advantage now influences the sectoral outputs directly. If the foreign firms are more productive in a specific zth sector, the outputs of the domestic firms engaged in the sector would be lower and this depends upon the degree of the technology gap. Low sectoral production demands now less labor and thereby has implication on the equilibrium wage. The resultant wage is supposed to differ under two labor market conditions. So, the technology gap seems to affect outputs indirectly through the change in the wage after trade. The presence of union in the labor market tends to have a differential impact than that without union.

3.2.1 No Union

Similar to the autarky, when all workers are employed in the absence of labor union, we can derive the wage in the domestic economy from the equality of labor demand and supply conditions in the follow form:

$$w_T^N = \big(a\mu_1 - \frac{2n+1}{2n}bL\big)\frac{1}{\mu_2 + n\delta} \tag{27}$$

Comparing with the autarky wage without union, there are three distinct forces affecting the wage after trade. *First*, the market size effect has now been doubled from $\frac{1}{n}$ to $\frac{1}{2n}$. Due to the increased number of firms in each sector, the demand for labor rises leading to an increase in the wage. *Second*, the number of competitors has now also been doubled. With this increased competition, each firm scales down the production and reduces the demand for workers. This slims down the price from $-(n+1)$ to $-(2n+1)$. Due to the presence of stronger market size effect than the competition effect, these two forces together create favourable impact on the net rise in the equilibrium wage and hence it goes up after trade. *Third*, the degree of comparative advantage, captured by δ, now has an adverse implication on the wage, because the productive firms after trade capture a greater market share and they demand less number of workers. Moreover, some low productive firms who need more labor might leave the market. As a result, the wage tends to fall. If this force is more powerful than the joint effects of market size and competition, the wage may rise after trade, otherwise not. In other words, the effect of trade on wage in this case in indeterminate and ambiguous.

3.2.2 Union

Following the assumption of 'right-to-manage' production, the union utility function can be expressed in terms of the sum of total wage rent to be derived by the workers as follows:

$$H_T^U = (w - w_0)\frac{2n}{b(2n+1)}\int_0^1 \alpha(z)(a - \lambda nw[\alpha(z) - \alpha*(z)] - \lambda(w\alpha(z))dz \tag{28}$$

Maximizing this, the union fixes the wage at:

$$w_T^U = \frac{a\mu_1}{2(n\delta + \mu_2)} + \frac{\lambda w_0}{2} \tag{29}$$

Now, the number of rivals in each sector can play a role in determining the equilibrium wage in this case. Comparing this wage after trade with the one at autarky with union, we find that the union wage unambiguously falls after trade. There are again three sources of difference. First, the market size effect raises the demand for labor and hence pushes up the union wage. *Second*, each firm receives the reduced demand due to a lower market share with the increased cournot competition from foreign rivals. The competition from foreign firms reduces the union strength and brings the wage into the previous level. The union fixes the wage at the monopsony level. The reduced price due to the increased international competition is compensated fully by the rise of the market size. As a result, the joint effect of these two forces do not affect wage at all. Hence, when $\delta = 0$, we find $w_T^U|\delta = 0 = w_a^U$ and this confirms that the wages are same in the absence of comparative advantage. *Third*, the effect of the comparative advantage occurring with δ after trade seems to be detrimental in making the difference between the two regimes. For $\delta > 0$, we get $w_T^U < w_a^U$. In other words, the wage falls after trade for any positive value of comparative advantage. Higher the value of δ, greater would be the market share of most productive rivals in the international market and lower would be demand for labor. The productive firms require less labor and thus depress the wage. In total, therefore, net effect of these three forces depress the wage unambiguously.

Proposition 1 *The joint effects of market size, competition and comparative advantage arising out of trade have been ambiguous on the equilibrium wage in the absence of union, but negative in the presence of union.*

The drop of the equilibrium wage essentially reduces the market price and thereby raises the sectoral production. The sectoral output of domestic producers and price are solved respectively as follows:

$$y(z) = \frac{2n}{b(2n+1)}[a - \lambda nw_T^U[\alpha(z) - \alpha^*(z)] - \lambda w_T^U\alpha(z)] \tag{30}$$

$$p(z) = \frac{1}{\lambda(2n+1)}[a + \lambda n(w_T^U(\alpha(z) - \alpha^*(z)) + 2\lambda n] \tag{31}$$

Again, multiplying labor requirements with the sectoral outputs and integrating over all sectors, the total employment has been found as follows:

$$L_T^U = \frac{2n}{b(2n+1)}[a\mu_1 - (\mu_2 + n\delta)w_T^U] = \frac{n}{b(2n+1)}[a\mu_1 - \lambda(\mu_2 + n\delta)w_0] \tag{32}$$

The comparative advantage reduces the demand for workers and the increased production. The net effect of trade on employment seems to be uncertain. *First*, the effect of market size increases the demand for labor from n to $2n$. *Second*, the increased competition reduces the demand from $\frac{1}{n+1}$ to $\frac{1}{2n+1}$. The joint effects of these two would be favourable to raise employment from $\frac{n}{n+1}$ to $\frac{2n}{2n+1}$. *Third*, the effect of comparative advantage reduces the demand by the degree λ. The net effect of these three forces has been ambiguous. If the positive effect of market size and competition is higher than the negative effect of comparative advantage, then the total employment can rise after trade, otherwise not. Then, this could be presented as:

Proposition 2 *The joint effects of market size, competition and comparative advantage arising out of trade have been ambiguous on the equilibrium employment in the presence of union. If* $\frac{1}{2(n+1)}(a\mu_1 - \mu_2 w_0) < n\delta w_0$, *then* $L_T^U < L_a^U$.

The wage gap between two cases with and without union shrinks after trade. The unionised wage declines unambiguously due to the adverse effect of comparative advantage. Hence, the union wage could be higher than the one without union after trade if the joint effects of market size and competition is weaker than the negative effect of comparative advantage. Note that the critical number of competitors required to equate these two wages (defined as n_T) after trade is lower than that under autarky (n_a).

