ISSN No. 2454 - 1427

CDE
October 2018

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Working Paper No. 292

http://www.cdedse.org/pdf/work292.pdf

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Abstract

This paper shows that, redistributing the cost-price margin between workers and firms, the trade affects distribute share of labour differently between the cases with and without union under heterogeneity. 'Generalised oligopoly framework' is applied to capture the impact of trade on wage and labour share through three channels - market size, strategic competition and specialisation. It is found that market size and competition effects jointly raise both wage and labour share without heterogeneity and labour union. But, the degree of specialisation (or comparative advantage) arising out of heterogeneous productivity distribution across sectors between trading partners dampens the labour demand with union unambiguously, but not necessarily without union. However, domestic entry in response to competitive policy recover wage and but cannot push upto the autarky level. Further, the wage rise may not necessarily be higher with union than that without union. An expression for labour share is derived from translog specification with additional terms capturing market imperfections for empirical verification. The results on cross-country panel data during 1954 to 2014 confirm that the trade weakens bargaining position of workers and explains the declining labour share significantly.
JEL Code: F16, L11
Key words: Trade, Union, Generalised Oligopoly, Market Imperfection, Labour Share

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[1]The earlier draft of this paper is presented at the international conference on Labour Share in Asia, held at Asian Development Bank Institute, Tokyo, Japan during 11-12th June 2018. I acknowledge the support received from ADBI for the visit to attend the conference. I must thank Gerry Field and Saumik Paul for providing useful comments. I also thank the organiser for the hospitality and other logistic supports provided during the visit. Usual disclaimers apply.

1 Introduction

It is evident that the labour share of workers engaged in the industrial sectors and of the national income 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 labour share in most of the countries and that has led to a recognition it as a important economic and social issue of the present time. In the advanced economies, it is observed that labour income shares began to trend down from around 1980s and reached their lowest level experienced in the past half century prior to the global financial crisis of 200809 (Dao et al., 2017). According to an ILO study in 2017, the labour share of national income, in terms of total earnings for all employees and self-employed, in Europe has declined from 75 percent of national income during 1970s to 65 percent in the recent years. OECD countries have also experienced a sharp fall from 64 percent to 59 percent during the same period (Sweeney, 2017). On the other hand, the IMF study shows that the share drops from a much lower 55 percent of national income to 50 percent (for advanced countries). In a sample of 35 advanced economies between 1991 and 2014, the labour share declined in 19, which accounted for 78 percent of GDP in 2014. This is not limited to the developed countries. In a sample of 54 emerging market and developing economies on average, the decline in the labour share over the sample period is concentrated in the early 1990s. The labour share declined in 32 economies, which accounted for about 70 percent of emerging market GDP in 2014. 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 market and developing economies, the sharpest decline was observed in agriculture. However, there has been substantial deviation of the pace and pattern of labour share across countries (Dao et al., 2017). The declining labour share of national income is, of course, accompanied by the huge rise in the share going to the owners of capital and a small elite of employees within the labour share. After the global financial crisis, the rising trend of unemployment all over the world led to investigate the pace and pattern of distributive share of labour and driving forces working behind it. While the scholars are engaged in finding responsible factors, this work attempts to investigate whether the trade plays any role both on wage and labour share when both product and labour markets are imperfect in a generalised oligopoly framework. Because, the trade expands the market size and increases the competitions between the domestic and foreign firms. In addition, the most productive firms in the distribution in both countries tend to release lower demand for labour and that has implication on the wage, which depends on the degree of comparative advantage over others. The resultant impact of these three forces must depend on the labour and product market conditions. So, this work extents Neary (2016), by introducing labour market imperfections, which could show the change in labour share along with the existence of unemployment and informal sector. No other framework could account for the impact of all the three channels.

While modelling trade theories, although heterogeneity has become integral part, but is considered in the environment of monopolistic or perfectly competitive framework to a large extent, which cannot capture strategic competition. Hence, both monopolistic and perfect competitions are not suitable environment to investigate the impact of trade on the distributive conflict. Because, there is no room for any surplus for profit earn-

ers that could be negotiated by workers. It is evident that the firms enjoy a degree of market power. Using a detailed aggregated 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 increased in most of the countries. Using a different dataset, two more recent studies (namely Weche and Wambach, 2018 and Calligaris, Criscuolo, and Marcolin, 2017) also find similar results. In addition, it is also evident that workers are not symmetrically affected by trade liberalization across countries, because they are not identical and the labour market is not frictionless. Therefore, scholars attempted to model labour market rigidity using mainly the frameworks, namely workforce composition (Yealpe, 2005), search and matching frictions (Davidson et al., 2008), efficiency wages (Amiti and Davis,2012) etc. 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 a source of comparative advantage and this shapes the impact of trade liberalization on aggregate unemployment. Following this tradition, the present work include such labour imperfections in the presence to union who care for 'right-to-manage' production. Neary (2016) ignores this and hence could not explain the existence of unemployment or informal sector.