Lemma 2*: If* $\frac{2n+1}{2n}bL - \frac{a\mu_1 - w_0(\mu_2+n\delta)}{2} > 0$ *or* $2\delta w_0 n_T^2 - 2(a\mu_1 - \mu_2 w_0 - bl)n_T + bl > 0$, *then* $w_T^U > w_T^N$.

4 Trade and Labor Share

A drop in absolute wage in the presence of union cannot assure the decline in distributive share of workers after trade. If the share is defined by the ratio of total wage bills paid to the workers out of gross value added, it can be written as $s = \frac{wL}{I}$, where W =wage rate, L=employment and I =total income or gross value added. The residue would obviously be profit share. Eliminating I, this can be represented in terms of the ratio of

total wage to profits: $\frac{s}{(1-s)}(=\theta) = \frac{wL}{\Pi}$. This suggests that if wage bills rise faster than profits the labor share must rise. It is the most convenient way to show the distributive conflict between wage and profit earners. For the comparative analysis, we shall derive this ratio for two regimes separately. Note that if θ rises, s also increases. Hence, they are monotonically related. We can derive the change in θ between two regimes. Alternatively, one can also represent θ in terms of logarithm change so that the effect of trade can be worked out. Taking logarithm and change, we express as follows:

$$dln\theta_T = dln(wL)_T - dln\Pi_T = (dlnw_T + dlnL_T) - dln\Pi_T \tag{33}$$

We use both approaches. Note that $dlnL_T^N = 0$ in the absence of union and $dlnL_T^U \neq 0$ in the presence of union. So, one needs to count the employment change in the presence of union only at the time of deriving the effect of trade on labor share.

Let us first derive profit. The aggregate profit across sectors is:

$$\Pi = \int_0^1 n\pi(z)dz \tag{34}$$

Where, $\pi(z) = [p(z) - w_a]y(z) = \acute{b}y^2(z)$. Substituting output under autarky, we get.

$$\Pi_a = \frac{n}{b(n+1)^2}(a^2 - 2a\mu_1 w_a + \mu_2(w_a)^2) \tag{35}$$

Similarly, substituting output after trade, we get

$$\Pi_T = \frac{2n}{b(2n+1)^2}[a^2 - 2a\mu_1 w_T + \{\mu_2 + 2n(n+1)\delta\}(w_T)^2] \tag{36}$$

Note that the joint effect of market size and competition reduces profit and the comparative advantage raises it directly and affects through wage change indirectly. The indirect effect is, however, ambiguous.

Let us first investigate the effect of trade on labor share in the absence of comparative advantage (when $\delta = 0$). Then, the wage in the absence of union can be represented as follows:

$$w_{T|\delta=0}^N = (a\mu_1 - \frac{2n+1}{2n}bL)\frac{1}{\mu_2} \tag{37}$$

Comparing the wage under trade with respect to the one under autarky without union, we get

$$w_a^N - w_{T|\delta=0}^N = -\frac{b^2}{n\mu_2} < 0 \tag{38}$$

This confirms that the absolute wage without union rises after trade. Because, the positive effect of market size dominates the adverse effect of competition on the labor demand. Substituting output and $\delta = 0$, the sectoral profit is:

$$\Pi^N_{T|\delta=0} = \big[\frac{2na^2}{b(2n+1)^2}\sigma^2 + \frac{bL^2}{2n}\big]\frac{1}{\mu_2} \tag{39}$$

$$\Pi^N_a - \Pi^N_{T|\delta=0} = \big[\frac{(2n^2-1)na^2}{b(2n+1)^2(n+1)^2}\sigma^2 + \frac{bL^2}{2n}\big]\frac{1}{\mu_2} > 0 \tag{40}$$

Where $\sigma^2 = \mu_2 - \mu_1^2$. In response to the above-mentioned two effects, since the wage rise increases the cost of production, the profit of the firms must fall. Using the equilibrium wages and profits under autarky and trade, the ratio of labor share under trade to autarky can be expressed as follows:

$$\theta^N_{T|\delta=0}/\theta^N_a > 0 \tag{41}$$

Because, $w^N_{T|\delta=0}/w^N_a > 0$ and $\Pi^N_{T|\delta=0}/\Pi^N_a < 0$

Lemma 3: *If $\delta = 0$, then $\theta^N_T/\theta^N_{a|\delta=0} < 0$.*

This confirms that the labor share rises after trade in the absence of union and heterogeneity.

In the presence of union, the wage does not change, but the employment is affected. When we compare the labor share between two regimes with union, the employment level must be compared as well. Comparing the wage in the presence of union at autarky with that of trade, we get: $w^U_a = w^U_{T|\delta=0} = \frac{a\mu_1}{2\mu_2} + \frac{w_0}{2}$. It is already found that there is no change in union wage in the absence of comparative advantage.

Similarly, we get $L^U_a = \frac{n}{b(n+1)}[a\mu_1 - \mu_2 w^U_a]$. Then, in the absence of comparative advantage we get $L^U_{T|\delta=0} - L^U_a = \frac{2(n+1)}{(1+2n)} > 0$. So, the employment level rises after trade. Because, the market size effect dominates the competition effect and hence employment rise at the same wage.

Similarly, substituting equilibrium outputs under two regimes in the presence of union, we get:

$$\Pi^U_a = \frac{n}{b(n+1)^2}[a^2 - 2a\mu_1 w^U_a + \mu_2 (w^U_a)^2] \tag{42}$$

Even when the union wage remains same, the employment rises due to the favourable market size effect at the domestic economy. This suggests that wage share must rise.

$$\Pi^U_{T|\delta=0} = \frac{2n}{b(2n+1)^2}[a^2 - 2a\mu_1 w^U_T + \mu_2 (w^U_T)^2] \tag{43}$$

Comparing them when $\delta = 0$, we get

$$\Pi^U_{T|\delta=0}/\Pi^U_a = \frac{2(n+1)^2}{(2n+1)^2} < 0 \tag{44}$$

The increased employment (at the same union wage) after trade slims down the profits of the firms. Therefore, the labor share after trade with union and without comparative advantage must rise. These shares will be compared with the ones after trade.