The distributive conflict between labour and capital is the most perennial problem in the literature. The sharp declining labour share in the recent years generates renewed attention among the scholars on the topic. Several explanations have been put-forward for the explanation of decline in the contemporary literature. Technological progress, automation, global integration, off-shoring, regulatory reforms are dominant factors among all. While these factors are not strictly disjointed from each other, the productivity growth driven by technological progress, which remains at the heart of the degree of substitutability between labour and capital, still seems to be playing the detrimental role. For example, Grossman et al. (2018) argue that the slow-down of productivity growth in the recent years in US is responsible for the declining share. On the other hand, IMF (2017) viewed the rising productivity growth during the last three decades for the same. These results indicate that the labour share is somehow correlated to the dynamics of labour productivity.

In an old and influencing 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 somewhat reflected in the current phase of technological progress led by information and telecommunications innovations and automations. In recent article, Acemoglu and Restrepo (2018) argues that automation of those tasks that were previously performed by labour is the root cause for a permanent reduction in the labour share. Moreover, although the price of capital goods declines as a result of the past innovations, but such technological progress substitutes 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. For a variety of reasons, aggregate savings have grown globally relative to the national incomes that has accelerated capital-to-output ratios. Autor et al. (2017) and Kehrig and Vincent (2017) further argue that

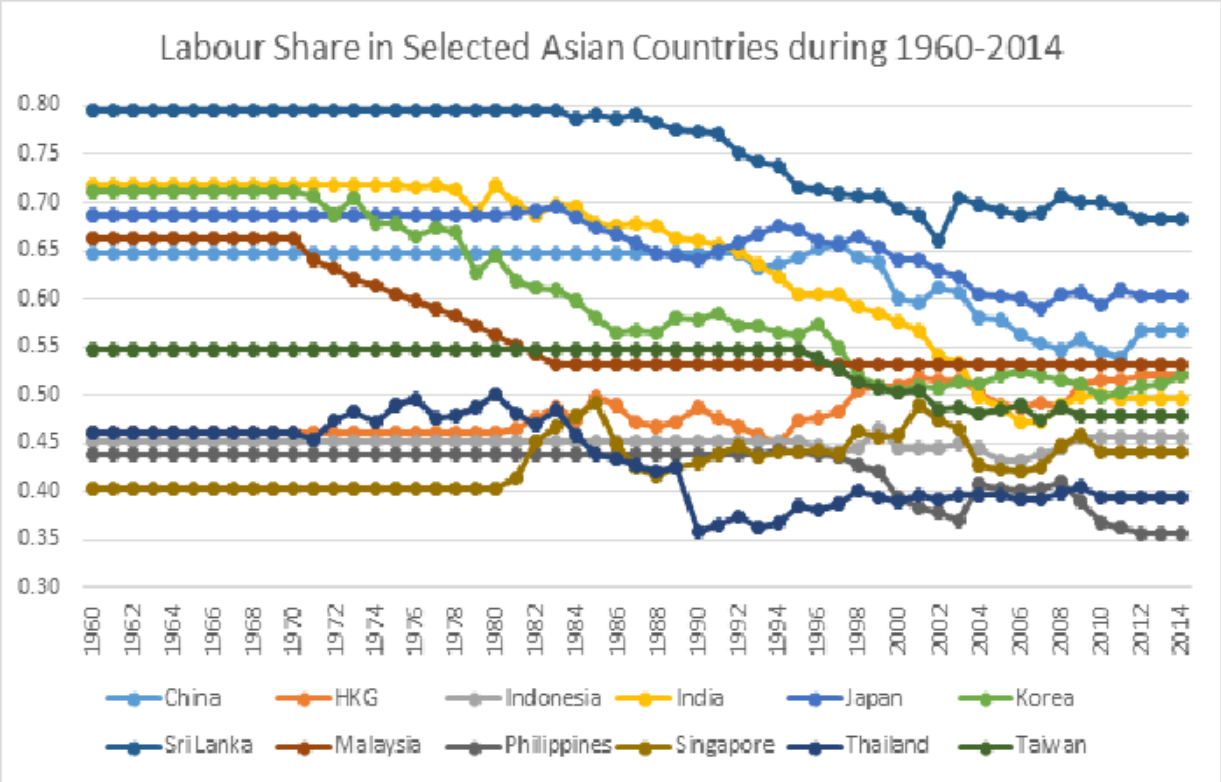
the fall in the labour share is driven by the rising industry concentration and the growing dominance of superstar firms. Barkai (2016) and De Loecker and Eeckhout (2017) find that gains in the profit share that reflect in the increased markups. Grossman et al. (2018) find that a one percentage point slowdown in the growth rate of per capita income can account for about one half of the observed decline in global labour shares. However, the productivity decline does not ensure a drop of labour share when the labour share is defined in terms of the ratio between real wage and labour productivity. There are other explanations as well. Most economies are engaged in tax reform to encourage the industrial activities during the last couple of decades. The decline in corporate taxation rates in the reform process raises inter-country competition to attract capital in a globalized world, where capital is freely mobile (Rodrik 1998). Hence, the current paper attempts to investigate whether increased trade changes the relative bargaining position of workers and capital owners over the use of labour-capital composition.