***Lemma 4**: If $\delta = 0$, then $\frac{\theta^U_T|\delta=0}{\theta^U_a} = \frac{2n+1}{n+1} > 1$.*

This suggests that the labor share rises because of increased employment and reduced profit after trade.

Now, we are in a position to compare the labor share between two regions even in the presence of comparative advantage. Since the comparison tends to be complicated, they are presented in logarithmic expression instead of the ratio. After substitution of equilibrium output and then logarithmically differentiating the level of profits, we find

$$Hdln\Pi^*_T = -2[a\mu_1 - \{\mu_2 + 2(n+1)n\delta\}w^*_T]w^*_T dlnw^*_T + 2n(n+1)\delta(w^*_T)^2 dln\delta \tag{45}$$

where, $H = a^2 - 2a\mu_1 w^*_T + \{\mu_2 + 2n(n+1)\delta\}(w^*_T)^2$. This suggests that the profit change is inversely related to wage change and positively related to the degree of comparative advantage.

In the absence of union, since $dlnL^*_T = 0$, we get

$$Hln\theta^N_T = [a^2 - \{\mu_2 + 2n(n+1)\delta\}(w^N_T)^2]dlnw^N_T - 2n(n+1)\delta(w^N_T)^2 dln\delta \tag{46}$$

This expression suggests that the direct effect of the degree of comparative advantage has been negative on the wage share. However, the indirect effect of the same via wage change is ambiguous. Taking logarithmic differentiation of wage equation in this case, we get $dlnw^N_T = -\frac{n\delta}{\mu_2+n\delta}dln\delta$. This confirms again that a rise of comparative advantage reduces the wage after trade.

Substituting these into the above expression, we write

$$H\frac{dln\theta^N_T}{dln\delta} = -[a^2 + (2n+1)\mu_2(w^N_T)^2]\frac{n\delta}{\mu_2 + n\delta} < 0 \tag{47}$$

It suggests that the negative direct effect of comparative advantage dominates the indirect effect via the change in wage and hence the degree of comparative advantage affects wage share adversely. The wage share falls unambiguously after trade even when the absolute wage rises without union.

On the other hand, $dlnL^*_T \neq 0$ in the presence of union, and hence the result seems to be a bit different from the one without union. At the w^U_T, we get the employment,

$L_T^U = \frac{2n}{b(2n+1)}[a\mu_1(\mu_2 + n\delta)w_T^U]$. Hence, taking logarithm and totally differentiating, we get

$$Gdln(wL)_T^U = [a\mu_1 - 2(\mu_2 + n\delta)w_T^C]w_T^U dlnw_T^U - n\delta(w_T^U)^2 dln\delta \tag{48}$$

Where, $G = [a\mu_1 - (\mu_2 + n\delta)w_T^U]$. This expression suggests that the direct effect of comparative advantage has been negative, but the indirect effect of this via wage change has been ambiguous on wage bills.

We have already seen before that the comparative advantage has positive impact on the aggregate profits directly. Since the absolute union wage declines in this case, the profit rise indirectly in response to the level of comparative advantage. Therefore, the net effect of the comparative advantage on the profit is much greater than the one without union. But, the overall effect of wage share depends the relative strength of indirect effect on wage bills against the direct effect of comparative effect. Taking difference between the changes in wage bills and aggregate profits, we get

$$\begin{aligned} dln\theta_T^U = & \frac{[a\mu_1 - 2(\mu_2 + n\delta)w_T^U]w_T^U}{G} dlnw_T^U - \frac{n\delta(w_T^U)^2}{G} dln\delta \\ & - \frac{2[a\mu_1 - \{\mu_2 + 2(n+1)n\delta\}w_T^U]w_T^U}{H} dlnw_T^U - \frac{2n(n+1)\delta(w_T^U)^2}{H} dln\delta \end{aligned} \tag{49}$$

The direct effect of comparative advantage can be found:

$$\begin{aligned} \frac{dln\theta_T^U}{dln\delta} &= -\frac{n\delta(w_T^U)^2}{G} - \frac{2n(n+1)\delta(w_T^U)^2}{H} \\ &= -n\delta(w_T^U)^2(a(a + 2n\mu_1 w_T^U) - (a + 2n)\mu_2(w_T^U)^2) \end{aligned} \tag{50}$$

This is definitely negative. In other words, a rise of comparative advantage directly reduces the labor share, because this reduces demand for workers and thereby reduces wage and encourages profits. On the other hand, the wage effect of the share can be represented.

$$\begin{aligned} \frac{dln\theta_T^U}{dlnw_T^U} &= \frac{[a\mu_1 - 2(\mu_2 + n\delta)w_T^U]w_T^U}{G} - \frac{2[a\mu_1 - \{\mu_2 + 2(n+1)n\delta\}w_T^U]w_T^*}{H} \\ &= aw_T^U(-2aw(n\delta + \mu_2) + \mu_1(a^2 - 2n^2w^2\delta + \mu_2(w_T^U)^2)) \end{aligned} \tag{51}$$

The wage effect on the share is not certain. Because, in response to the trade, if union wage declines, the employment increases as a result. So, the net effect depends on

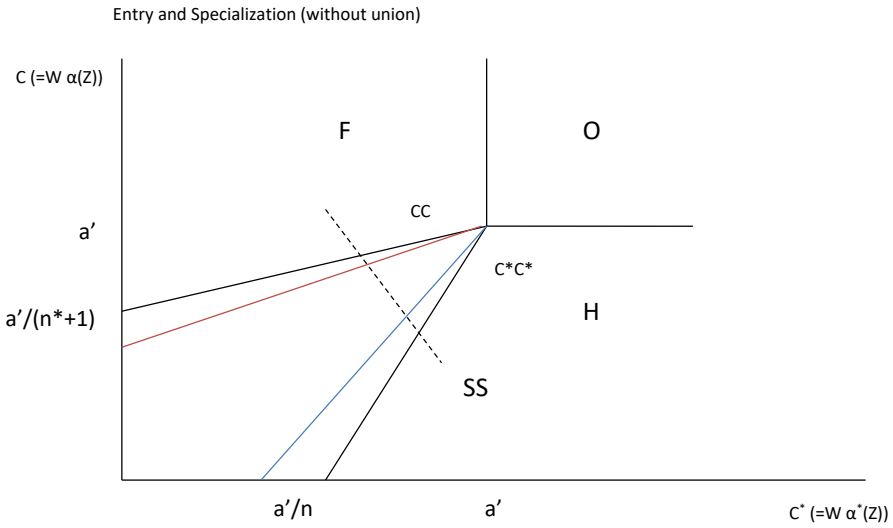
the relative strengths between these two. Since the comparative advantage is mediated through wage change, we can replace $dlnw_T^U = -\frac{n\delta}{n\delta+\mu_2}$. After substituting this we get the total effect of comparative advantage on the share:

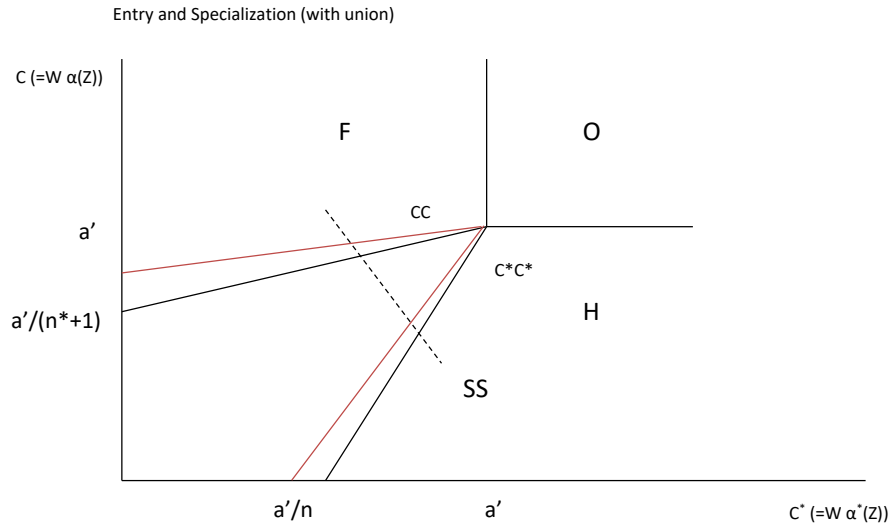
$$\frac{dln\theta_T^U}{dln\delta} = -\frac{n\delta w_T^U(a^2+(1+2n)\mu_2 w_T^U)(a\mu_1-(n\delta+\mu_2))}{(n\delta+\mu_2)GH} < 0 \tag{52}$$

This confirms that the total effect of comparative advantage has been adverse on the labor share unambiguously. Although the trade reduces the wage rate, it does not necessarily depress the aggregate wage bills. Because the lower wage rate raises the aggregate employment. At the same time, the lower wage leads to a drop in price and thereby increases production. So, the effect on wage bills is ambiguous. However, while the degree of comparative advantage diminishes the wage, it cannot raise the employment, because the market share of most productive firm rises and that leads to a drop in the demand for labour. This force tends to be strong enough to compensate any favourable effect on wage bills. As a result, the labour share shrinks.

Proposition 3 *Even if the trade affects absolute wage differently between with and without union, the labor share falls unambiguously in both case due to direct and indirect effects of wage change via specialization (or comparative advantage). But, the share does not fall without specialization.*

Therefore, it is found that the labour share rises after trade due to the composite effects of market size and competition and in the absence of comparative advantage. The composite effects could not raise the share due to the strong effect of comparative advantage. As a result, the joint effects of these three forces arising out of trade lead to a decline in labor share after trade. This result is different from Neary (2016) on two accounts. *First*, the composite effects of market size and competition do not raise absolute wage in the presence of both product and labor market imperfections. This is not true when labor market imperfection is ignored. *Second*, this explains the existence of unemployment along with a declining labor share in a number of countries. *Third*, the ex-post degree of comparative advantage moves in opposite directions. Since the union wage declines, the locus of threshold level of z moves in opposite directions for both countries. The firms with z who were just immediately outside the ex-ante threshold level (or at autarky wage) can now survive. As a result, the degree of competition between two countries rises and the degree of specialization falls in presence of labor market imperfection. On the other hand, the wage can rise in the absence of union and hence, the degree of competition falls, leading to a rise of country specializations (see Figure 3).





5 Entry, Trade and Wage

A fixed set of firms are considered in the previous discussion. However, the domestic economy can adopt strategies to raise competition so that the firms can enter. Or, the increased international competition can generate a spillover effect that may reduce fixed costs and hence encourage entry in each sector to some extent. Let us discuss

the implication of such entry in the domestic economy on the equilibrium wage. The entry affects the demand for labor and the resultant wage. But, this is not straightforward, because any change in wage or marginal cost has implications for the degree of specialisation and competition. The change in specialization has further implication the labor income.

When the domestic economy specializes in the sectors, $z \in [0, \tilde{z}^*]$ and compete with the foreign firms over sectors, $z \in [\tilde{z}^*, \tilde{z}]$, the total demand for labor in the domestic economy is as follows:

$$L^D = \int_0^{\tilde{z}^*} n\alpha(z)y(z)|_{n^*=0}dz + \int_{\tilde{z}^*}^{\tilde{z}} n\alpha(z)y(z)|_{n^*>0}dz \tag{53}$$

The first term of integration shows labor demand from the specialized sector and the second term shows the demand from competitive sectors. Needless to say that the demand is inversely related to own wage and directly related to the foreign wage. Similarly, when the foreign economy specialises on the sectors, $z \in [\tilde{z}, 1]$ and competes with the domestic firms over sectors, $z \in [\tilde{z}^*, \tilde{z}]$, the total demand for labour in the foreign economy can be expressed as follows:

$$L^{*D} = \int_{\tilde{z}}^1 n^*\alpha^*(z)y^*(z)|_{n=0}dz + \int_{\tilde{z}^*}^{\tilde{z}} n^*\alpha^*(z)y^*(z)|_{n^*>0}dz \tag{54}$$

Again, the first term of the integration captures the demand for labor from those sectors where the foreign firms specializes and the second terms includes the demand from competitive sectors. The demand for foreign labor is negatively related to own wage and directly related to the domestic wage.