It is observed that the increased off-shoring and participation in global value chain have fuelled the declined trend (Feenstra and Hanson,1997). While this could explain the falling labour share in the developed countries, they may not be true for the emerging and developing countries. There must be a set of common factors working behind the secular declining trend (Figure 1). When we look at the trend of labour 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. 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. The trade definitely change the market conditions and thereby redistributes the resources and payments in such a way that it would make an impact of the labour share.

Rodrik (1997) and later Slaughter (2001) find that trade weakens the bargaining position of workers, causing a drop of labour share. Because the unionization rates and labours bargaining power might have been declined as a result of trade integration (Rodrik, 1997; Elsby et al., 2013). A Firm-level study on China indicates that firms in the industries experienced tariff cuts raised labours 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 enter and, thus reduces unemployment. In addition, the product market deregulation reduces the incentives for workers. Keil et al. (2007) undertook a similar kind of study for Belgium firms and found that the rise in liberalization has led to a reduction in the union bargaining power and greater share of distributive rents in favour of firm owners.

On the other hand, 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. 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, labour-intensive firms but a reduction in this share in the case of larger, less labour-intensive firms. On the other hand, Dutt (2007) showed that workers employed in industries with high tariffs received higher wages than apparently identical workers in low-tariff industries during 1983-2000.

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



Source: Peen World Table Version 9.0

While the empirical results seem to show a robust impact of trade on the labour and market powers and on the distributive shares, the theoretical results are quite different. They are highly influenced by the assumptions on the market conditions. Since it is evident that firms engaged in trade tend to enjoy a certain level of market power as the entry is limited due to the presence of various restrictions. When firms earns certain level of profits, they must face strategic competitions from rivals and union in the labour market as well. Hence, we apply 'generalised oligopoly framework'. This framework accommodates strategic competition among a set of continuum heterogeneous firms who face union that counts 'right-to-manage' the production. The sectors vary in terms of productivities. In each sector, there are fixed number of competitors. 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 whether labour market is unionised or not. If the joint effects increase the production and thereby raise the labour demand, it essentially fuels union wage when there is no union. But, the union in the industrial sector bargains for a rent. This creates an extra distortion and could be responsible for unemployment or the existence of informal sector as well. As a result, the benefit accrued by the firms tends to be lower when the labour market is rigid enough not to accept a lower level of employment and wage to be paid to the workers. The profitability of firm and rate of capital formation depend on the degree of labour market rigidity (Blanchand and Giavazzi, 2003). However, the union negotiates for higher wage in response to the additional demand arising with the integration. The higher wage raises cost and thereby discourages production leading a fall in labour demand. The demand for labour is finally adjusted to the level where the wage rate remains as before.

On the other hand, each economy would enjoy a certain level of comparative advantage due to the presence of difference in technology distribution between the countries. After the trade, the market of the most productive firms rises who requires less labour. 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 labour market frictions. But, it unambiguously depresses wage when workers are unionised. The movement of bargaining power plays very vital role in determining the level of impact. On the other hand, the implication of trade on the distributive share is not straightforward. Because, the change in market condition after trade influences employment in the presence of union, not otherwise. Accommodating the employment effect, it is observed that the distributive share of workers fall in both cases. Neary (2016) observed that when trade takes place the firms who are more productive are able to contribute much. If this prevails, it could dominate over other forces on the demand for workers.

Therefore, using the 'generalised oligopoly framework', this paper shows that the trade unambiguously has negative effect on both wage and labour 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 occurring 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 labour shrinks and this inevitably reduces the bargaining power of workers. In the absence of union, since the market size effect can increase the wage, the net effect is ambiguous. On the other hand, an increase in domestic entry due to various competitive policies may lead to an increase in domestic wage, but cannot push upto the level of auturky. Moreover, the wage rise in the presence of union may not necessarily be higher than that without union. In spite of the ambiguity of the wage movement in response to trade, the labour share drops unambiguously in this case as well. An attempt has been made to empirical investigate the results. An expression for labour share is derived from country-level of production function of translog type and two terms capturing market and labour 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 labour share.

The rest of the paper has been organized as follows. Section 2 outlines literature relevant for the topic and section provides a theoretical frameworks. Then, the empirical framework of estimation of mark-up and bargaining powers on the labour share are discussed in section 3. Section 4 ends up with concluding remarks.