From the expressions for outputs, the threshold sectors in each country, $\tilde{z}$ and $\tilde{z^*}$, are defined by the following equations:

$$y(\tilde{z}) \geq 0 \Rightarrow (\bar{a} - (n^* + 1)w\alpha(\tilde{z} - n^*w^*\alpha(\tilde{z^*})) \geq 0, \tilde{z} \leq 0 \tag{55}$$

$$y^*(\tilde{z^*}) \geq 0 \Rightarrow (\bar{a} - (n^{+}1)w^*\alpha(\tilde{z^*} - nw\alpha(\tilde{z^*})) \geq 0, \tilde{z^*} \geq 0 \tag{56}$$

The effect of an increase in n on wages depends on the net change of the demand for labor after accounting for competition and specialization effects. The results of these two interaction effects seem to be different. Hence, they are discussed differently. Before that, let us look at the partial effects of these sources arising out of the domestic entry.

The effect of specialization on the labor demand is derived by taking partial derivative of the threshold demand function with the respect to the threshold sector $\tilde{s}$. Using

L'Hospital Rule, they are: $L_{\tilde{z}}^D = n\alpha(\tilde{z})y(\tilde{z}) = 0$ since $y(\tilde{z}) = 0$. Similarly, $L_{\tilde{z^*}}^D = \alpha(\tilde{z^*})[x(\tilde{z^*} - ny(\tilde{z^*}) = 0$ since $x(\tilde{z^*} - ny(\tilde{z^*}) = 0$

This is also true for $L_{\tilde{z}}^{*D}$ and $L_{\tilde{z^*}}^D$. Therefore, even if the entry affects specialization, a small change in threshold does not have any impact on labor demand and hence these terms can be ignored from further derivations. The effect of entry has direct impact on the labor demand both in the domestic and foreign economies. Taking partial derivatives with respect to n, we get

$$L_n = n\int_0^{\tilde{z^*}} \alpha(z)\frac{\partial y(z)}{\partial n}|_{n^*=0}dz + n\int_{\tilde{z^*}}^{\tilde{z}} \alpha(z)[y(z) + n\frac{\partial y(z)}{\partial w}|_{n^*>0}dz$$
$$\frac{1}{n+1}\int_0^{\tilde{z^*}} \alpha(z)y(z)|_{n^*=0}dz + \frac{n^*+1}{n+n^*+1}\int_{\tilde{z^*}}^{\tilde{z}} \alpha(z)y(z)|_{n^*>0}dz > 0 \qquad (57)$$

Though the effect of entry reduces individual outputs, it increases total output and thereby demand for labor in the domestic economy. This is a standard result of any strategic competition.

Similarly, taking partial derivatives of the foreign labor demand function with respect to n, we get

$$L_n^* = n^*\int_{\tilde{z^*}}^{\tilde{z}} \alpha^*(z)\frac{\Delta y^*(z)}{\Delta n}|_{n>0}dz = -\frac{n^*}{n+n^*+1}\int_{\tilde{z^*}}^{\tilde{z}} \alpha^*(z)y^*(z)|_{n>0}dz < 0 \qquad (58)$$

So, the foreign labor demand decreases with the increased domestic entry, because the entry raises domestic production and hence reduces international market prices. As a result, the foreign production and the resultant demand for labour fall.

The entry also affects the labor demand in both the economies indirectly through the changes in wages. Taking the partial derivative of labor demand with respective to w, we get

$$L_w = n\int_0^{\tilde{z^*}} \alpha(z)\frac{\Delta y(z)}{\Delta n}|_{n^*=0}dz + n\int_{\tilde{z^*}}^{\tilde{z}} \alpha(z)\frac{\Delta y(z)}{\Delta w}|_{n^*>0}dz < 0 \qquad (59)$$

When the entry in the domestic economy raises the demand for labor, it pushes up the domestic wage and hence reduces a demand bit. On the other hand, taking derivative of the domestic labor demand with respect to w^*, we get

$$L_{w^*} = n\int_{\tilde{z^*}}^{\tilde{z}} \alpha(z)\frac{\Delta y(z)}{\Delta w^*}|_{n^*>0}dz > 0 \qquad (60)$$

As the domestic entry reduces the demand for foreign labor, this diminishes the foreign wage. The drop in wage recovers the demand marginally.

The second order derivative of L_w and L_{w^*}, with respect to n we get

$$L_{wn} = -\frac{1}{b'(n+1)^2}\int_0^{\tilde{z}} \alpha^2(z)dz - \frac{n^*(n^*+1)}{b'(n+n^*+1)^2}\int_{\tilde{z}}^{\tilde{z^*}} \alpha^2(z)dz < 0 \tag{61}$$

Similarly,

$$L_{w^*n} = -\frac{n^*(n^*+1)}{b'(n+n^*+1)^2}\int_{\tilde{z}}^{\tilde{z^*}} \alpha(z)\alpha^*(z)dz > 0 \tag{62}$$

The domestic entry could also affect marginal demand of wages. So, taking derivatives of L_w^* and $L_{w^*}^*$ with respect to n, we get

$$L_w^* = \frac{n^*}{b'(n+n^*+1)^2}\int_{\tilde{z}}^{\tilde{z^*}} \alpha(z)\alpha^*(z)dz > 0 \tag{63}$$

$$L_{w^*n}^* = -\frac{n^*(n+1)}{b'(n+n^*+1)^2}\int_{\tilde{z}}^{\tilde{z^*}} \alpha^2(z)dz - \frac{n^*}{b'(n+1)^2}\int_{\tilde{z}}^{1} \alpha^{*2}(z)dz < 0 \tag{64}$$

Given the results of these partial derivatives, we are in a position to estimate the total effect of entry on the wages. Since, the resultant effects depend on the degree of labor market imperfections, they are discussed separately.

5.1 No Union

In the absence of union, the wages are determined from the equality between total demand and supply of labor without any rigidity of employment. Then, from the equilibrium conditions, the total change of demand due to wage effects can be represented as follows:

$$L_w dw + L_{w^*}dw^* + Ldn + L_{\tilde{z}}d\tilde{z} + L_{\tilde{z^*}}d\tilde{z^*} = 0 \tag{65}$$

$$L_w^* dw + L_{w^*}^* dw^* + L^* dn + L_{\tilde{z}}^* d\tilde{z} + L_{\tilde{z^*}}d\tilde{z^*} = 0 \tag{66}$$

Even if the change in marginal cost of production affects degree of specialization, we prove that the change in specialization does not influence the labor demand directly. Hence, with $L_{\tilde{z}}^* = 0$ and $L_{\tilde{z^*}} = 0$, and ignoring these terms, we can solve the entry effects on the wages as follows:

$$\frac{dw}{dn} = [-L_n L_{w^*}^* + L_n^* L_{w^*}]/A \tag{67}$$

$$\frac{dw^*}{dn} = [L_n L_w^* - L_n^* L_w]/A \tag{68}$$

where $A = L_w L_{w^*}^* - L_{w^*} L_w^* > 0$. Considering signs of the partial derivatives, we cannot guarantee the effect of entry on wage rise. However, with some simplified assumptions, we can comment specifically on the relative change of domestic wage to foreign wage in

terms of proportional change. Converting them into the proportional change and taking the difference, we get

$$\frac{\hat{w} - \hat{w^*}}{\hat{n}} = \frac{1}{nww^*A}[L_n^*(wL_w + w^*L_w^*) - L_n(w^*L_{w^*}^* + wL_w^*)] \tag{69}$$

If we assume own-effects of wages dominates the cross-effects in home and foreign labor demands and the positive own-effect of n on home labor demand dominates its negative cross-effect, one can write $L_n^*(wL_w + w^*L_w^*) < 0$ and $L_n(w^*L_{w^*}^* + wL_w^*) > 0$. Then, we get $\frac{\hat{w}-\hat{w^*}}{\hat{n}} < 0$.

The wage tends to rise due to the increase in domestic demand for labor without union. But, the increased wage raises cost of production at the intensive margin and hence reduces the demand for workers. Moreover, at the extensive margin some domestic sector who were around the threshold sectors may leave the market due to increased production costs. And, the domestic economy loses specialisation. On the whole, there would be a fall in the domestic demand. Moreover, the wage rise cannot go upto the autarky level. Because, the higher wage gain in the domestic market in comparison to the foreign market shifts the market share towards the foreign producers. This limits the demand for domestic production and wage further.

5.2 Union

In the presence of union, the workers centrally determine the wages. The utility functions in the domestic and foreign economies can be represented respectively as follows:

$$H = (w - w_0)[\int_0^{\tilde{z}} \alpha(z)y(z)|_{n^*=0}dz + \int_{\tilde{z}}^{\tilde{z^*}} \alpha(z)y(z)|_{n^*>0}dz] \tag{70}$$

$$H^* = (w * -w_0)[\int_{\tilde{z}}^{\tilde{z^*}} \alpha^*(z)y^*(z)|_{n>0}dz + \int_{\tilde{z}}^{1} \alpha^*(z)y^*(z)|_{n=0}dz] \tag{71}$$

Maximising these two expressions with respect to their wages and then taking derivative with respect to the domestic entry, we get:

$$2L_w\frac{dw}{dn} + L_{w^*}\frac{dw^*}{dn} = -Ln - (w - w_0)L_{wn} \tag{72}$$

$$L_w^*\frac{dw}{dn} + 2L_{w^*}^*\frac{dw^*}{dn} = -L^*n - (w * -w_0)L_{w^*n}^* \tag{73}$$

Solving these two equations, we get:

$$\frac{dw}{dn} = \frac{-(L_n + (w - w_0)L_{wn})2L_{w^*}^* + L_{w^*}(L_n^* + (w^* - w_0)L_{w^*n}^*}{A} \tag{74}$$

$$\frac{dw^*}{dn} = \frac{-(L_n^* + (w^* - w_0)L_{w^*n}^*)2L_w + L_w^*(L_n + (w - w_0)L_{wn}}{A} \tag{75}$$

Looking at the signs of the partial derivatives, we cannot confirm the effect of domestic entry on the respective wages. However, we can represent the proportional change:

$$\frac{\hat{w} - \hat{w^*}}{\hat{n}} = \frac{n}{ww^*A}[(2wL_w + w^*L^{w^*})(L_n^* + (w^* - w_0)L_{w^*n}^*) - (2w^*L_w^* + wL_w^*)(L_n + (w - w_0)L_{wn}] \tag{76}$$

Similarly, assuming own price effects of wage on the labor demands are stronger than the cross effects, we can say that the domestic wage rises relative to foreign wage. Hence, $\frac{\hat{w} - \hat{w^*}}{\hat{n}} \geq 0$. Comparing the proportional wage change between two regimes, we get

$$\frac{\hat{w} - \hat{w^*}}{\hat{n}}|_{Union} - \frac{\hat{w} - \hat{w^*}}{\hat{n}}|_{No-union} = -L_{w^*}^*(L_n + 2L_{wn}(w - w_0)) + L_{w^*}L_{w^*n}^*(w^* - w_0) \tag{77}$$

One cannot firmly conclude that the union wage gain is always higher than that without union, because the domestic entry encourages the union to negotiate for an extra rent. This shifts away demand from the domestic to the foreign economy. As a result, the wage cannot rise upto the level of the autarky.

Proposition 4 *The domestic entry raises the domestic wage relative to the foreign level. The union wage gain is not unambiguously higher than that without union due to the cross-wage and specialization effects between countries. In none of those cases, the wage cannot reach upto the level of autarky for the same in response to the domestic entry.*

The relative rise of domestic wage due to an increase in domestic entry limits the output rise. But, with the assumption of stronger own and direct effect, we can find the expansion of domestic output. If the domestic output expands, we can safely argue that the labor share tends to rise in response to the domestic entry. However, if foreign country adopts the same competitive strategy, then it has spillover effects on the labor market in similar fashion and hence the wage can go upto the autarky level. In case the foreign country does not adopt the policy, if the domestic economy raises the trade barriers the wage and labor share can both rise but at the cost of lower output. Hence, this justifies the need for bilateral and multilateral agreements for joint adoption of a competitive policy under liberaized environment so that both countries can reap up its benefits for the labor market.