2 Literature

As far as the impact of trade on wage and labour share is concerned there is substantial dis-aggrements among the scholars in the theoretical literature. It received a renewed interest with the upsurge of research on firm heterogeneity. Whole literature can be summarised into four generations of trade theories that have relevant on the distributive share of workers. The favourable impact of trade on the share has been dominant in the literature. First, the Ricardian model accounted for the effect of comparative advantage arising out of technology difference on the gains from trade in perfectly competitive environment. But, this is ill-suited to address this question, 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 the favourable effect of trade on workers if it is abundant factor in the economy in a perfectively competitive environment (Jones, 1971). But, these theories fail to account for competition and size effects. The second generation of theoretical exercises discuss the possibility of gains from trade under homogeneous conditions in two forms of markets - monopolistically competitive and oligopoly. The results are highly influenced by the assumption of market conditions. On the whole, 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). Krugman (1980) offers pioneering framework, using Dixit-Stiglitz utility setting of differentiated goods, to analyse the gains from trade between similar countries that occurs through 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. Following this tradition, Brander and Spencer (1988) show, however, how union limits the gains from trade under strategic competition. But, theoretical results do have provided unambiguous conclusion. Huizinga (1993) and Srensen (1993) show that the unionised wage is higher under autarky than under free trade. According to Acemoglu et al. (2001), unions benefit by encouraging productive training, and such training is incentive compatible for firms only when the wage structure is compressed. Alternatively, collective decision making within a 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 rise unionized wage. Bastos and Kreickemeier (2009) find 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.

Third, although this framework analyses various forms of strategic competitions, they have been often criticised that they use either partial equilibrium framework or are relied on homogeneity. If the firms are assumed to be heterogeneous in terms of productivities or technologies while catering differentiated goods to the consumers, the Krugmen effects of competition and scale seem to be absent from the gains from trade (Melitz, 2003). This led to incorporate variable mark-ups across industries (McMillan, 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 distributions in terms of productivities plays a detrimental role in the gains. However, such favourable impact of trade on the wage and distributive share of workers has not been uniform across all sectors and types of labours. It depends not only on the relative strength of market size and competition effects but also on the extent of labour reallocation within the industries and across industries (Melitz and Ottaviano, 2008). Since the final price declines after trade, the workers tend benefit in real terms at the aggregate level. However, the trade has differential impacts on the mark-up across industries and the resultant demand from workers.

This form of modelling with heterogeneity becomes workhorse for modern trade theories to find answer of various questions arising out of trade. More importantly, this allows to capture variable mark-up effects of pro-competition of trade. 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 of 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 labour 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.

According to this tradition, the opening of trade leads to a larger 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 us-

ing heterogeneity and variable mark-ups. They are models 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 into a CES demand (Edmund et al., (2012) etc. However, they do not specifically model labour 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 framework could not even prescribe any specific policy suggestion required on market reform for the desired outcome. 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 at 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. These two forces could go against each other. On top of this, the outputs of most productive firms would be selected more by the trade (through comparative advantage effects) and this leads to shrink the market share for labour intensive industries. If the competition effect along with comparative advantage dominate the market size effect, the net demand from labour and wage can rise. The wage rise could be so high that may improve the distributive share of workers. Neary (2016) demonstrates that if the competition and comparative advantage effects dominate the market size effect of trade under identical situation between trading partners, the net effect could raise the wage but may even tilt down the labour share. But, Neary (2016) does not consider neither labour market frictions nor show the existence of unemployment.

3 The Model

This paper applies the generalised oligopoly model in the presence of product and labour 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 differentiates the demand function from the one used in monopolistic competitive environment must capture the effect of retaliation from any rival. 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 to be producing the homogeneous good in each sector, z. It is assumed that the entry to each sector is restricted and hence the competition is confined within the limited number of firms in each sector. This allows them to draw positive surplus and hence the labour finds scope to bargain 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 determines 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 lead to a drop in the marginal utility of money. This derivation endogenises 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 labour 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, the presence and absence of labour union is supposed to be the key in influencing the resultant labour 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 labour 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 labour requirements, lower is the productivity and sectoral output. There must be some sector where labour requirement is such a high, it may not be profitable. Hence, 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 lower 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 labour market imperfection is supposed to show differential outcomes under the autarky and trade. In order to investigate them, two cases will be compared with the presence and absence of union. For the sake of conveniences, we assume that the workers from each take part in a centralised union. We can consider sector specific decentralised union. But, this will offer an intermediate solution between two extreme cases and hence can be ignored here. The existence of a strong centralised union is evident in the developed European countries (Chowdhury,1994). Evidences of centralised 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 labour market. Hence, all workers in the economy are employed. The issue of unemployment and informal sector does not arise then. If L is labour force available in the economy, the equality between labour 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 per unit f labour requirement 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 an union that takes members from all sectors and try to earn a rent from the production surplus. When the market expands, the demand for workers rises and the union negotiates too 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 has a utility function that counts 'right-to-manage' the production. They maximise wage rent with an outside option working at 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:

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

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 labour 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 labour 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 always 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 rival in a sector (given same μ_1 and μ_2), greater would be demand for labour without union and lower would be 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 unionised wage (given the outside option,

w_0). Because, more firms create additional demand for labour without union. In the presence of union, the increased demand encourages bargaining power 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 labour 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 is negatively related to the second moment of the distribution. In the presence of higher first moment, the demand for labour rises. Higher the dispersion of technology in the presence of high productive firms along with low productive ones reduces demand for labour 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 what would be the impact on wage and labour share, seen in the exist the literature on Krugman tradition. In addition to them, an effect of comparative advantage, arising out of difference in productivity distribution between two countries, would play an important role. Because, firms who are highly productive receive less competition and demand less workers as well. Hence, it makes differential outcome in the labour market in the presence and absence of unions.