6 Empirical Analysis

It seems really difficult to demonstrate the effect of each channels originates from trade on the labor share. An attempt has been made to account for the overall effects using

cross country data, provided by Penn World Table version 9 (Feenstra et al., 2015). The theory deals with how the trade through market size, competition and specialization effects affects the wage and share at the aggregate level and hence the country level data has been used for the investigation. The main empirical question that needs to be answered is whether the trade affects the labor share through the change in product and labor market imperfections. A general form of country level production function is assumed to get an expression for labor share and then two market imperfections terms interacting with trade are added on to this. We assume a country level GDP function of i-th sector at t-th period with a mix of factors and product prices for s-th country as follows (using translog form):

$$lnY_{st} = a_0 + a_{st}t + \sum_{i=1}^{N} \alpha_i lnp_{sit} + \sum_{k=1}^{M} \beta_k V_{sit} + \frac{1}{2}\sum_{i=1}^{N}\sum_{j=1}^{N} \gamma_{ij} lnp_{sit} lnp_{sjt} + \frac{1}{2}\sum_{k=1}^{M}\sum_{l=1}^{M} \delta_{kl} lnV_{skt} lnV_{slt} + \sum_{i=1}^{N}\sum_{k=1}^{M} \theta_{ik} lnp_{sit} lnV_{skt} \tag{78}$$

Where, $\sum_i^N \alpha_{it} = 1$; $\sum_k^M \beta_{it} = 1$,$\sum_{it}^N \gamma_{it} = 0$ and$\sum_{kt}^M \delta_{kt} = 0$; $k = 1, ..., M$ and $i = 1, ..., N$. This satisfies the homogeneity condition. The function enables us to derive a flexible expression for labor share. Taking derivative with respect to lnV_{it}, we get

$$s_{skt} = \beta_k + \sum_{skt}^{M} \delta_{kl} lnV_{slt} + \sum_{it}^{N} \theta_{kl} lnp_{sit} + u_{sit} \tag{79}$$

This expression for labor elasticity represents labor share when there is no market imperfection. Since we are interested in investigating the effects of product and labour market imperfections, we modify this expression and relax the homogeneity condition. If market imperfection only prevails in the product market, the wage is not paid according to the value of marginal physical product, rather is equal to the marginal value of revenue product. Then, the factor share would be different from the elasticity. If the price over marginal cost is defined by μ, then it shows that $s_L = \mu s_L^M$. Here, s_L^M represents the labor share when the product market is imperfect. Since, the firm tends to raise the price over the marginal cost, the labor share would be lower than that under perfect competition depending upon the degree of market power.

On the other hand, when the imperfections prevail both in the product and labor markets, a rise in bargaining power of workers tends to reduce the labor share. The union derives a relatively higher wage than that in competitive market depending upon

their bargaining power. Formally, we can derive the relationship between them. Let us assume that $\bar{L}$ is the total workers available in the economy,w_0 is the alternative wage available to the workers outside the firm and θ is the bargaining power of the union, the union wage can be derived from the following Nash bargaining equation

$$max_{w,L}\Omega = (Lw + (\bar{L} - L)w_0 - \bar{L}w_0)^{\theta}(PY - wL)^{1-\theta} \tag{80}$$

Differentiating with respect to wage and employment, substituting $\frac{\delta(PY)}{\delta L} = \frac{P\delta Y}{\mu\delta L}$, where $\mu = \frac{e}{e-1}$ and $e = \frac{P}{Y}\frac{dY}{dP}$, then rearranging the terms, we get:

$$s_L^U = \frac{\theta}{1-\theta}(1 - s_L^U) + \frac{s_L}{\mu} \tag{81}$$

Where s_L^U represents actual labor share in the presence of both product and labor market imperfections. Note that when $\theta = 0$ and $\mu = 1$, then $s_L^U = s_L$. The difference between them would essentially be captured by the values of θ and μ. This is expressed as follows (similar the one used in Dobbelaere, 2004 and Maiti, 2013):

$$s_L^U = \theta + \frac{(1-\theta)}{\mu}s_L \tag{82}$$

Note that when $\theta = 0$ and $\mu = 1$, then $s_L^U = s_L$; and when$\theta = 0$ and $\mu > 1$, then $\mu s_L^M = s_L$. The first term on the left-hand side captures the extent of deviation due to labour market rigidity and the last term represents the same due to the mark-up. Higher the value of μ greater would be the deviation and higher the value of θ lower the difference. We define lr (represented by $lnY - lnL$) as proxy variable capturing the market size and the coefficient of this is expected to show the market power. On the other hand, br is defined by $(s_L^U - 1)(lnL - lnK)$) as a variable capturing the size of wage bills. Note that this rises with either an increase of L (given K) or wage (given the same value addition). The coefficient of this variable captures the bargaining power of labor union. Adding these two terms in the right-hand side of labor share expression, we get:

$$\begin{aligned} s_{slt} = \beta_l + \theta_l(1 + \theta_{lT}TR_{st})BR_{st} + \mu_l(1 + \mu_{lT}TR_{st})LR_{st} \\ +\beta_X X_{st} + \sum_{slt}^{M}\delta_{kl}lnV_{slt} + \sum_{it}^{N}\theta_{kl}lnp_{sit} + u_{sit} \end{aligned} \tag{83}$$

Where, X_{st} represents additional exogenous variables like human capital. Dynamic panel regression in difference form has been run on the data. The regression results are presented in Table 1. Note that the interaction terms of $lntr$ (logarithm of trade) both

with LR (defined by $lnY - lnL$) and BR (defined by $(s_L^U - 1)(lnL - lnK)$) are found to be negative and significant. These definition was used by Dobbelaere (2004). This suggests that the trade reduces market power as well as bargaining power of workers. The result confirms our conjecture. Moreover, the investment price has direct and significant impact on the labor share. If the investment good prices fall quickly, the demand for investment goods would be more and that essentially displaces labor. This is what Piketty (2014) found. Hence, labor share declines. Moreover, the exchange rate (xr), defined national currency against USD, has also direct and significant effect on the share. A rise of exchange rate discourages trade but encourages capital mobility (or FDI or outsourcing) to the economy. This essentially raises the demand for labor and thereby the labor share.