Under the free trade, the aggregate demand faced by each firm would simply be addition of demands from two country 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 labour market so that one can see the differences. It is now also important to understand that the degree of product market competition affecting labour market depends on the level of specialisation or competition to be seen over the continuum of sectors.

Sectoral specialisation depends on the labour costs per unit of production, similar to the Ricardian definition of comparative advantage. The marginal cost of labour in a sector depends on labour requirement ($\alpha(z)$) and wage after trade (w_T^*). Since the labour requirement in the respective sector is assumed to be fixed, the degree of specialisation or competition essentially depends on the market wage and technology. There is no other cost in order to trade and transport goods. We assume that each sector requires an exogenously fixed labour 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 at producing goods with lower value of z and foreign country is more efficient at producing goods with higher value 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 will help us to define degree of specialisation and comparative advantage over sectoral productions across countries.

Let us now try to specify how specialisation patterns based on the marginal or labour costs in home and foreign countries that are influenced by the market condition and the union presence. Given the fixed labour per units 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 equilibrium outputs and international market price for each sector using cournot competition game. 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 labour cost and directly related to the rival costs. 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 labour 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 using a lower level of technology so that they cannot derive sufficient marginal revenue to meet the marginal costs in order to remain in one market, but not in the other. In this case, the economy which has better technology enjoys comparative advantage over other and will be fully specialised on some sectors.

In order to find the range of specialisation and competition between the two rival groups over the range of z, we find a boarder line sector who manages to survive respectively in both domestic and foreign economies. They could be drawn from their

respective profit expressions and 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 so along 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 value of marginal cost of domestic firm for a sector, z, against that of foreign rivals where the profit of domestic firm should be 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 of the axis of marginal cost of domestic firms and then rises gradually thereafter along with the marginal cost of foreign firm. For any sector z with the 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 would prefer to produce in this region (say F). In this region of z, the foreign firm specialises. If this critical z along the locus CC is defined by $\tilde{z}$, then the foreign country specialises 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 is represented as follows (along the locus C^*C^*):

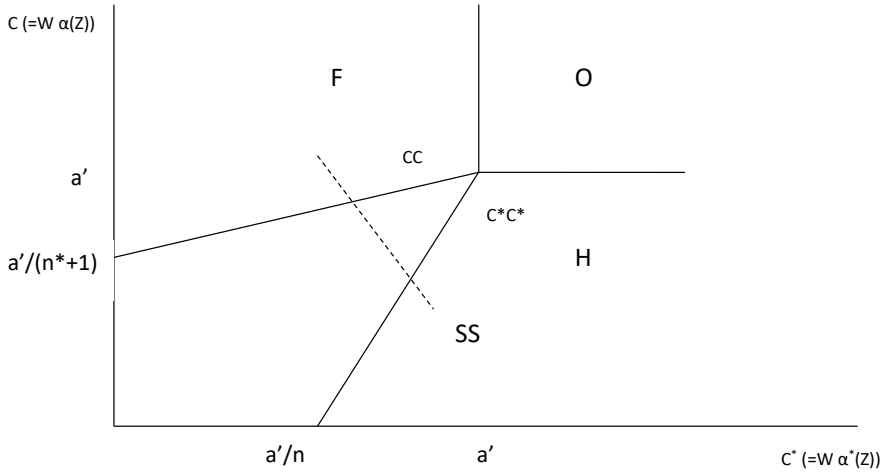
$$w\alpha(z)|_{\Pi^*(z)=0} = -\frac{\acute{a}}{n} + \frac{n+1}{n} w^*\alpha^*(z) \tag{20}$$

This condition is satisfied along the line C^*C^*, originating at a negative value of 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 gets zero (at a positive value in 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 reason. If the threshold value of z along the locus C^*C^* is defined by $\tilde{z^*}$, then the domestic economy specialise 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 for $\tilde{z^*} < z < \tilde{z}$. In each sector, there will be Cournot competition between n domestic and n^* foreign firms.

The range of competition and specialisation discussed above is very much influenced by the marginal cost 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 labour 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

has 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 factor 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 specialisation



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 labour 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 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 labour requirements, at least, for some sectors could be different in two countries, meaning that the comparative advantage of producing some goods would be higher in one country in comparison to 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 catures 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 from two respects. (i) the domestic firm can now face the foreign market and vice versa. This is reflected to a fall in the slope of 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 have gone up. The slope of perceived demand function has fallen from $\frac{b}{\lambda}$ to $\frac{b}{2\lambda}$.

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

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

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

It is interesting to note that the dissimilarity of technology or comparative advantage now influences the sector 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 requires now less labour and thereby has implication on the equilibrium wage. The wage is supposed to differ under labour 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 labour 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 labour union, we can derive the wage in the domestic economy from the equality of labour demand and supply conditions as follows.

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

Comparing this with the autarky wage in the absence of 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, the demand for labour rises leading to a rise of the wage. *Second*, the number of competitors has now been doubled also. 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 net rise of 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 labour might leave the market. As a result, the wage tends to fall. If this 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:

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

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 labour 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 and brings the wage into the previous level and the union maintains the wage at the monopsony level. The reduced price due to increased international competition is compensated fully by the rise of the market size. As a result, the joint effect of these two forces appears to be nothing on the wage rise.

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 the 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 labour. The productive firm require less labour and hence depresses the wage. In total, therefore, 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:

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

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

Again, multiplying labour 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 labour 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 in the presence and absence of union would be narrowed down 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 competition 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 Labour Share

A drop of absolute wage in the presence of union cannot assure the directional change of distributive share of workers after trade. If the labour share is defined by the ratio of total wage bills paid to the workers out of the total income, it can be written as $s = \frac{wL}{I}$, where W =wage rate, L=employment and I =total income. 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 bill rises faster than profits the labour share must rise. It is most convenient way to show the distributive conflict between wage and profit earners. We shall derive this ratio separately between two regimes for the comparison. 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 labour 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 labour 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 in the absence of 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 labour 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 the 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 labour 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 labour share rise after trade in the absence of union and specialisation.

In the presence of union, the wage does not change, but the employment is affected. When we compare the labour share between two regimes in the presence of 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 of 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 labour share after trade with union and in the absence of comparative advantage must rise. These shares will be compared with the ones after trade.

***Lemma 4**: If $\delta = 0$, then $\frac{\theta_T^U|\delta=0}{\theta_a^U} = \frac{2n+1}{n+1} > 1$.*

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

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

$$Hdln\Pi_T^* = -2[a\mu_1 - \{\mu_2 + 2(n+1)n\delta\}w_T^*]w_T^* dlnw_T^* + 2n(n+1)\delta(w_T^*)^2 dln\delta \quad (45)$$

where, $H = a^2 - 2a\mu_1 w_T^* + \{\mu_2 + 2n(n+1)\delta\}(w_T^*)^2$. This suggests that the profit 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

$$Hln\theta_T^N = [a^2 - \{\mu_2 + 2n(n+1)\delta\}(w_T^N)^2]dlnw_T^N - 2n(n+1)\delta(w_T^N)^2 dln\delta \quad (46)$$

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 logarithmically differentiation of wage equation in this case, we get $dlnw_T^N = -\frac{n\delta}{\mu_2 + n\delta} dln\delta$. This confirms again a rise of comparative advantage reduces the wage after trade.

Substituting these into the above expression, we write

$$H\frac{dln\theta_T^N}{dln\delta} = -[a^2 + (2n+1)\mu_2(w_T^N)^2]\frac{n\delta}{\mu_2 + n\delta} < 0 \quad (47)$$

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. One can argue that the wage share fall 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 bit different from the one without union. At the w_T^U, 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

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

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.

On the other hand, we have already seen before that the comparative advantage has positive impact on the aggregate profits both directly. Since the absolute union wage declines in this case, the profit rise as an indirect of comparative advantage as well. Therefore, the net effect of the comparative advantage on the profit much be greater than the one without union. But, the overall effect of wage share depends the relative strength of indirect effect of its in wage bills against others. Taking difference between the changes in wage bills and aggregate profits, we get

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

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 labour share. Because, this reduces demand for workers and thereby reduces wage and thereby 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 wage declines in the presence of union, the employment increases as a result. So, the net effect depends on their relative strengths of 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:

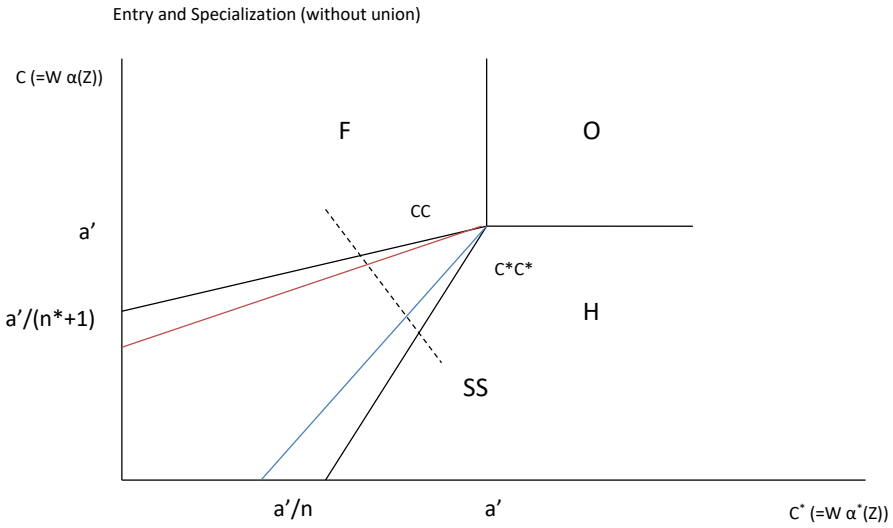
$$\frac{dln\theta_T^U}{dln\delta} = -\frac{n\delta w_T^U(a^2+(1+2n)\mu_2 w_T^U)(a\mu_1 - (n\delta+\mu_2))}{(n\delta+\mu_2)GH} < 0 \tag{52}$$