Table 1: Trade on Labor Share across countries during 1954-2014: Dynamic Panel Regression

VARIABLES	(1) labsh	(2) labsh	(3) labsh
Capital (log)	0.005***	0.035***	0.042***
	(0.001)	(0.001)	(0.001)
Labour (log)	-0.007***	-0.035***	-0.043***
	(0.001)	(0.001)	(0.002)
Consumpt. goods price (log)	-0.008***	-0.001	-0.002*
	(0.001)	(0.001)	(0.001)
Invest. good prices (log)	0.011***	0.001*	0.002**
	(0.001)	(0.001)	(0.001)
Trade (log)	-0.004***	-0.001***	0.001***
	(0.000)	(0.000)	(0.000)
Human Capital	-0.045***	0.002	0.004**
	(0.001)	(0.002)	(0.002)
Exchange rate	0.001***	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
LR		-0.000	0.050***
		(0.001)	(0.004)
BR		-0.081***	-0.066***
		(0.001)	(0.001)
LR x Trade (log)			-0.002***
			(0.000)
BR x Trade (log)			-0.002***
			(0.000)
Constant	0.678***	0.590***	0.462***
	(0.006)	(0.009)	(0.012)
Observations	5,953	5,839	3,088
Number of country	116	116	63
Model	GMM-DPD	GMM-DPD	GMM-DPD

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1;
LR = lnY- lnK; BR = (S^{U}_{L} -1)(lnL-lnK); labsh = Labour share (% of gross value added)

Let us now examine whether trade affects market and bargaining power significantly as an alternative for robustness checking. It is a popular approach to estimate the degree of market imperfections by the regressing inputs on the residual of production. The standard approach is to regress these two terms along with the interaction of trade on Solow residual (defined by $(lny - lnK) - s_L^U(lnL - lnK)$. The residual should fall with the increase of competition and drop of bargaining power. Two terms, lr and br representing market power and bargaining power of labor, are interacted with trade share ($cshtr$, defined by trade out of GDP). The interaction term with LR is found to be negative, meaning that the increased trade share reduces the residue. Similarly, the interaction term with BR shows statistically significant and positive results, meaning that the trade weakens bargaining power of workers and thereby raises the residue (Table 2). These evidences support the conjecture that the trade weakens the bargaining power of workers.

Table 2: Trade and market powers across countries during 1954-2014

VARIABLES	(1) sr	(2) sr	(3) sr
LR	0.435***	0.436***	0.649***
	(0.002)	(0.003)	(0.003)
BR	-0.961***	-0.969***	-0.923***
	(0.001)	(0.001)	(0.001)
Capital (log)	0.481***	0.471***	0.622***
	(0.001)	(0.001)	(0.002)
LR* TR_SHARE		-0.048***	0.088***
		(0.004)	(0.004)
BR*TR_SHARE		0.003***	0.036***
		(0.001)	(0.001)
Human Capital			-0.378***
			(0.004)
Government Exp. (%)			0.179***
			(0.007)
TFP	0.487***	0.491***	
	(0.002)	(0.002)	
Constant	3.984***	4.112***	3.394***
	(0.007)	(0.008)	(0.014)
Observations	5,953	5,953	5,953
Number of countries	116	116	116
Model	GMM-DPD	GMM-DPD	GMM-DPD

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
sr = Solow Residual; LR = lnY- lnK; BR = $(S^{U}_{L} -1)$(lnL-lnK)

7 Concluding Remarks

The question of technology change and productivity rise on the labor absorption capacity is dominant in the existing literature while investigating any policy implication on the distributive share of workers. This paper investigates whether trade influences both product and labour market conditions in such a way that affects the distributive share of labor without considering strong substitutability assumption in the production function. Using a generalised oligopoly framework the paper incorporated both heterogeneity and strategic competition of trade and have been able to capture the effects of market size, competition and specialization arising out of trade with union and without union. Assuming fixed number of firms belonging to each sector for homogeneous production, the strategic competition is included. The difference between sectoral productivities between two countries offers to estimate the degree of specialization and competition between them. The joint effects of market size, competition and specialisation determine the wage. It is observed that the trade tends to raise wage, but not necessarily the labor share in absence of labor market imperfections. Since the labor market is not perfect in this case, unemployment and informal sector do not exist. Hence, we introduce a union using right-to-manage model. With the introduction of labour market imperfection, this paper finds that both union wage and labor share decline substantially in response to trade in the presence of unemployment. Because, the joint effect of market size and competition after trade cannot increase the wage as in the case without union. But, the degree of specialization adversely affects them unambiguously. The firms that are more productive demand less labor after trade and hence the wage tends to fall. We applied a translog specification to derive the expression for labor share from country-level production function. Then, two terms representing product and labor market imperfections are added to capture the influence of trade. We find the interaction terms of trade with these market imperfections are negative and significant. This suggests that the trade increases market competition as well as reduces bargaining power of workers, which explains the declining labor share.

Interesting, a competitive policy encouraging the entry in the domestic market can raise wages under some conditions. However, it cannot reach the autarky level due to the presence of its retaliation effects across countries. Because, the demand rise arising out of entry is diverted to the foreign economy and that too at the higher rate with the greater degree of specialization. By restricting trade, one can ensure higher wage and labor share but it is at the cost of lower output. Moreover, the union wage gain may be higher than that without union and it can further restrict employment and the resultant share.

However, if foreign country adopts the same competitive strategy, then the wage can go upto the autarky level and share can rise. In case the foreign country does not adopt the policy, if the domestic economy raises the trade barriers the wage and labor share can both rise but at the cost of lower output. Hence, this justifies the need for bilateral and multilateral agreements for joint adoption of a competitive policy under liberaized environment so that both countries can reap up its benefits for the labor market.

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