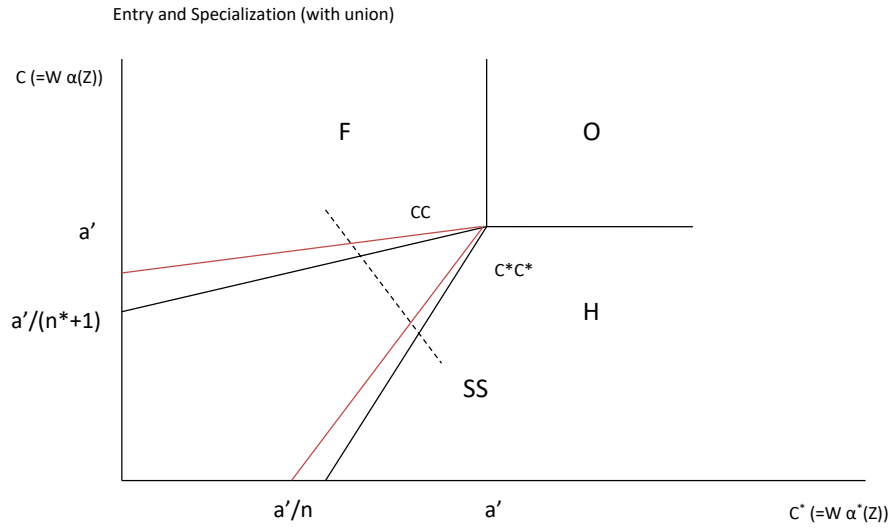
This confirms that the total effect of comparative advantage has been adverse on the labour share unambiguously. Although the trade reduces the wage rate, it does not necessarily depresses the aggregate wage bills. Because, the lower wage rate raises the aggregate employment. At the same time, the lower wage leads to a drop in price and 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 leading to a drop in 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 in the presence and absence of union, the labour share falls unambiguously in both case due to direct and indirect effects wage change via specialisation. But, the share does not fall in the absence of specialisation.*

Therefore, it is found that the labour share rises after trade due to the composite effects of market size and competition and in the absent 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 labour share after trade. This result is different from Neary (2016) on two

accounts. One, the composite effects of market size and competition do not raise absolute wage in the presence both product and labour market imperfections. This is not true when labour market imperfection is ignored. Second, this explains the reason behind the presence unemployment along with a declining labour share in number of countries. Third, the ex-post degree of comparative advantage moves in opposite directions. Since the wage declines in the presence of union, the locus of threshold level of z moves opposite directions. The firms with z who were just immediate outside ex-ante threshold (or at autarky wage) can be able to survive. As a result, the degree of competition between two countries rises and the specialisation falls in presence of labour market imperfection. On the other hand, the wage can rise in the absence of union and hence, the degree of competition may fall, leading to a rise of country specialisations respectively (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 entry can rise. Or, the increased international competition can generate a spillover effect that may reduce fixed costs and hence encourage some entry in each sector. Let us discuss the implication of domestic entry on the equilibrium wage. The entry affects the demand for labour and the resultant wage. But, this is not straight forward. Because, any change in wage

or marginal cost has implication on the degree of specialisation and competition. The change in specialisation has further implication the labour income.

When the domestic economy specialises on 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 labour 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 labour demand from the specialised 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 compete 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 capture the demand for labour from those sectors where the foreign firms specialises and the second terms includes the demand from competitive sectors. The demand for foreign labour is negative related to own wage and directly related to the domestic wage.

From the expressions for outputs, the threshold sectors in each country, 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 demand for labour after accounting for competition and specialisation 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 specialisation on the labour 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: $L^D_{\tilde{z}} = n\alpha(\tilde{z})y(\tilde{z}) = 0$ since $y(\tilde{z}) = 0$. Similarly, $L^D_{\tilde{z^*}} = \alpha(\tilde{z^*})[x(\tilde{z^*} - ny(\tilde{z^*}) = 0$ since $x(\tilde{z^*} - ny(\tilde{z^*}) = 0$

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

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

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

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

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

So, the foreign labour 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 would also effect labour demand in both the economies indirectly through the changes in wages. Taking the partial derivative of labour demand with respective to w, we get

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

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

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

As the domestic entry reduces the demand for foreign labour, this diminishes the foreign wage. The drop in wage would recover 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 labour 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 supplies of labour without any rigidity. Then, from the equilibrium conditions, the total change of demand due to wage effects can be represented as follows:

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

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

Even if the change in marginal cost of production affects degree of specialisation, we prove that the change in specialisation does not influence the labour 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 response to proportional change of domestic entry. 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 over the cross-effects in home and foreign labour demands and the positive own-effect of n on home labour 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 demand for domestic demand for labour 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 increase production costs. And, the domestic economy loose specialisation. On the whole, there would be a fall in the domestic demand. Moreover, the wage rise cannot push 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 in 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 labour 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

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

Once 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 that seen in the autarky.

Proposition 4 *The domestic entry raises the domestic wage relative to the foreign. The union wage gain is not unambiguously higher than that without union due to the cross-wage and specialisation effects. Both wage cannot reach upto the level of autarky for the same.*

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 labour share tend to rise in response to the domestic entry.

6 Empirical Analysis

It seems really difficult to demonstrate the effect of each channels originated from trade on the labour 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 specialisation 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 needs to be answered is whether the trade affects the labour share through the change in product and labour market imperfections. A general form of country level production function is assumed to get an expression for labour share and then two market imperfections terms with the interaction of 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 homogeneity condition. The function enables us to derive a flexible expression of labour 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 of labour elasticity represents labour share when there is no market imperfection. Since we are interested to investigate the effects of product and labour market imperfections, we modify this expression and relax the homogeneity condition. If market imperfections only prevail in the product market, the wage is not paid according to the value of marginal physical products, rather is equal to the marginal value of revenue products. Then, the factor share would be different from the elasticity. If the price over marginal cost is defined by μ, then it is to show that $s_L = \mu s_L^M$. Here, s_L^M represents the labour share when the product market is imperfect. Since, the firm tends to raise the price over the marginal cost, the labour 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 labour markets, a rise of bargaining power of workers tends to reduce the labour 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 labour share in the presence of both product and labour 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 in 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 a rise of L (given K) or wage (given same value addition). The coefficient of this variable captures the bargaining power of labour union. Adding these two terms in the labour 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 regress in difference form have been run on the data. The regression results are presented in Table 1. Note that the interaction terms of lntr (ln trade) both with LR (defined by $lnY - lnL$) and BR (defined by $(s_L^U - 1)(lnL - lnK)$) are negative and significant. These definition were used by Dobbelaere (2004). This suggests that the trade reduces market power as well as bargaining power workers. The result confirms our conjecture. Moreover, the investment price has direct and significant impact of the labour share. If the investment good prices fall fast, the demand for investment goods would be more that essentially displace labour. This is what Piketty (2014) found. Hence, labour 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 labour and thereby the labour share.

Table 1: Trade on Labour 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. Standard way is done by regressing 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 labour, are interacted with trade share (cshtr, defined by trade out of GDP). The interaction term with LR is negative, meaning that the increased trade share reduces the residue. Similarly, the interaction term with BR shows statistically significant and positive, meaning that the trade weakens bargaining power of workers and thereby raises the residue (Table 2). These evidences supports 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

Trade changes both product and labour market conditions in such a way that it affects the distributive share of labour. Conventionally, the relative strength of market size and competition effects are dealt with the trade impact on the distributive share of workers ignoring the firm heterogeneity. At the same time, the contemporary works of firm heterogeneity, based on the assumption of monopolistic competition, ignore the issues of strategic competition. Both these approaches seem to argue that the trade has favourable effect on the wage and labour share. Neary (2016) provides a generalised oligopoly framework by accommodating both components. Firms differ in terms of labour productivities across sectors. But, firms belong to one sector are homogeneous and fixed. The difference between sectoral productivities between two countries offers to estimate the degree of specialisation and competition between them. The joint effects of market size, competition and specialisation determine the wage and hence affect the degree of specialisation. Using this approach, Neary (2016) finds that the trade tends to raise wage, but not necessarily the labour share in absence of labour market imperfections. Since the labour market is not perfect and unemployment and informal sector exist, we introduce union in the framework. With the introduction of labour market imperfection, this paper finds that both wage and labour share decline substantially in response to trade. Because, the joint effect of market size and competition after trade cannot push up the wage further in the presence of union as in the case without union. But, the degree of specialisation adversely affects them unambiguously. The firms who are are productive demand less after trade and hence the wage tends to fall. Note that the union wage could be lower than that without union if the number of competitors are significantly high. Any competitive policy encouraging the entry in the domestic market only can raise wages under some conditions. However, it cannot reach the autarky level in the presence cross-country demand and specialisation effects. Because, the demand rise arising out of entry would be shifted to foreign economy and that too at the higher rate with the greater degree of specialisation. Moreover, the union wage gain may not necessarily be higher than that without union. We applied a translog specification to derive the expression for labour share. Then, two terms representing product and labour 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 has explained the declining labour share.

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